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THIRST FOR MARKETS

Criteria for successful water trade

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ABSTRACT

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Purpose: The purpose of this thesis is to investigate the need for a trading place for water. The aim of the thesis is to present a number of criteria needed for water trade to progress in a larger scale and in order for futures markets for water to develop. Since trading places for water barely exists, the thesis will fill a gap in current research of the area. It will further provide a basic understanding for industry people, scholars and researchers on how the water market will develop and progress in the coming years.

Methodology: We have used a comparative approach and compared different cases in a qualitative manner. From our theoretical framework we identified 10 criteria we believe to be necessary for trade. The criteria are verified against our empirical results. In order to analyze our gathered information we have chosen to create two matrixes to serve as a framework and create an overview.

Theories: We have chosen to use trade theories as well as theories of commodities suited for trade and futures trading theories

Empirical Results: Our empirical results are gathered from six different components. Three of them are commodities sharing similar characteristics to water, and the other three are areas where water trade occurs.

Conclusion: We have concluded that all the criteria are more or less important in order for successful water trade to arise but the most significant proved to be demand and supply.

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1. INTRODUCTION

In the opening chapter a background on the thesis subject will be presented, as well as a discussion about the problems surrounding the subject. Further, a framing of the thesis major question, its purpose and limitations are accounted for. Finally, the thesis' contribution to further research and its disposition is provided.

1.1 BACKGROUND

In 1776, Adam Smith described in his well renowned book *Wealth of Nations* the paradox of Water and Diamonds;

"The word value, it is to be observed, has two different meanings, and sometimes expresses the utility of some particular object, and sometimes the power of purchasing other goods which the possession of that object conveys. The one may be called value in use; the other, value in exchange. The things which have the greatest value in use have frequently little or no value in exchange; and, on the contrary, those which have the greatest value in exchange have frequently little or no value in use. Nothing is more useful than water; but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it"
(Smith, 1776. book I, chapter IV).

Not much has changed as for the value in use of water since 1776 when Adam Smith wrote these famous words. Water is still extremely valuable in use and vital to human survival and for all living creatures on earth. In production, it is the one component commonly denominated no matter what type of products is produced and virtually every business has some sort of need for water (IBM, 2010). Water can therefore be thought of as the most important substance on our planet.

And the planet actually does have water in abundance. However, although about 70 percent of the world is covered in water, only 2.5 percent of that is fresh water. From that fresh water, nearly 70 percent is frozen and most of the rest is present as soil water or deeply underground groundwater that is not accessible to human use. As a result, only about 0.007 percent of the world's total water supply is accessible for direct human use. This is water found in river, lakes and water reservoirs. (University of Michigan, 2000)

According to University of Michigan (2000) the water supply available for human use today is part of a closed circular flow cycle and is renewable through rain and snowfall. This water is therefore the only water that is available to us on a sustainable basis (University of Michigan, 2000). This makes fresh water supplies partly a finite resource and there are limited options to increasing it (UNESCO, 2009). However, what is changing every day is the quality of existing water supplies, for example through chemical contaminations (IBM, 2010).

The UNEP report on the “Global Environment Outlook” (2002) states that there are three major factors contributing to increases in water demand. These are “population growth, industrial development and the expansion of irrigated agriculture” (UNEP, 2002). Another pressing issue is that the agriculture industry uses more than 70 percent of the available freshwater today, of which a substantial part is groundwater (UNEP, 2002). As demand rises on freshwater, farmers are pumping groundwater off the ground in a higher pace than can be naturally recharged by the earth (UNEP, 2002). This form of “overpumping” can for example lead to salt-water intrusion in coastal areas (UNEP, 2002) and, in a way, freshwater supplies are decreasing as demand for freshwater is increasing.

In Europe, the city of Barcelona has lately experienced a threat towards their water supplies as demand has risen (BFSC, 2011). Floods and draughts are the main reasons that supplies are endangered to shortages (BFSC, 2011). In 2008, Barcelona was forced to import a shipload of almost 23 million liters of drinking water from Tarragona and Marseille, to support the water needs for 180 000 people for one day (Keeley, 2009). At the cost of € 22 million, six shiploads were to follow every month for three months (Keeley, 2009). According to Keeley (2009) other countries that are rich of water are now beginning to export water. For example Turkey exports water to Israel, France supplies Algeria with millions of gallons of water and Russia, New Zealand, Norway and Scotland are all considering exporting water (Keeley, 2009).

Thus, we can see that trade with water is emerging. Even trade with water derivatives are increasing in certain areas in the world. One may wonder why this market is not larger. Far less essential commodities than water are available to investors through a various range of derivatives – options, futures swaps etc. Even environmental related commodities, such as carbon credits, are being introduced, so why not water? (CMEgroup, 2010)

In Australia, a market place for water has been a controversial topic since the early 1990s. The origins of the water trade dates back much longer but had a somewhat different objective when it was implemented. It was implemented as a mean for Australia as country to grow and prosper, when it today it is a tool to manage scarcity of freshwater resources. Today it is one of the most important tools in Australia to manage scarcity of fresh water resources. (Turrall, 2005)

There are great risks associated with water. One pressing issue is what will happen as water supplies get contaminated. What can Japan do if their water supplies turn out to be radioactive, and the earthquake and subsequent tsunami of March 2011 has destroyed important infrastructure and consequently left people in many regions without access to fresh water? In this case the United Kingdom has stepped in, providing Japan with one hundred tons of bottled emergency water in response to an urgent request from the Japanese authorities. (Purt, 2011)

This tragic incident is hopefully a one-time experience for Japan but for other countries, these kinds of water shortage related risks are an every-day fact. Due to extreme drought and deterioration of renewable aquifers in the Middle East, all countries in the Gulf Cooperation Council (GCC) are dependent on desalinated water as a main source for domestic use. The dependency makes the plants very vulnerable to pollution and emergency conditions. If a desalination plant breaks down peoples' lives are at risk since they cannot survive without water. There are in many GCC countries only as little as 24 hours of emergency water reserves for domestic use. (Landais, 2007)

1.2 DISCUSSION OF PROBLEMS

Water scarcity is a reality; the constantly fast-growing population of the world in combination with changes in the climate and natural disasters increases the water demand and decreases the water supplies (2030 Water Resource Group, 2009).

The term scarcity for renewable resources, fresh water included, has several dimensions. In physical terms scarcity arise either through a decline in supply, an increase in demand or through a change in relative access to the resource from one party to another¹ (Homer-Dixon, 1999). However, Wolfe & Brooks (2003) states that this view does not reflect how human beings tend to use or misuse the resource. Therefore, in order to handle the severe problems of water

¹ Referred to as supply-induced, demand-induced and structural scarcities

scarcity, one has to take into consideration a dimension of the resource endowment, and the socio-economic context of its use (Wolfe & Brooks, 2003).

Studies suggest climate change accounts for 20% of increase in water shortages in the world (UN/WWAP, 2003) and even if this might be a generalized statement on a world perspective it is still a source of uncertainty.

There are limited options in increasing the fresh water supply and even if desalination would increase with 5 times by the year 2050 it would still only account for 1 % of the available? fresh water supply (MS-S B, 2010). The problem lies to a great extent in finding ways to enhance the existing supplies. Arguments for implementing a market for water and let the mechanics of price bring balance in supply and demand is one option (The Economist, 2010).

Water prices rarely reflect scarcity even when it comes to the most arid markets. To come up with a valuation of water, various issues need to be addressed. For example, the dependability of the resource, the dependability of the suppliers, the processes of moving it and the cost structure in relationship to other options is such issues. In the long term, availability will be more important than cost as we can really sense the impacts of the climate change. (Szydlowski, 2011)

Water pricing is in fact a political and ethical issue. People are in general opposed to pricing water, especially in politically sensitive segments and households. Therefore, water is often massively underpriced (UNESCO, 2009). This is yet another reason of why the emergence of trade with water derivatives has been so slow. Water is both complex and interesting and it has the further complication of therefore being very political (Szydlowski, 2011). The emotional and symbolic elements versus the economic function makes supply and demand different and more complex than most other commodities (Hanneman, 2005).

Apart from that, there are several obstacles with water as a tradable asset. There are great difficulties involved in measuring moving and storing fresh water. Lack of information regarding water use, quality and quantity in most countries makes it very challenging to handle decision-making and look at long term planning. (UNESCO, 2009)

Another reason why trade with water and water derivatives to date has not been fully developed is due to a lack of physical transaction possibilities of the underlying asset - water, in the financial market (Szydlowski, 2011).

1.2 QUESTION/QUESTIONS

Based on the background, and the problems identified and discussed above, we have outlined a (thesis) question, on which we will base our research and finally attempt to answer with our results.

Which criteria are needed in order for a water trading market to develop?

1.3 PURPOSE

The purpose of this thesis is to investigate how a trading place for water may evolve. The aim of the thesis is to present a number of criteria needed for water trade to progress in a larger scale and in order for futures markets for water to develop. Since trading places for water barely exists, the thesis will fill a gap in current research of the area. It will further provide a basic understanding for industry people, scholars and researchers on how the water market will develop and progress in the coming years.

1.4 LIMITATIONS

In regards to time and space, the thesis has limited its research to use a comparative method as to analyze the already existing water trading markets of three specific areas in the world. The thesis has also limited the number of comparison components to water to three subjects. These components will be compared to water as to find similarities. Further, the thesis is limited to only researching the regular commodity trade market developments of these areas and commodities, as well as the development of futures contracts of these subjects.

There are many available theories of trade and its many aspects. As a result of the purpose, we have limited the theories as to focus mainly on evolution of commodities markets and futures markets. In addition, we will use theories, of which commodities are adaptable to trade, and the benefits and costs of future markets.

1.5 THEORETICAL CONTRIBUTIONS

As described above, water is an indispensable resource that is absolutely vital for all organic and human survival. The fact that the world's water supplies is so unevenly distributed among countries and regions makes it an interesting subject to research in the aim of investigating how marketplaces for water arises. Further, we find it is most interesting to study why trade with our most important resource not yet has emerged in a larger scale. In addition, very little research has been made on the emergence of commodity trading places, much less on trading places for water. We therefore see a knowledge gap that can be filled.

Because of the increasing threats to our environment we have been able to witness in recent years, we believe it is in order to raise a discussion of how we are going to allocate our most important natural resource in the coming years. In order for supply and demand to be balanced throughout the world, governments and decision makers all over the world need to address the issue of water management with utmost severity, and place it on top of their political agenda.

1.6 DISPOSITION

1. INTRODUCTION

In the opening chapter a background on the thesis subject will be presented, as well as a discussion about the problems surrounding the subject. Further, a framing of the thesis major question, its purpose and limitations are accounted for. Finally, the thesis' contribution to further research and its disposition is provided.

2. METHODOLOGY

This chapter will illustrate the model of the theoretical framework. Initially, the concept of trade will be presented. The focus of the first part of this chapter will be on commodity trading, as the second part will focus on futures trading. Theories of which commodities that are suitable for futures trading and international trade theory will be presented. Finally, we will present the criteria derived from the theories, and on which we will base the thesis

3. THEORETICAL FRAMEWORK

This chapter will illustrate the model of the theoretical framework. Initially, the concept of trade will be presented. The focus of the first part of this chapter will be on commodity trading, as the second part will focus on futures trading. Theories of which commodities that are suitable for futures trading and international trade theory will be presented. Finally, we will present the criteria derived from the theories, and on which we will base the thesis

4. EMPIRICAL RESULTS

This chapter presents the results of our empirical research. We will motivate the choices we have made in regards to the comparison components, and then present the results for each component. A section on water and its characteristics is located between commodities and the areas.

5. ANALYSIS

This chapter is devoted to an analysis of the empirical results we identified in the previous chapter. The chapter begins with two matrixes displaying an overview of the most important findings when comparing the comparison components to the criteria. The rest of the chapter will provide a deeper analysis, which outlined these matrixes.

6. DISCUSSION

In the final chapter we will discuss the issues we identified in the introductory chapter along with the knowledge gained throughout the process of this thesis. We will present our conclusion and our own thoughts of the subject. Lastly, we will provide some recommendations of further research.

2. RESEARCH STRATEGY

In this chapter the choice of research design, the approach and the chosen theories are presented, as well as a motivation as to how these will serve the purpose of the thesis. The process of data collection and the further analytical progression is also described here and finally, a critical analysis of the reliability and validity of the final thesis is performed.

2.1 RESEARCH DESIGN

As this thesis will explore how potential trading arenas for water can arise, there is not yet much data available on the subject. For this reason we have chosen to use a comparative approach and compare different cases in a qualitative manner. The fundamentals for applying a comparative approach is to be able to distinguish which characteristics of the assessed cases that are similar and which are different from each other, which will serve as ground for theoretical reflections. The main argument for using a comparative approach is that it facilitates the development of a new theory. (Bryman & Bell, 2005)

Bryman (2008) argues that to study the relationship between theory and research there are traditionally two main approaches. The deductive approach which derives observations and findings from existing theory, and the inductive approach which derives theory from existing observations and findings (Bryman, 2008). Today it is also common to speak of an abductive approach. The abductive approach is a mix of deduction and induction, and emanates in the research but does not reject theory (Alvesson & Sköldbberg, 1994).

The main focus with this thesis is to explain how market places for water (or water contracts) can arise. In order for a result to derive from this, information and observations will have to be examined first, and from that formulate a theory or some sort of results. However, since this is an unexplored subject we cannot disregard existing theories on the origins of other commodity trading places. The idea is to analyze other chosen commodities and compare them with water in order to find similarities and possible criteria which have to exist for trade to arise. The same will be done with different regions in the world in order to answer the question on what criteria that were needed for water market places to arise there. The conclusion is therefore drawn that the planned strategy for this thesis will best be successful using the abductive approach with a comparative character.

2.3 APPROACH

Based on the chosen subject and the methodology presented above we began this thesis by collecting articles, earlier research and general facts about the chosen comparison components. We made a compilation of the material in order to outline which theories to use and which commodities and areas that best would serve the purpose of this thesis.

2.3.1 Gathering of Facts/Results

Because there is limited research conveyed on the chosen subject, an extensive amount of secondary data from other similar analyses and research papers was gathered. Since the aim is to compare and contrast how trade with other commodities has emerged, considerations had to be taken about research already made by others.

There are substantial benefits with using “secondary” empirical findings for a comparative study. Primarily, it saves a lot of time and money since we, as researchers, do not have to conduct the initial data gathering. Instead, we have been able to collect the already processed data and use the relevant compilations. Since we further have a very limited time frame and budget, secondary data collection will serve as a good base in the working process. While using this approach more time could instead be spent on analyzing the empirical findings.

To get additional insights in the market of water today, primary data was collected from industrial insiders in the form of shorter interviews. This information will help us gain deeper understanding and an overview of the present market for water, and are used in the thesis as a support in areas where secondary may not be sufficient.

2.3.2 Choosing theories

The theories used are based on trade theories as well as theories of commodities suited for trade and futures trading theories. Even though the thesis will attempt to formulate a new theory, criteria for trade, from the empirical material, existing theories will have to be taken into consideration. Theories used in this study will emanate from theories within the field of commodity trade and trade with futures contracts. For the thesis to be credible and exhibit powerful results, a strong theoretical framework is required. There are a significant number of theories to use in this purpose and the chosen theories importance is motivated in this section.

To get a notion as to how commodity trade functions today, a general overview of how and where trade and commodity trade emerged is provided in the beginning of the theory chapter.

To intertwine the emergence of commodity trade with the emergence of future markets, Baer & Saxon's (1949) fundamental economic functions of a commodity exchange is presented. In addition, some theories on how futures markets develop are accounted for, as well as the costs and benefits of these. In order to understand which kind of commodities that is suitable for futures trade, we have added theories in this field as well.

2.3.3 Choosing empirical subjects

To investigate as to what kind of geographical conditions that has to be present for trade to arise, we have made a deeper analysis on some of the few existing market places for water in the world. Similarly, in order to study water as a traded commodity, we have made a deeper analysis on some commodities that share one or more characteristics with water. To give the reader a deeper understanding about water characteristics and how it would act as a traded commodity, it is also relevant to discuss theories about water. The chosen commodities, areas and water theories/facts will be presented in chapter four. From this we have made a thorough analysis of all aspects in the theories and in our empirical findings.

2.3.4 Analytical process

In order to analyze our gathered information we have chosen to create two matrixes. The matrixes will serve as a useful tool in order to get an overview of the criteria we have identified in our theoretical framework in relationship with the empirical results from our commodities and areas respectively.

With our matrix as a framework we move towards a deeper analysis where we through a comparative analysis will try to find similarities, disparities and patterns among our subjects for comparison. We will make a deeper analysis in respect of each criterion and try to establish the degree of importance each criterion has in order to establish a market for water derivatives.

2.8 CRITIQUES

This thesis is made with a solid foundation of previous research material from scholars, researchers and industrial insiders, which make it highly reliable. The fact that we can account for how we how executed the work process is another factor as to the reliance of this study.

As to be sure to measure what we originally wanted to measure, we have planned a research strategy that will give validity to the work. We have thoroughly worked with keeping ourselves

updated with the whole process of the thesis as to be able to present the information as correct as possible. We have also presented the material to the interviewed object in order to accurately account for their contributions.

Our research is based on a limited number of three chosen commodities to compare to water and on three chosen markets for water trade. With this in mind, we have to emphasize that the results of this thesis cannot be generalized on any commodity. It might be possible to apply the criteria framework on other commodities that are on the verge of develop organized trading. However, this will not be analyzed in this thesis, and thus, the results of which criteria that are most important in organized water trade may not be applicable on other commodities.

3. THEORETICAL FRAMEWORK

This chapter will illustrate the model of the theoretical framework. Initially, the concept of trade will be presented. The focus of the first part of this chapter will be on commodity trading, as the second part will focus on futures trading. Theories of which commodities that are suitable for futures trading and international trade theory will be presented. Finally, we will present the criteria derived from the theories, and on which we will base the thesis

3.1 TRADE

In this section we have identified theories and empirical findings developed by other authors and scholars that we believe to be important for understanding the origins and evolution of commodity trade and futures contracts.

3.1.1 Introduction to commodity trade

Trading dates back a long time. People in ancient societies had virtually the same needs for trading commodities on a central marketplace as we have today. They also had the same need for timely and transparent information as modern corporations today face. (CBOT, 2006)

The earliest form of trade was carried out through bartering. However, barter is a state that gravely limits the extent of the exchange, through volume and efficiency. To eliminate the limitations of barter, ancient societies used seashells, tobacco or furs as money or a common denominator as to measure wealth and value. These, the earliest kinds of money were seriously exposed to risks, such as destruction and deterioration and thus, lost in value. (Baer & Saxon, 1949)

As a consequence, different metals were introduced as a medium of exchange. According to Baer & Saxon (1949) these metals had “all the essential characteristics of a satisfactory medium of exchange, namely, relatively high value in small bulk, durability without risk of loss from shrinkage or deterioration, relative scarcity, and ready adaptability to storage or safe-keeping at small expense”.

Although trading with metals as money had eliminated certain risks concerning potential value losses of the physical capital, as well as facilitated trade between countries and regions, there were still risks from external factors that would influence the value of the metal money. For

fiscal and political reasons the government had a great impact of the value of the money and could use devices to manipulate its value. (Baer & Saxon, 1949)

As the economic and political climate stabilized in the world, and as transportations and communications facilitated, the volume of trade expanded and eventually led to the organization of specialized commodity trade markets. Organized trade on the New York Stock Exchange was formally first attempted in 1792. The world's most important commodity exchange, the Chicago Board of Trade, was officially organized in 1848, and did fully function as a grain cash market in 1865. (Baer & Saxon, 1949)

3.1.2 The economic functions of the commodity exchange

Bear and Saxon (1949) concludes that "Commodity Exchanges not only are vital to a free economy, but they serve a much more important function than do Stock Exchanges. The Commodity Exchanges, however, not only provide constant liquidity for the basic staple commodities traded upon these Exchanges, but they also perform other vital economic functions which are not served by Stock Exchanges". They further establish five fundamental economic functions, all of which an exchange possesses. These are:

1. The insurance function – The exchange provides liquidity and price stability through the large funds available in the market. It further gives options of protection against adverse price changes, known as hedging. Lastly, the exchange controls that all contract made through the exchange are withheld, that is that the parties keep their commitments regarding payment and delivery.

2. The financing function – The liquidity of commodities provide banks more incentive to give liberal loans and acts as a safeguard to them. The ability to finance and insure commodities against price changes enables producers, dealers and manufacturers to work with smaller margins, which will benefit the final customer.

3. The price registration function – Information Technology focuses on following price influences in the world, which makes all futures exchange markets in the world interconnected. Because of the large volumes often being traded, risk-bearing speculations that could influence the price are carefully evaluated before prices are changed. The interpretation of news concerning commodities, made by stakeholders, assures a certain degree of anticipation of future trends, which may not otherwise be possible.

4. The publicity and Information function – The exchanges gathers information from all available and reliable sources and present them in an unbiased manner for the public. This information is available to the public, and also to interested parties in a business transaction concerning prices, delivery dates etc., as well as future trends. This helps potential clients to make well informed decisions with a higher degree of certainty regarding their purchases and sales.

5. The regulatory function – The exchange regulates speculation and provides a conduct as to act in the lines with existing public interest. It also provides guidelines concerning grading, quality and inspection of the commodities traded. The exchange itself establishes, enforces and settles disputes that have risen from transactions on the exchanges through guidelines provided by the exchange.

3.2 TRADING WITH FUTURE CONTRACTS

Commodity exchanges can, in theory, be thought of as an insurance device to hedge and transfer market and credit risks for those who wish to do so (Baer & Saxon, 1949). For this purpose futures trading with standardized contracts have a large impact in the trade of commodities in the world.

3.2.1 Origins and evolution of futures markets

Trade in Chicago developed mainly due to the city's strategic location at the base of the Great Lakes and close to the Midwest's favorable farmlands for cultivating crops and grains. (Chicago was also an important rail road center at this time). For these reasons the Chicago Board of Trade grew rapidly. The always present risks of crop failure and reoccurring problems with supply and demand imbalances resulted often in seasonal surpluses and the Chicago Board of Trade soon faced large storage problems. This also led to very volatile prices of the traded grains. Another pressing issue was the transportation difficulties that affected the Chicago Boards of Trade due to extreme weather conditions and poor maintenance of the roads surrounding Chicago. (CBOT, 2006)

For these reasons trade with contracts with forward delivery began to develop (CBOT, 2006). The earliest forward contract recorded on The Chicago Board of Trade was in 1851 (CME group, 2007). Forward contracts are not standardized contracts, and must be negotiated each time a buyer and a seller engages in a trading deal (CBOT, 2006). Thus, these contracts gave the parties flexibility to design the contracts after whatever specific needs that prevailed the transactions.

After the introduction of forward contracts, the development of futures contracts followed quickly (CBOT, 2006). Forward contracts had the disadvantages of not being standardized in grades and quantities and buyers sometimes faced problems with sellers who did not fulfill agreements (CBOT, 2006). The Chicago Board of Trade adopted formal rules concerning futures trading in 1865² (CME group, 2007). These standardized contracts also made it possible to cancel out obligations by taking an offsetting position in another contract (Williams, 1982).

One of the most important features of organized trade is, in fact, that of the standardization of contracts and trade terms. At the start of contract trade with a commodity there will be many different standardized contracts available on the market, but slowly as the commodity grows in size it will take advantage of the interconnection of the world and move towards a point when there will only be a limited number of standard contracts on the market. It will probably never be possible to reduce trade in a commodity to one single standard contract. (Baer & Saxon, 1949)

Another important feature of organized contract trade is the standardization of grades and qualities. This makes up an international standard of the quality of the commodity, which all producers have to conform. Buyers can thus be sure on what sort of produce quality to receive. (Baer & Saxon, 1949)

3.2.2 The accepted account

In his book "Evolution of futures markets", Harold S. Irwin (1954) finds that trade on markets, and eventually with forwards and futures had evolved through a slow process from advanced spot markets. His analysis also shows that futures trading evolved gradually to meet specific marketing needs. In practice, this meant that in each instance analyzed

[...] time contracts that preceded organized trading arose in response to marketing needs, developed over a period of years as the commodity market grew in size and complexity, and ripened into organized futures trading. In each instance the organized trading then showed considerable evolution before reaching its full stature. (Irwin, 1954, p.5)

Irwin (1954) bases his study on the evolution of futures contracts of eggs and butters, which he states has evolved through similar processes.

² It should, however, be noted that as early as 1730 the Dojima rice exchange in Tokyo was officially authorized to start trading with rice futures and is usually mentioned as the first functioning futures exchange market in the world (West, 2000).

It is evident of Irwin's (1954) findings that the marketing of eggs and butters facilitated with organized trade, and that time contracts were very helpful in expanding trade of these products. Even though trade was withheld by refrigerated (or stored) products, it clearly helped with the merchandising of these products when sold fresh.

Lastly, Irwin (1954) also learned that it was the produce merchants that were the initiators of the development of futures markets. Evolution of futures contracts clearly arose from the added problems resulting from the accumulation of seasonal surpluses by dealers. Irwin's (1954) views on growth and process of futures trade became somewhat of an accepted account of how futures markets evolve.

Burns in 1979, as cited in Williams (1982), believed that "an economy and its markets become increasingly specialized: from rudimentary local spot markets to centralized spot markets, to forward markets, to futures markets and decentralized spot markets, and to option markets for futures and actuals". This truly verifies Irwin's beliefs.

Williams (1982) himself, however, is of another view and believes that the accepted history of futures markets is not correct. He argues that forward contracts were present in different areas of the world before 1847 and did not develop from advanced spot markets, thus criticizing the importance of organized exchanges. He uses the example of "the flour squeeze"³ in New York 1847 to illustrate his point. (Williams, 1982)

However, Williams (1982) summarizes his study by concluding that the precise events that led up to the evolution of the modern day futures market is not important. Rather, the focus should be placed on the fundamental need to trade for future delivery.

3.2.3 Organized future markets, costs and benefits

One may wonder why, of all hundreds of thousands of commodities in the world, only a few has been traded on forwards and futures markets. Telser & Higinbotham (1977) tries to answer this question with the theory of money and compares the futures contract with money, as a medium of exchange. That is, future contracts facilitate trade in organized markets similar to money in ordinary barter trade. They make the following comparison "a futures contract is to forward contract as payment in currency is to payment by check" and quotes the work of Working (1953,

³ See Williams, J., C. 1982. *The Origins of Futures Markets*. Agricultural History, vol. 56, no. 1. Symposium on the history of agricultural trade and marketing

1967) when stating that futures contracts provide a “temporary abode of purchasing power in terms of the commodity” (Telser & Higinbotham, 1977, p. 972). This view, and not the general view that futures markets enables traders to hedge risk, would be the true benefit of an organized futures market according to Telser & Higinbotham (1977).

Another of Telser & Higinbotham’s (1977) arguments is that any commodity that is not made to order benefits from an introduction to futures trade. The important factor here is however the cost of futures trade for each commodity. Therefore, only commodities with a positive net benefit will be traded on future exchange markets.

There are certain factors that increase the benefits of futures contracts and organized markets. The number of participants on the market place, and the fact that they are strangers to one another is examples of these factors. If there are a small number of participants that know each other, there would be little use for a futures contract. (Telser & Higinbotham, 1977)

If, however, the members of an exchange have problems relying on the integrity of their potential clients, the number of participants in the market may increase to such a high number that it will incur disproportionate costs for the exchange (Telser & Higinbotham, 1977). That is, members will seek other participants for business transactions than their usual clients.

Another issue relating confidence between buyers and sellers on the market place is the possibility of lemons problem that occur when different parties have different information regarding a product (Akerlof, 1970). A well organized futures market can, however, decrease these problems of moral hazard and their related costs by introducing a standard contract on a product (Telser & Higinbotham, 1977). Thus, Telser & Higinbotham’s (1977) results shows that the net benefits of an organized exchange is an increasing function of the number of potential participants on the exchange. These results do, however, not satisfactory explain why futures trade are not carried out on more commodities.

3.3 COMMODITIES ADAPTABLE FOR FUTURES TRADING

To try to answer the question as to why futures trade is only established for certain commodities, Baer & Saxon (1949) has outlined some characteristics the commodity itself must possess for trade to be possible. They state that “the reason (for trade) cannot be found in the

relative importance or value of the commodity in question”, but rather in the nature of the commodity (Baer & Saxon, 1949, Ch. VI). These are;

1. *Units must be homogeneous*
2. *The commodity must be susceptible of standardization of grades*
3. *Supply and demand must be large*

World-wide demand. Supply and demand should at least be large enough to assure that the futures exchange market can function as a continuous and orderly market, and not just for speculations.

4. *The supply must flow naturally to the market*

Free from artificial restraints by governments or private agencies. That is, the supply or the price of the commodity cannot be under effective control by groups, cartels, governments or companies. In that case the futures market would merely work as an adjunct to the arbitrary will of the controller. Perfect competition.

5. *Supply and demand must be uncertain*

Makes the relationship between supply and demand to constantly change, and thus produces the constant fluctuations that are necessary for a futures market to be successful.

6. *The commodity must not be perishable*

The commodity must be able to be stored at all times and for considerable periods, so as to not deteriorate.

A commodity may still possess all these characteristics without being traded on the futures market. The conditions presented above must be present, as well as a condition in the trade and the related industry to make futures trade a natural development from ordinary commodity trade. It should further be noted that the conditions can vary with different commodities. (Baer & Saxon, 1949)

3.4 CRITERIA

Based on our theoretical framework we have identified certain criteria that we believe are essential for a futures trade with commodities to arise. Our choices have been based on events in the historical evolution of trade and future we believe have been vital for a commodity market. We have also taken into consideration theoreticians’ findings when analyzing these events. These are;

NEED / DEMAND

SUPPLY

DEPENDABILITY OF THE RESOURCE

GEOGRAPHIC CONDITIONS

POLITICAL CLIMATE / REGULATORY FRAMEWORK

OWNERSHIP OF THE ASSET

STANDARDIZATION

DEVELOPED INFORMATION SYSTEM

INFRASTRUCTURE

PRICE

In the next chapter we will account for our empirical results based on areas where trade with water exists, as well as commodities that have similarities with water. These will help us verify the degree of importance of our chosen criteria.

4. EMPIRICAL RESULTS

This chapter presents the results of our empirical research. We will motivate the choices we have made in regards to the comparison components, and then present the results for each component. A section on water and its characteristics is located between commodities and the areas.

4.1 CHOICE OF COMMODITIES FOR COMPARISON

The commodities we have chosen to research are presented in this section. These commodities are chosen based on the fact that they each have at least one characteristic in common with water. The chosen commodities are presented partly with a focus on the commodity trade evolved, and partly with a focus on how futures contract trade started. Our findings are based on the criteria presented in the previous chapter and will later be used for comparison in order to establish our final results.

As oil is one of the world's most important commodities, we find it appropriate to compare it with water, which also is described in a section. Similar to water, oil is vital in most industrial processes and demand increases with globalization. Further, oil and water share the characteristic of being a finite resource. That is, oil cannot be reproduced.

Rice is one of the major produced grains in the world and essential as nutrition to a substantial part of the world population. In addition, the fact that rice is highly dependent on large quantities of water makes it a good reference for comparison. Since the world's first functioning futures exchange is said to have traded in rice, it will give a valuable insight in how the world's first contract trade started.

Carbon Emission Rights are chosen as a comparison to water because of the environmental aspect of water trade. Water scarcity is highly interlinked with climate changes that derives from carbon emissions and global warming. Because of the recent introduction of carbon emissions rights on the New York Mercantile Exchange and the fact that it is still under development it will give an up to date observation over how futures trade arise

4.2 OIL

Usage of oil dates back to about 4000 years BC when the people in ancient Babylon used asphalt in construction of buildings. Azerbadjan was one of the first oil-producing countries in the world. By 347 AD oil was drilled with bamboo from wells in China. (Chisholm, 1911)

The crude oil we use today is a composition of molecules created by carbon and hydrogen atoms (Hyne, 2001). There are two types of oils; organic and mineral oils. Organic oils are oils produced by plants, animals and other organisms through organic processes. Mineral oils are found in soil and below the earths' surface. These oils originated from fossils of organic organisms accumulated on the seafloor through thousands of years. Through geochemical processes these substances has converted in to crude oil, or petroleum. Today, petroleum is the substance that usually springs to mind when hearing the word oil.

According to Hyne (2001) there are several geological conditions that have to be met in order to manage a commercial deposit of crude oil. These are conditions that have to do with the actual composition of the sub-surface beneath the land of where the oil is drilled. Thus, where these conditions are met, crude oil drilling can be carried out (Hyne, 2001). The top oil producers today are Russia, Saudi Arabia, United States, Iran and China (CIA, 2009).

Different types of crude oil have variations in viscosity and in appearance depending on what field or area they are found in. There are variations in colour, odour and in their molecular structure. Classifications on different types of crude oils are based on the American Petroleum Institute (API) gravity scale (Oilprices, 2010). The API scale is based on pure water and gives water an assigned denomination of 10°. Since oil is lighter than water it has API degree levels greater than 10°. (Encyclopædia Britannica, 2011)

As mentioned above trade with oil on a "spot-basis" has been carried out since ancient times and demand has increased as the scope of use has widened. Trading with oil futures, however, originates from the second half of the 1900th century, when a petroleum exchange existed in New York. In 1930 another market place for oil was established in California. These soon shut down due to a restoration in the market place as a result of a big alliance by the largest oil companies and the government. After this, prices remained somewhat stable for four decades, and there was no need for a futures market. (Elting, 2000)

In September 1960 five oil producing countries formed an organization called OPEC (Organization of the Petroleum Exporting Countries), which would give the member countries⁴ the right to “exercise permanent sovereignty over their natural resources in the interest of their national development” (OPEC, 2011). OPEC's objective is “to co-ordinate and unify petroleum policies among Member Countries, in order to secure fair and stable prices for petroleum producers; an efficient, economic and regular supply of petroleum to consuming nations; and a fair return on capital to those investing in the industry”. In 1973 a series of macro environmental shocks⁵ in the world impacted oil prices which became very volatile. (OPEC, 2011)

First in 1978, NYMEX reintroduced oil futures in the form of the No. 2 heating oil contract and the No. 6 fuel oil contract. The fuel contract never gained any support and stopped trading. The heating oil contract, on the other hand, progressed quickly and the significant price increases of 1979 and 1980 are proof of this. (Clubley, 1998)

Since the reintroduction prices on oil has remained volatile (McMahon, 2011). One of the reasons is that OPEC lost a relatively large part of their dominance on the world market⁶, and thus prices were not influenced of as much control as they had been. However, while prices continued to be volatile, demand and supply levels remained somewhat stable (Baumeister & Peersman, 2009). Baumeister & Peersman (2009) describes that for any small excess in demand or supply, a large jump in oil prices is recognized.

Most contract trade with crude oil is made for hedging purposes and there is usually several parties participating in one trading chain. Even the large oil companies and refiners engage in trade. Oil is traded on futures and on spot markets all around the world and is a widely traded international commodity. (Clubley, 1998)

Oil is a substance that can be environmentally threatening when handled incorrectly. Recent year's oil accidents can witness this. The environmental effects of the explosion on the oil rig Deep Water Horizon in 2010 are now being assessed. The accident resulted in a spillage of 4.9 million barrels of oil, as well as the death of 11 people and countless animals (BBC, 2011). Even though the accident, called the worst natural disaster in American history, occurred a year ago it

⁴ Iran, Iraq, Kuwait, Saudi Arabia & Venezuela

⁵ The end of Bretton Woods, OPEC (Organization of Arab producing countries) proclaimed an oil embargo, OPEC decided to stabilize prices, the 1973-74 stock market crash, the Yom Kippur War between Syria and Egypt.

⁶ Some authors have accused OPEC for controlling prices through a price cartel, which collapse resulted in the decrease in dominance for OPEC. See for example Baumeister & Peerson (2009)

is still early to account for the full extent of the impacts it will have, even in the years to come (BBC, 2011). What is clear at this moment though, apart from the apparent environmental effects, is the heavy impact on people's life it has had. Many, who made a living using the resources of the sea, has had to find new job opportunities (KÄLLA). The accident will come to heavy costs to society and to the owner of Deepwater Horizon, British Petroleum (Szabo, 2010).

Since oil is a finite substance, development on alternative fuels has begun to emerge. A common apprehension is that there is no real substitute for crude oil (Hesler, 2008), and for all of its usage possibilities. However, emergence of substitutes for crude oil petroleum as a fuel is available, for example in the form of ethanol (Wharton Universia, 2006).

4.3 RICE

The Dojima futures exchange in Japan is usually referred to as the world's first futures exchange. At around 1600 Japan was ruled by a consortium of local shoguns⁷, led by Ieyasu Tokugawa. The Tokugawan government did not use one single currency, but three, gold coins, silver currency and copper coins. However, production of these currencies soon could not meet demand and people started to search for substitutes. Letters of credit or bills of exchange were sometimes used as a medium of exchange (West, 2000). After a while, because of the availability and the ease of measurement, rice became an accepted substitute to the metal currencies. Many feudal shoguns already collected taxes in rice and it was regularly used as a measure when the government made annual budgets (Wakita, 2001).

Sometime in the earlier part of the 17th century, people in the area around Tokyo began to trade rice with each other. The exact time is difficult to account for as there are many different observations and opinions in the matter. What is clear, however, is that depending on the respective rice shortages in different areas in Japan people began to trade rice futures to hedge the possibility of running out of stock (West, 2000). The fact that there were seasonal surpluses in some regions and a shortage of storage facilities also facilitated the emergence of futures trade. Soon the governing lords of the Japanese shogunate began to follow this example, and started issuing rice receipts. However, unlike other commodities, rice was already an accepted currency and hence people began trading only the receipts which received currency-like qualities independent from the underlying commodity, namely, the rice (West, 2000). Thus, the spot market at Dojima are sometimes considered an exchange of the rice receipts, and not of the actual rice itself (Takatsuki, 2007).

⁷ Shogun is the title of a Japanese general that lived sometime between ca 1200 -1880 AD.

The Dojima rice market was officially authorized to engage in futures trading in 1730 and was active until 1868 when the Takugawan era ended with the Meiji Restoration⁸ (West, 2000).

Today, rice is one of the most important commodities in the world, accounting for more than 20 percent of global calories consumed, and about 29 percent in low-income countries (Wailes, 2005). According to Dawe (2001, p. 164) “rice eaters comprise the bulk of the world’s poor”, emphasizing the dominance of rice as a staple good. Especially in Asia, where about 70 percent of the world poor people lives. Rice is also of great importance to the millions of farmers in Asia that together grow crop on millions of hectares, as well as for the many workers on the rice fields that derive their income from rice production (Dawe, 2001), or even receive their wage in rice (Calpe, 2002). Thus, one can appreciate the impacts government regulations, trading policies and environmental changes in these areas can have on people’s lives, both locally and globally.

As much as 90 percent of rice production is located in Asian countries, and just as much of the consumption occurs in the same countries (Wailes, 2005). As a result, most countries are self-sufficient in rice and only about 6, 5 percent of global consumption of rice is traded (Wailes, 2005).

With so much of the global rice production concentrated to one area, the world-wide rice supply is affected by local weather effects. In, Asia the monsoon weather is of particular concern to the rice production (Wailes, 2005). The US Rice Producers (USRPA, 2011) even mean that it is getting harder to forecast future rice production due to the extreme weather and climate changes that have been a fact the last decades. Thus, ensuring that supplies are going to be sufficient can be problematic.

The thinness of trade in rice depends to a large extent on the fact that governments in rice-producing countries use strict protection regulations to ensure food security and support to domestic producers (Wailes, 2005). At the same time, policymakers are generally concerned about the stability of domestic prices. Large price fluctuations in international prices in such an important commodity can lead to instability in the domestic political climate (Dawe, 2001).

⁸ A revolution that brought the fall of the Takugawa shogunate, and returned the control of the whole country to the emperor Meiji. This resulted in an era of major changes in the economic, political and social climate. Source: Encyclopedia Britannica.

Whether regulated or not, prices on rice are, and have been, very volatile (Dawe, 2001). Wailes (2005) states that it is the high level of government combined with the climate, geographic concentration and the small volumes traded that causes the volatility in rice prices.

Since then, rice trade has again developed through the trading of rice futures. China, the largest rice producer in the world, just recently started to trade with rice futures (People's Online Daily, 2009). Today, trading with rice futures is concentrated to exchanges in The United States, Thailand & China. These are in fact some of the world's largest rice exporters in the world (Workman, 2008).

Other countries are looking into starting trading with rice futures as well. Even though Japan has had an organized trading place for rice for as long as 300 years ago⁹, trading with rice futures today do not exist. Japan has recently applied to list rice futures on the Tokyo grain exchange, thus reviving their long time history of trading with rice futures (Reuters Africa 2011). Many believe that a rice futures exchange in Singapore could act as a global hub of rice futures and spot trading (The Australian, 2010). According to IRRI (2010, p.12)

[...]the successful development of a commodity futures market depends heavily on the legal structure of the contracts (and their perceived enforceability) and on access to modern financial markets to provide the underlying liquidity that makes a futures market useful to traders.

Singapore satisfies these criteria and can thus help stabilize prices and act as a safeguard to the world's poor (The Australian, 2010, IRRI, 2010).

India (the world's second largest rice producer) traded rice futures up until 2007, when the government banned trading after alleging that unsupervised futures trades had caused a severe inflation in the underlying commodity (Dow Jones, 2008). According to Reuters Africa (2011), India are now trying to relaunch rice futures contracts, but the Forward Markets Commission (FMC) do not believe that the Indian market is ready for this yet. The FMC states that it is difficult to create a benchmark contract in rice due to the many different varieties of rice (Reuters Africa, 2011).

Rice exists in a variety of types which in turn leads to a wide spectrum of qualities on rice. Rice trade, is thus, and differentiated by type, quality, degree of processing, and degree of milling. Since different types of rice need to be produced under different particular conditions farmers

⁹ Up until 1930 Japan, again, had a working futures market. This is however not covered in this thesis.

have a hard time switching the type of rice they are producing in order to respond to market price incentives. (Wailes, 2005)

4.4 CARBON EMISSION

As an action to mitigate climate change and reduce the potential effects of global warming development of market-based environmental policy instruments has emerged. This is one way to control pollution caused by industries and to limit the effects of the climate change. According to Stavins (2001, p. 2)

[...]in theory, if properly designed and implemented, market-based instruments allow any desired level of pollution cleanup to be realized at the lowest overall cost to society, by providing incentives for the greatest reductions in pollution by those firms that can achieve these reductions most cheaply.

Examples of these instruments include tradable permits, pollution charges, market friction reductions, and government subsidy reductions. There are two types of systems world-wide designed for these purposes, credit programs¹⁰ and cap-and-trade systems (Stavins, 2001)

Central authorities or governments set caps on the amount of emissions that are allowed to be emitted. The cap is sold to companies and specifies how much of a certain pollutant they can discharge (Stavins, 2001). The total number of permits a firm holds is equivalent to their total emissions. If a firm requires more permits they need to buy more from firms that do not take full advantage of their own permits (Stavins, 2001). This corresponds to economic theory in the way that for any level of emission control required, emissions trading can be carried out at a minimal cost to society, and thus resources will be optimally allocated (Voss, 2007).

Cap and trade systems were developed in the 1980's when they first appeared as a policy proposal by the US Environmental Protection Agency in order to introduce flexibility under the US Clean Air Act (Voss, 2007). It was later, in the mid-90s, introduced along discussions on the climate change in the Kyoto Protocol negotiations (Betsill & Hoffmann, 2011). However, at this time they were merely mentioned and little happened in the design of these instruments. Developments started to progress during the decade subsequent to the Kyoto Protocol by different interest groups, such as governments, states, cities and corporations (Betsill & Hoffmann, 2011).

¹⁰ Credit programs will not be covered in this thesis, for further reading see Stavins (2001)

In 1988, a group of policy entrepreneurs had initiated a project called “Project 88” as a way of finding “innovative solutions to major environmental and natural resource problems” (Voss, 2007). Project 88 was at this time a prototype of a system for emissions trading. Since the project would impact many different areas of society a number of interest groups had to participate on the project in order for it to function. In 1993, official rules for trading was authorized, and in 1994 a market had developed. Project 88 was designed in line with the cap and trade system and was state of the art at the time (Voss, 2007).

After the implementation of Project 88, emissions trading became accepted in the United States. It did, however, face concerns regarding political and ethical aspects, and gave rise to conflicts about alternative ways to limit emissions (Voss, 2007). The European Union, developing countries and environmentalists strongly objected to the cap and trade systems (Betsill & Hoffmann, 2011). This has resulted in several design improvements of these instruments since Project 88. As late as 1999 there was still resistance against emission trading systems internationally. In the United States, cap and trade systems has developed with other underlying assets, such as greenhouse gas emissions. Standardization in regards to the design of the instrument usually adapts with the present political climate (Voss, 2007).

The largest functioning cap and trade system is the European Union’s emission trading system. Although well functioning, the European trading system has been subject to fraud and corruption, as well as faced challenges during the recent financial crises (Betsill & Hoffmann, 2011)

4.5 WATER

We will start this chapter with a section of generalized water theories. We believe it is vital to understand what characteristics water possesses and how these can facilitate or aggravate trade with water and water derivatives.

4.5.1 Introduction to Water

The Oxford dictionary (2011) defines water as: “a colourless, transparent, odourless, liquid which forms the seas, lakes, rivers, and rain and is the basis of the fluids of living organisms.”

Although water may be perceived as a simple subject, it is vastly complex both in its physical and chemical properties. Water can appear in the forms of vapour, liquid and solid, and it has the

ability to dissolve many other substances. Water differs from other similar substances in that it has a higher melting and boiling point than would be expected in contrast to other comparable compounds. It has further the unusual property of being denser in its liquid form than in its solid form, thus making ice float on top of water. (Encyclopaedia Britannica, 2011)

Water is both cohesive and adhesive which means that the molecules attract both to each other and to other molecules in other materials (Seavey, 2002). Since water has no taste it makes it particularly sensitive to captivating flavours from other substances (Eriksson & Strömbäck, 2011).

Further, water is characterised by a dynamic and stochastic supply. It is both used consumptive and a non-consumptive, and requirements when it comes to quality vary depending on the purpose, since different users have different needs. The concept of quality appears to be disregarded in the formal determination of water rights. However, this may accurate in reality. (Colby, 1995)

Water goes beyond the bounds of jurisdictions set by agencies, states or even on a national level. The forces of gravity decide the flow and it has the ability to steep and to evaporate. This lack of control has complicated the defining of property rights. (Tisdell *et al*, 2002)

4.5.2 Economic conception of water

In order to develop an argument around the economic conception of water, one has to define the meaning of economic value. In his research from the 16th and 17th century, Hanneman (2005) identifies three key principles related to the meaning of economic value;

First, demand is separated from supply. Demand indicates what things are worth to people; supply indicates what things cost. Second, market price reflects the interaction of demand and supply and, in principle, is separate from each of them. Third, the value that people place on an item (the demand for the item) inevitably reflects their subjective preferences (Hanneman, 2005, p. 63).

Dupuit (1844) and, independently, Marshall (1879, 1890) were the first to point out the modern concept of difference between price and economic value. Their idea is defined in terms of a trade-off¹¹, distinguishing between marginal and total value. In general, marginal value declines with quantity and is not likely to be constant. This is the key resolution to what Smith (1776)

¹¹ The trade-off can be logically explained with the notions *maximum willingness to pay* according to Dupuit and Marshall and as a newer measurement *minimum willingness to accept* by Henderson (1941)

was lacking in his analysis in his water diamond paradox: water may at the margin have a smaller value than diamonds but it has without doubt a larger total value (Hanneman, 2005).

However, it was not until the 1970s this became accepted within modern economics and operational procedures to measure economic value separately from price became available. Water as a commodity played a role in these developments¹².

In Hanemann's (2005) article treating the economic conception of water he explains some distinctive physical and economic features distinguishing water from other goods making it more complex.

Water as a public good, water as a private good – Public goods are known for non-rivalry in consumption and non-excludability while consumption of public goods by one person often renders a smaller amount left for someone else. Water can be recognized both as a public and a private good depending on the context. Used at home it is a private good but *in situ* it is a public good.

The mobility of water – The mobility of water and particularly opportunities for sequential use makes it quite unique as a commodity. Since it is hard and expensive to keep track of water flows it complicates establishment and enforcement of property rights.

The variability of water – Water is very unevenly distributed across the globe, within countries and over seasons. This spatial distribution makes it very difficult to match demand with supply.

The cost of water – If you compare water with other commodities there are several distinctive features that make the supply more complicated. Relative to its value, water is expensive and bulky to transport and as a result, water infrastructure is not even close to as advanced as for other more valuable liquids such as petroleum.

The price of water – reflects, in the best cases the costs related to physical supply, for example operating costs. In many countries there is no charge for the water *per se* so the value of its scarcity is not accounted for. In comparison with oil, there is a difference in treatment where a royalty is paid to the government for extraction of the resource and there is no similar rule for water.

¹² For further reading see Hanneman, 2005

The essentialness of water – the economic concept of essentialness can be applied either an input to production or as a final good directly used for consumption. Water fits in to both classifications since humans cannot live without approximately 5-10 litres per day and it is an essential input for both industrial production and manufacturing.

The heterogeneity of water – water has many dimensions and the value for a user of one litre of water depends on the location, point in time, quality and probability of having the resource at hand.

4.5.3 Water as an economic good

Water as an economic good was first conceptualized in 1992 during the preparations for the Earth Summit in Rio de Janeiro. It was later brought forward at the 1992 International conference on Water and the Environment and was established as one of the four Dublin Principles. The principle holds that: “water has an economic value in all its competing uses, and should be recognized as an economic good”. (ICWE, 1992)

Savenije and Van der Zaag (2000) distinguish two schools of thoughts interpreting water as an economic good. The first uphold that the economic value should set the price for water and the second interpretation does not necessary involve financial transactions but focuses on the decision making process around scarce resource allocation.

Later, in their article “Water as an Economic Good and Demand Management”, Savenije and Van der Zaag (2002) argue that financial sustainability should be the primary objective for water pricing. This should be obtained by cost recovery since an activity only can be sustainable if the financial costs are recovered. Savenije and Van der Zaag illustrate this with the example of the “free water dilemma”. If water is free, water providers will not get sufficiently paid for their services, and not be able to maintain water systems, consequently leading to a break-down in systems. People will now drink unsafe water and rich people will be able to purchase clean drinking water very cheap. This constitutes a vicious circle that is hard to break out of.

4.3.4 Water Rights

Sampath (1992) defines water rights one can look at three systems; riparian rights, prior (appropriative) rights, and public allocation.

The riparian right infers that if you have land connecting to a stream or river you may use the water as long as there is enough left for the downstream users. Prior rights are based on the

appropriation doctrine where water right is defined by actual use over time and applies the “first come, first served” principle. The last system, public allocation, is used by most developing countries and involves publicly administrated water distribution. There is often a charge for the water (based on irrigation size) but there is no charge for the rights since they are linked to the irrigation land. (Sampath, 1992)

Further definitions of water rights pertain to either volume as a share of a stream or canal flow, the available water in a reservoir or lake; or of availability in terms of shifts or hours at a source. (ibid)

4.3.5 Water Markets

When water is diverted some 50 percent of the water will percolate back to the stream where it came from. When the water on the other hand is traded, this return flow may not occur. Chang and Griffin (1992) found that trade commonly occur where the impact of these technical externalities are not that extensive, either because the limited number of potential third-parties are being deprived of their rights, or that the geographical conditions make return flow easy to track and quantify.

Water markets depend on the opportunities of conveyance and if transfer is hindered or very expensive, arbitrage opportunities can be significantly reduced. (Brewer *et al*, 2007)

Allocation by the means of markets has by economists been a favoured solution for most commodities. According to Coase (1960) allocation will be efficient given that initial property rights are completely specified, exclusive, transferable, and enforceable, and that there is zero transaction costs. The latter, of course, does not hold in markets for water rights since costs pertaining to information, conveyance and enforcement may be higher for water than most other commodities markets (Rosegrant & Gazmuri, 1994). Despite transaction costs, trade with water rights may still bring considerable gains in efficiency. By requiring consent in case of reallocation, tradable water rights empower water users. Secure rights bring incentives to investments in water-saving technology and induce users to consider the full opportunity cost of water, including alternative costs, since users can benefit from the selling water that is saved. Finally, tradable water rights provide flexibility as demand pattern changes, affecting prices of crops and the value of water (Rosegrant & Gazmuri, 1994).

Howe, Scurmeier & Shaw (1986) found that an economically efficient water allocation system must integrate both the quality and the quantity of the water and that the system would neither be based on priority nor proportional rights.

Another basic element for a water market to operate effectively observed by Tisdell and Ward (2003) is that they must be accepted. If farmers and rural communities are not willing to accept the legitimacy of water trading, there may be no operational efficiency.

4.6 CHOICE OF AREAS TO COMPARE

The areas we have chosen to study are presented in this section. The results of these analyses will be compared in order to help us find similar characteristics that are present in areas where trade with water has emerged. We have chosen to investigate countries and regions that in one way or another have designed market mechanisms in order to achieve a more effective management of water resources, namely Australia, Chile and Western United States.

The reason why we have chosen the Australian market is that in terms of water trade they have, by far, the most sophisticated and effective in the world. In 2009 roughly 30,000 individual trades took place at a total value of approximately \$3 billion.

Chile is another country that has set an example of being successful in trade with water. With 30 years of experience they are internationally famous with the “Chilean Model”.

The western United States has assumed a more gradual reform towards flexibility in water markets and trade despite a somewhat unfavorable water law tradition. We have chosen two States for a deeper analysis, these are Colorado and California.

4.7 AUSTRALIA

Located directly under the Southern Oscillation, a climate phenomenon causing a subtropical belt of air pressure between the Asian and East Pacific regions. Australia counts as one of the driest countries in the world. They have the lowest average rainfall of any inhabited continent and it is characterized by extreme climate variability (Bureau of Meteorology, 2011).

Rainfall variability is during high season classified as extreme in a major part of the country. 90 percent of the rainfall is directly evaporated back to the atmosphere or is consumed by plants and vegetation, and only 10 percent runs off into rivers or replenishes the groundwater aquifer. This results in substantial differences in availability of water across the country (Bureau of Meteorology, 2011).

Water management in Australia dates back to 1886 when a principle was established which stated that water streams were owned and administrated by the government in each state in Australia. This led to local developments in the supply infrastructure. Each state had further public water authorities allocating water rights (Tisdell *et al.*, 2002). The water trade in Australia has historically been made possible through institutional growth but the objectives of water allocation when implemented were somewhat different than they are today. (Turrall *et al.*, 2005)

Until 1980s the Australian water industry was in an expansionary phase where development was encouraged and the increased demand for water was met by increased supply. However, it became evident that water systems were over-allocated and the total volume of water extracted was exceeding a level sustainable for the environment. In the 1980s, the idea of water management changed from just expanding resources to conjunct with social and environmental policy objectives by improved allocation of existing water entitlements. (Tisdell *et al.*, 2002)

A water entitlement refers to an exclusive access to a certain amount of water, and a water allocation is defined by the fixed amount of water distributed to these entitlements in a given season. With this point of reference, water trade occurs when water access entitlements or water allocations are bought, sold, leased or exchanged. (NWC, 2011)

Along with the changed idea of water management in the 1980s, a number of reforms were introduced in most states, such as moving to volumetric allocations that varies with supply and governmental powers to suspend allocations during shortages, but conflicts of interests between expansionary forces and environmental policies still remained. (Tisdell *et al.*, 2002)

Continuously increasing demand on water resources in combination with aging infrastructure systems resulted in a remarkable increase in operational and maintenance costs. By 1990, the opportunity cost of capital for water resource development had reached an all time high and the issue needed to be addressed. In order to meet requirements for a mature water market in such

an arid country as Australia, the governments needed to define the water entitlements, change pricing and treat water as a tradable good. (Tisdell et al., 2002)

The 1994 Council of Australian Governments (CoAG) Water Reforms was initiated by the Federal Government with the goal to establish a proper market value of water and re-allocation of water consumption where the economic value was the highest. The system of water allocations and entitlements were backed by the separation of water property rights from land titles. Further, the entitlements were supposed to be clearly specified in terms of ownership, volume, reliability, transferability and even quality if that was applicable (Turral, 2005).

Informal markets for water trade in Australia had actually started already in 1989 and a formal market was introduced in 1991. During the first seven years trade was modest, but since 1997 the market for water trading increased dramatically. A number of factors caused the upswing, and the relaxation of trading rules from the 1994 CoAG is one of them. Other contributing factors were several years of extreme drought, irrigators becoming more familiar with trading rules and that the initial success of water markets had activated large volumes of unused water. (Bjornlund, 2003)

Each state in Australia are obliged to commit to the reform and the Federal Government can impose financial penalties by withholding grants to financial assistance if these obligations were not to be reached. (Bjornlund, 2003)

The individual implementation of the 1994 CoAG reform has, due to different interpretation of the reform, has varied between states. Each jurisdiction has different terminology when it comes to defining water access entitlements, allocations and transactions. This inconsistency contributes to difficulties in encouraging water trade. There has also been a notable variation in nature, degree of unbundling, duration and tradability of the rights. (Tisdell et al, 2002)

However, the 1994 CoAG was not free from impediments to trade and complications in defining property rights for water, development of water markets and environmental sustainability still remained. As a response to this, CoAG further agreed on several water reforms aiming to expand the water market. One of them is the National Water Initiative of 2004.

The National Water Initiative (NWI) was Australia's "enduring blueprint" for water reform. It represents a compatible framework for the surface and groundwater systems that optimizes economic, social and environmental outcomes. The main objective is to increase water trade by

removing institutional barriers and to clarify the water property rights. It also aims to provide a higher level of flexibility for individuals as well as how they manage their water rights or chose to pass them over to someone else. Systems suffering from over-allocation are to be taken back to environmentally sustainable levels of extraction of the resource. Under the NWI all states and territories are required to implement compatible and reliable water registers that are publicly accessible of all access entitlements and trades, including both permanent and temporary trades. (NWC, 2011)

In terms of infrastructure for fresh water supply Australia has a total of 501 large dams with capacity of storing a total of 83,853 gigalitres. In addition to that there are around 2 million farm dams all across the country (NWC,2011). It is very difficult to determine supply of groundwater since we know very little about ground water systems. It is estimated that groundwater makes up for roughly one fifth of Australia's 'sustainable' water resources and Australia is highly dependent on their ground water system when the surface water is unavailable (ACIL Tasman, 2003).

Australia's major river system is called The Murray Darling Basin (MDB) and accounts for some 75 percent of all irrigation in Australia and drains one seventh of Australia's land mass. The area is by far the most important agricultural area in Australia but accounts for no more than 6 percent of total water runoff ¹³ (Bureau of Meteorology, 2011). It has taken two decades for the Murray Darling Basin to establish an active trade; however it is still limited in terms of volume and reallocation of surface water entitlements among users. (Turrall, 2005)

Only around 50 percent of permanent water entitlements are activated and this allows the water users to receive 100 percent of their seasonal allocation during 80 percent of the water year. If more entitlements are activated, volumes retained in storages are reduced and consequently, reliance on supply for the following year. If all the nonusers and partial users¹⁴ were to be activated entitlements allowances reliability would drop to 40 percent. (Turrall, 2005)

There are already a number of different levels of water products available on the market. The products are partly defined by the extent of reliability, for example water products with a high level of reliability in terms of annual allocations and water products that has a lower level of reliability, providing irrigators and other people involved in the market with important

¹³ Data from Bureau of Meterology from the year of 2004.

¹⁴ Referred to by Turrall (2005) as sleepers and dozers.

flexibility to determine on how they wish to acquire and what level of risk they are prepared to take on.

The water risk in the Australian rural economy is a striking reality that not only affects the users but also banks, insurers, processors and suppliers. Unlike for the equity, money or commodity markets, investors and users exposed to water availability risk, have no market place where they can effectively hedge that risk. (ACIL Tasman, 2003)

4.8 CHILE

The country of Chile has been a pioneer in the area of water trade through their success of market reforms, which deals with scarcity of water supplies. Chile has a tradition of privately developed irrigation, allocating water by shares of a river. This serves as an advantageous setting for establishing transfers of water rights. Since the 1981 National Water Code was established in Chile, the country has been a world-leading example of a free-market approach to water law. The World Bank, the Inter-American Development Bank, and other related institutions have even encouraged other countries to follow the Chilean model in water law reform. (Bauer, 2008)

Chile, just like Australia, is considered as a primarily arid area. With its long and narrow shape extending 2,700 miles from north to south, climate vary from hot and dry in the north to cold and wet in the south. (Mentor, 2001)

The first National Water Code was proclaimed in 1951, allowing the Chilean government the authority to grant water concessions to private parties. A concession worked as a private property and could be transferred if the purpose of use was the same. If the transfer was for another intention the concession had to be returned to the State and a new request had to be filed. In 1969, the code changed and water rights were now all State property. No transfer or trade was permitted. Thus, this piece of legislation has historically been conversed with respect to prior and posterior legislations that have, with different approaches, encouraged private water rights. (Ríos Brehm & Quiroz, 1995)

Following the seizure of power by General Pinochet in 1973, economic policies in Chile changed to a more market-oriented approach where land and water rights shifted to private ownership. The new National Water Code introduced in 1981 reflected the overall economic and political

objectives and established permanently tradable water rights, independent from ownership and land use in order to strengthen property rights and allow flexibility. (Bauer, 2004)

The code brought empowerment to water users by requiring their consent in any reallocation of the water. This code grants existing water users secure and well-defined water rights without charge and new allocations or unallocated rights are auctioned. Once the water right is granted it becomes fully protected as private property rights under the Chilean Constitution. Following the Chilean Civic Code for property law, the property rights to water can, apart from few restrictions, be transferred or sold under freely negotiated terms and prices for any purpose and to anyone. (Holden & Thobani, 1996)

The 1981 Water Code was designed to encourage investments in infrastructure for irrigation. The government also believed in market forces to stimulate efficiency and bring augmented value to agricultural products. A group of Chilean economists believed the economic mechanics would make farmers start saving in on water in order to sell the surplus. (Mentor, 2001)

Thanks to the legalization of water trading and the recording of the usage of water rights, an active formal water market was adopted with relatively low transaction costs. Well developed irrigation infrastructure and efficient water user associations facilitated trade throughout the system. (Hearne & Easter, 1998)

In 2005 a reform of the 1981 Water Code was passed to address social equity and environmental concerns. The reform had been negotiated during a period of 15 years and is designed in response to specific problems. Examples of the provisions are improved information about water right titles and improved ground water management. The reform also implemented fees for non-use in order to prevent speculation, hoarding or monopoly on private water rights. (Bauer, 2008)

Trading has occurred in spite of loose regulatory frames. A study from 1995 showed that less than half of the entitlements were legally registered. However this did not prevent trade and a major part of water transactions in Chile is the “renting” of water between neighboring farmers that have different water requirements. The owner sells a portion of his water rights over a limited period of time, sometimes without even involving any legal requirements between the two parties. (Ríos Brehm & Quiroz, 1995)

However, empirical evidence from the late nineties showed that the extent of trading in most parts of the country has not been that extensive (Bauer, 2004). For the most part farmers actually did trade between each other and trade between sectors rarely occurs. Constraints to trade have been due to the physical geography with short rivers and high expenses involved in moving water between basins. Further constraints relate to legal and administrative complications, cultural resistance to treating water as a commodity and inconsistent and variable price signals about the economic value and real scarcity of water (Bauer, 2004).

The difference between the Chilean water market and that of other countries which, in one way or another, have addressed the issue of water resources management is that the Chilean government uses a “laissez faire” approach that leaves the institutional framework in the image of that of a free market. Governmental regulations are weak, while property rights and economic freedom is strong. (Bauer, 2008)

The General Water Directorate (DGA) is the governmental water agency in Chile. The agency grants rights to water for free as long as they are physically and legally available. There is no legal doctrine of “beneficial use” which means that new users do not have to specify their intentions or purposes for their water rights. As opposed to Australian water rights, water rights in Chile are defined as volumes of flow per unit of time. The DGA retains some important administrative and technical functions but the users control decisions regarding water management. (Bauer, 2004)

Studies on water market price in the Maipo River Basin show a relevant price dispersion that is determined by type of market agent and experience in the water rights market as well as expected value and geographical location of the transaction. (Jordan, 2007)

4.9 WESTERN UNITED STATES

Water regimes in the United States vary extensively between states but they have the common characteristic that changing the use of water requires authorization from state water authorities and can be a long and costly process. When it comes to trade of water, the Western United States has the most extensive market (Brewer et al, 2007).

The vast area of the western United States including 19 states is an area with clearly outlined contrasts ranging from the desert areas of the southwest to the coastal rain forests of the Pacific

Northwest. There are four major river basins: the Colorado, the Columbia, the Missouri and the Rio Grande (Mentor, 2001).

In the Western states, the individuals hold legal rights to use and derive profit or benefit from the water but the ownership belongs to the state. This makes the holders of the water rights subjects to requirements and the state is monitoring transactions to make sure they are in line with public interests. (Mentor, 2001)

Water rights in the western United States are based on the 'appropriation doctrine' as opposed to the eastern states that follows the 'riparian doctrine' where water rights are tied to land. Appropriation rights are considered independent property rights and can be transferred in the event of the sale of the appurtenant land or could be transferred independently. (Mentor, 2001)

The reallocation of the appropriation rights has been significant, from agricultural users to urban and industrial users, in the western regions and this is cited as evidence for an active water market. (Colby et al., 1993)

Water trade in the western states has been a slow evolution due to three fundamental reasons. First, water has characteristics of being a public good with the ultimate property right belonging to the states. Existing individual property rights are more similar to rights of use than to actual private property rights. Second, the stochastic supply resulting in periods with few market participants. Third, transfer of water involves significant costs related to both institutional aspects and physical transportation. (Howitt & Hansen, 2005)

The Bureau of Reclamation has invested large public expenses to develop storage and transportation infrastructure in the Western United States. Not surprisingly, trading places have occurred most frequently around these states' water projects (Howitt & Hansen, 2005).

Water markets in the Western United States are generally local or at the most limited to States. In a study on price variability across twelve western states, Brewer *et al.* (2007) find that (1) state water markets are quite different as reflected in the varying state prices and (2) there are few arbitrage activities across the states to narrow those differences.

4.9.1 Colorado

Trade in the Western United States has evolved as a solution to farmers' over-appropriation. In the 1930s Northern Colorado, a project initiated by the Bureau of Reclamation called "The

Colorado-Big Thompson (CBT) Project” started for this very reason. The CBT scheme was to supply water from the Colorado river through a tunnel and was partially paid for by the subscribers. The project was approved in 1937 and constructions started the following year (Bureau of Reclamation, 2011). As the project became fully operational 20 years after that, it became apparent that demand varied enormously between users and districts. Soon, the Northern Colorado Water Conservancy established a system allowing permanent trade with water rights, which facilitated the development of a water trade market. The rights could be sold as long as the rights stayed within the district, is for “beneficial use” and that the users acted in accordance with the rules set by the Conservancy (Holden & Thobani, 1996).

A very sophisticated market evolved with a variety of contracts being used, from transfer of the water rights to put and call options of water. The complexity of the infrastructure stays within the hands of the users while the Conservancy records the transactions and keeps track of the ownerships. (Mentor, 2001)

The water allocation is defined in consistency with, and proportionally adjusted to the variations in supply. Since the trade is limited to one district, effects from return flows are internalized which helps mitigate third party losses (Brewer et al., 2007). The system provides a risk sharing idea between shareholders and shares fluctuate seasonally in response to water conditions. (Mentor, 2001)

Water shares in the CBT have the advantage of being completely homogenous and transfers can be made with minimal fees and paperwork. Since it is imported from another watershed there are no externalities imposing on water trade that often occur with natural rivers (Howitt & Hansen, 2005).

4.9.2 California

As opposed to the Colorado-Big Thompson, Californian water shares are far from homogeneous and water trade in California has been more of a slow process. Until the 1980s the law even prevented transactions since a person seeking to sell water technically had no “beneficial use” for it and was therefore obliged to abandon the water right. The gradual water reform in California has been driven by two main factors. First, the rapidly increasing urban demand, with rising costs in expansion and maintenance of water infrastructure. And second, depletion of supply sources, increasing the economic value of water. (Rosegrant & Gazmuri, 1994)

In the 1990s, the existing water law was modified in order to facilitate transfer of water rights between users. California Department of Water Resources (DWR) developed a water transfer guide and coordinated activities among state agencies.

After 5 years of unceasing droughts the Californian, The California drought water bank was established in 1991. It was operating only in case of emergency and it was followed by a legislation allowing transfer of water rights. The aim was to efficiently re-allocate water from agriculture in the northern parts of California to urban, municipal and agricultural sectors in the southern parts of California. (Mentor, 2001)

In California, two thirds of the state population lives in Southern California which is a region that merely receives 10 percent of the state's total precipitation. There is also a large seasonal variability in supply and demand since 80 percent of the annual Californian precipitation falls between October and March, while 75 percent of water use takes place between April and September. (Hanemann, 2005)

The reforms towards increased flexibility of trade with water are moving slowly considering California's long-established water law tradition that from some perspectives has been unfavorable to water markets. (Mentor, 2001)

California eliminated this financial disadvantage with a statute, proclaiming that when water use is reduced for conservation, the conserved amount may be sold, leased or transferred. (California Water Code, section 1011)

5. ANALYSIS

This chapter is devoted to an analysis of the empirical results we identified in the previous chapter. The chapter begins with two matrixes displaying an overview of the most important findings when comparing the comparison components to the criteria. The rest of the chapter will provide a deeper analysis, which outlined these matrixes.

5.1 CONSIDERING THE FACTS

Even when trade originated it was because of a need of having a common denominator as to measure the value of an asset. From this need, currencies have evolved to the money we use to make purchases today, and markets for futures have grown. As currencies, futures contracts can also be regarded as a mean of exchange. This is highlighted in Telser & Higinbotham's (1977) view that a futures contract shares the same characteristics as a payment in currency.

As earlier described, we have compared all six components with each other and with the general characteristics water. In order to highlight the important findings of our analysis we have created a matrix containing what we believe are the key characteristics for each box in the criteria framework. The matrix will help us gain an overview of which criteria are the most important for trade to arise. After the matrix is presented, a deeper analysis of each criterion is provided.

5.2 THE MATRIXES

	Oil	Rice	Carbon Emissions
Need/Demand	Demand increases with GDP.	Vital to a large part of the world's poor population	Demand is increasing.
Supply	Finite	Can be difficult to predict due environmental shocks	Controlled by governments
Dependability of the Resource	Emerging substitutes	Connected to supply	Dependent of emission
Geographic Conditions	No so important	Concentrated areas for production Dependent on soil	Reason for why trade started
Political Climate / Regulatory Framework	Unregulated	Strong trade regulations	Highly regulated
Ownership Structure of the Asset	Anyone can own to a certain extent	Strong ownership	Virtual ownership
Standardization	Standardized contracts	Standardized contracts	Standardized contracts
Developed Information System	Very well developed	Well developed	Hard to monitor
Infrastructure	Well developed infrastructure	Well developed	Not necessary
Price	High price volatility Market clearance	High price volatility	Price is set

	Australia	Chile	Western United States
Need/Demand	Vital due to extreme climate variability/drought	Vital due to extreme climate variability/drought	Vital due to extreme climate variability/drought
Supply	Over-appropriation Seasonal	Seasonal	Over-appropriation Seasonal
Dependability of the Resource	Water right as a share	Enforced water right	Correlates with supply
Geographic Conditions	Extreme climate variability	Wet in south dry in north	Climate variability
Political Climate / Regulatory Framework	Moving towards eased regulation	“laissez faire” approach	Circumventing regulations
Ownership Structure of the Asset	Government owner Significant Separate from land	Strong water right Separate from land	Government owner Separate from land
Standardization	Fairly standardized	Individual contract negotiations	Example of good standardization in Colorado
Developed Information System	Good information system	Poor information gathering	Hard to monitor
Infrastructure	Good infrastructure thanks to historical expansion	Self sustainable Limits trade	Limits trade
Price	Not available	Significant price disparity	Not available

5.3 NEED/DEMAND

It is vividly clear that a basic prerequisite for all chosen comparison components is that a demand for them has been present each time trade has evolved. Depending on individuals' respective assets and their level of desirability to acquire other assets, trade will naturally arise.

Rice accounts for about 20 percent of consumed calories in the world, and this must be categorized as a very large demand, thus, trade with rice is inevitable. The fact that a considerable number of farmers in Asia depend on rice as their primary source of income is another evidence of the importance of the ability to trade with rice. Another fact is that different types of rice are cultivated in very different ways, giving farmers little flexibility if demand changes.

As with rice, oil is one of the most important commodities in the world and has also been used and traded since ancient times. As innovations and industrialization has taken part, the scope of use has increased, and thus, the demand of oil has increased. The demand for oil has continued to increase with globalization, and correlates positively with increases in a country's GDP. This is probably true for rice too, as well as for most commodities. Because of external factors the oil demand curve has been relatively constant, however on a high level.

As for carbon emissions, there was not a specific demand for carbon emissions rights *per se*, rather the need for controlling emissions in order to reduce negative environmental impacts was the primary goal for the development of the emissions rights as a traded product. The demand for emissions rights has, however, increased since it became widely accepted in the world and tradable rights on other emissions have evolved.

Demand for water is extremely high and will always be for all of us. All of the areas we have analyzed have a very dry climate and the need for water in these areas is apparent. This serves as a basic criterion for a need for optimal water allocations within the respective countries, and thus, trade with different types of water rights has emerged. The great demand for water in both Australia and Western United States has actually led an over-appropriation of water extraction.

In some cases demand is a seasonal factor, and can be different in different areas. This is particularly true for the areas which we have studied. Demand for rice, for example, varies with the available supply, which is a direct result of when, and how much, rice is produced. Oil demand is also dependent on other macroeconomic factors, mainly price and supply. As for

water, the need is obviously greater in the driest parts of the researched areas, than in the parts that have a less dry climate. We identify the basic solution for solving resource imbalances like these would be to start trading with the resource. According to basic economic theory, imbalances should naturally balance out when allocation (trade) erupts.

Based on these facts, we can see that the need for water is twofold in these areas as for areas where there is not as dry climate. That is, there is a fundamental need for water that all people share. In these areas there is also the added need for irrigation because of the natural dryness in their arable soil. Demand is therefore identified as an important factor for trade to evolve. For virtually every analyzed component, demand, in addition, has to be very large. With this insight we can conclude that the criterion of need/demand is met. This also verifies the “large demand criterion” defined by Baer & Saxon (1949).

Another dimension of the need/demand criterion is the underlying need to insure and hedge risks. This can be done with contracts trade. This verifies the view of Baer & Saxon (1949), that states that one of the fundamental functions of an exchange is in fact the insurance function, which can provide price stability and risk protection. Most oil trade is in fact carried out for the purpose of hedging. An oil futures contract changes often hands several times before the contracted commodity actually reaches its final destination. Rice was very early traded to hedge for supply shortages, and today also for price volatility. Hedging activities are also visual in the cases for water trade in the analyzed countries. As water is as important as it is, the need for hedging shortages and insure against price risks is large in the areas we have studied, and without a doubt in other areas with similar characteristics as well.

5.2 SUPPLY

Supply is always negatively correlated with demand, and therefore equally important for the purpose of trade. Supply is basically fundamental to trade. If there is no supply there is, of course, nothing to trade.

The oil supply cycle is somewhat evenly distributed over the year. This is probably because increase in demand and globalization correlates with each other. This would be one of the reasons why oil supply is not more volatile. Even when knowing that oil is a finite substance and the environmental impacts it have on the world, one may find it strange that demand levels does not decrease, making supplies to increase on a yearly basis relative to demand. We believe an explanation to this is a lack of real substitutes. There are some substitutes for petroleum, but

nothing that really can replace oil. In regards to the environment, concerns have been raised on the matter if petroleum substitutes are that much more environmental friendly than oil. Still, all substitutes for oil will in some sense help save current oil supplies.

The fact that there are no substitutes for oil is also a characteristic that water also possesses. No substance is equal to water in its importance for human survival. One reason for the current water situation, which has raised the issues processed in this thesis, is what we have identified as a lack of knowledge regarding supplies and of water as a general substance, for a major part of the world's history. This is another area where oil and water coincide, since this is exactly true for oil as for water. Qualified knowledge of these two substances and their respective supplies may have been around for a couple of decades at most, which is only an insignificant fraction of the world's billion year long history.

As mentioned in the previous section, seasonal surpluses affect the supply level. This has always been a fact in rice and is what made people in ancient Japan to start trading rice with each other to hedge shortages in their own production. Due to the fact that so much of the world's rice production takes place in one area, supplies are extra sensitive to externalities and extreme weather conditions, which also make it hard to calculate if rice supplies are going to last. This can, in a way, be compared with oil that is a finite substance which is not possible to reproduce. This is, of course not true with rice, since oil is definitely finite, but the difficulties in predicting supplies, whether for a season or forever is still equally difficult. Oil production is a controversial topic. In many ways it is greatly dangerous for the environment and causes differences in opinions among people. The same can be said for carbon emissions rights, which has encountered a lot of opposition before it became accepted. The irony with emissions rights is that in order for there to even be a supply, there has to be emissions. Since supplies for emissions rights are set by governments, current supply levels are always known.

In Australia and Colorado trade with water was initiated due to the over-appropriation in water extraction, which caused a supply surplus. This has instead made surface water supply levels very uncertain. In addition, we would have to assume that also groundwater is affected by this. However, groundwater measurement is severely complex and supplies are very uncertain, as well as far beyond the scope of this thesis. All countries' trade with water is affected by supply and similar to rice, market supplies in Western United States of water is also stochastic.

As demand and supply is dependent on each other, we have identified the supply criterion as critical for trade. It is a obvious that there cannot exist trade in a commodity if there is no supply

of that commodity. However, what is interesting is the degree of importance. If there are substitutes, supply will not be equally important. Rice for example can suffer from

What is also clear from our findings is that both demand and supplies are, more or less, uncertain in the chosen commodities as well as for the regions used for comparison. This is Further, this verifies the result of Baer & Saxon (1949).

5.3 THE DEPENDABILITY OF THE RESOURCE

The dependability of the resource is strongly connected with supply levels. The greater the level of supply, the more dependent the resource is.

A distinct finding of our research is that the water rights in the countries we have analyzed were overall less secure in contrast to those assets we have chosen for comparison. From this we can only draw the conclusion that water as a commodity is far from dependable.

An answer to this can be connected to regulatory framework. In order to trade with commodities or contracts on the underlying security, there is usually a strong need for some sort of regulations that depends on the legal structure of the contracts. Otherwise trade might not be conducted correctly. This is what happened with rice futures in India where heavy trading in unsupervised contracts lead to the suspension of rice futures altogether.

As rice is a commodity that can be reproduced, we would still assume that the dependability of rice is fairly large. However, since rice production is dependent of water (in terms of irrigation), which we have identified as uncertain, rice, in turn, must also be identified as less secure than we originally thought. It should be noted though that this probably not will be notable for a perspicuous time.

Similar to water, oil is also defined as a finite commodity. This, of course, greatly impacts the dependability of the resource. There are some theories that have attempted to calculate how much oil is left for usage. These theories state that we already have passed the peak of the total oil supplies, and that we therefore are running out of oil¹⁵. What is somewhat alarming from

¹⁵ See The Peak Oil theory of Hubbert, M., K. (1956) "Nuclear Energy and the Fossil Fuels "Drilling and Production Practice""

these insights are the impacts this could cause since both oil and water (and to some extent even rice) are extremely vital to human use.

The dependability of fresh water in our chosen areas are uncertain partly because of the variations in climate but also as a result of the regulatory framework. In Australia water rights are defined as a share of total entitlements and if there due to extreme drought would be no asset to share, the right becomes useless. Enforcement of rights to the asset is essential for investments. Liquidity of commodities makes them act as safeguard to loans. Be able to capitalize on water rights.if you want to . Users that want to capitalize on their right need

5.4 GEOGRAPHICAL CONDITIONS

Among the commodities we have compared it has been obvious that they all demand different geographical conditions in order to prosper. Without the right geographical conditions for rice, for example, there would be no production. An important evidence for this is, again, the fact that different types of rice are cultivated in vastly different manners.

Oil can also only be produced if the right geographical conditions exist, which, not surprisingly, differs from those required when producing rice. Even though we have not found a clear relationship between these commodities, we can however draw the conclusion that they do require special geographic conditions. When it comes to carbon emissions rights we have not been able to identify any specific geographic conditions that have to prevail in order for trade to take place. However, in some way geographical conditions in forms of increased climate changes and environmental issues is the reason why trade with carbon started in the first place, which is a pattern we have seen with water as well.

When speaking of rice and oil as traded commodities, history tells us that the geographic location of the commodity exchange, where the physical trade actually occurs, might be of relevance. The Chicago Board of Trade was established in Chicago because of its strategic location. At that time though, commodities were stored at the exchange why the location and infrastructure were of importance. Trade in rice futures takes place in the United States, Thailand and China and the important

We have identified geographical conditions to oil somewhat different to what they are in the case of water but it has an equal importance to where trade is possible.

In all of the countries we have used for comparison we have witnessed similar patterns in geographic conditions. The areas are alike in that they all span over several degrees of longitude, giving them very different climate in different places within the area. That is, a climate of extreme dryness on some places and others which are water-rich. Precipitation is a factor that also varies within all of the chosen areas. Southern California only receives about 10 percent of total precipitation in the state, whereas the northern parts receive about 90 percent. This would serve as another reason as to why trade has emerged within these areas; resources within the area can be optimally allocated. We can also speculate if a reason for trading mostly within the state could be that California wants to secure water supplies for their own inhabitants. Much like China does with their rice supplies. The extreme weather variability in California is also a seasonal matter, with a grave mismatch in demand and supply of water over the seasons. Thus, a need for trade with water rights is probably incredibly important. Also in Australia, where there is not much precipitation at all, but is actually one of the driest countries in the world, a need for trading with water rights is not difficult to identify. In Chile, trade with water is instead constrained by certain geographical conditions, such as limitations in the length of rivers.

When peaks in supply and demand do not coincide it is even more desirable to have a functioning market for water. However in Chile, when the same characteristic that constitute an important criteria for trade (supply, i.e. the river) in the first place, is then a hinder for continued trade (length of the river) we find ourselves in front of a catch 22 in terms of the “geographical conditions” criteria.

It might actually be that geographical conditions are becoming less important in terms of trade. The geographical conditions of producing the underlying commodities will always be present, but trade with contracts on the underlying commodities is clearly not as important any more. Today’s infrastructure does not require that the physical commodity is available at the actual exchange trading place. We can instead very easily carry out the trading agreement by transferring the commodity using the international infrastructure network of today. With the constant improvements of the infrastructure and information technology, we are led to believe that the importance of a physical exchange market place is changing towards a minor role in trading activities.

5.5 POLITICAL CLIMATE / REGULATORY FRAMEWORK

Political climate, regulatory framework and society are major elements deciding the rules of the game for commodity trade. They also determine the economic value, as defined by Dupuit (1844) and Marshall (1897), of the asset.

In Australia and in California we have seen that over time they have changed and renewed their regulatory framework towards a more relaxed approach towards trade and continue to do so when impediments arise. In both countries, improved efficiency of water use can readily be seen as a result of changes in structure of entitlements and trading rules. In Australia the structure of the entitlements and the transfer rules appears to have been developed principally with an eye to the primary market with set physical water trades. Less attention has been paid to secondary market offering composite physical and financial risk management products, based around rights and not necessarily requirements to transfer water.

Chile's political climate, applying a free-market approach is reflected in their regulatory frameworks, which gives strong water rights and weak governmental regulations. However, global pressure on sustainability has changed the Water Code to takes into consideration the environmental concerns.

Water use rights have been implemented in all our three chosen regions. This is no big surprise since that was part of the reason of why we chose them in the first place. The regulations have, to varied extents, decentralized the resource management by facilitating trade and ensuring secure transfer of water from low to high value users.

How oil is regulated in each country it is traded is beyond the scope of this thesis. However we have identified regulatory frameworks in form of unified policies between trading countries like the case of OPEC, which acts in order to secure fair and stable prices. OPEC has had a central role on the market but in 1985 they lost dominance on the market and this showed significant changes in price which verifies their major influence. There are no price regulations for oil, leading to market clearance, resulting in high price volatilities.

Trade with rice has, as opposed to oil, no major actor that stabilizes world rice price through trade policies. In countries where rice is produced it is however highly regulated as a mean to secure food supply for local inhabitants and mitigate international price volatility leading to instability in domestic political climate. The regulatory framework for carbon emissions is much

specified, since it is the governments decide how large the caps on emissions are. Since the system has evolved in order to live up to environmental policies, strong regulations are in order.

We have seen different patterns from our commodities and areas but they all seem to move towards the same direction of a regulatory framework that takes into consideration the social and environmental perspective. Still there are reasons why water markets most likely needs stronger regulatory framework than other commodities. Such an important resource with a history of being squandered leaves lasting equity consequences if mistreated.

We can see that trade of rice in many countries are much regulated. Trade in India was banned due to poor regulations, and for Singapore to begin trading with rice futures, IRRI (2010) states that regulations and a strong legal structure is vital. However balance between markets and regulations might be the best solution for water trade.

There is also the present environmental aspect of water usage to take into consideration. Discussions about global warming started decades ago and never ceased even if groups thought of it as an environmental vogue that would eventually pass. Water now has the same intensity. Historically water trade was not used as a management tool for environmental consideration but we have envisaged that trade regulations are moving towards reflecting public values. Regulatory framework is overall identified as more important from a socioeconomic perspective than pure market efficiency. We have concluded that it is essential to have a complete set of rules for trading in water rights and institutions are needed to supervise trading activities and resolve eventual conflicts.

5.6 OWNERSHIP OF THE ASSET

For any market that operates, they who hold the assets need to have clarity and security on the entitlements they hold. Ownership might seem banal but in the case of water it is a more complex phenomenon.

Individuals, corporations and state or federal governments can all own oil rights to a particular extent and if you own it, you are free to trade it. Equally, rice ownership belongs to the farmers. IRRI (2010) defines one criterion for successful development of a commodity futures market on as perceived enforceability on the contract. Ownership of carbon emission rights is somewhat particular since it is a virtual. The governments decide on how much users can emit but the

ownership of the right is clearly specified which makes it easy to trade. Carbon emission enforcement is very important since the value of this virtual asset otherwise is highly diminished. These ownership structures are all somewhat similar, that is, if you own the asset, you are free to trade it in whichever way you want.

The most prominent factor our countries have in common is the separation of water right and land title. Equally we can see that none of the commodities are attached to any other items.

Chile is the only country in the world that, once you get a concession, protected by the constitution you become the owner of the water and it is registered as private property. The state is the owner of the water in both western United States and Australia, but regulations have been implemented to strengthen the rights to the water for the users.

The Australian water property rights have been developed in order to ration the physical water available. The rights provide access to an amount of water determined on the basis of what is available but they do not themselves provide parties with exposure to water availability with a risk management tool since if there is no water in the system, the possession of the water right is of no value. Even if other risk mitigating strategies has been adopted such as reservoirs, during long droughts, stored water can provide only a limited hedge to water availability risk.

Public and private characteristic makes water reallocation controversial especially when profits are involved since it often to some extent has been publicly financed or subsidized, which has especially been observed in California. This is supported by Hanemanns (2005) theory as one of the characteristics making water different and more complex than other commodities.

In agriculture many users entitled to the same water since only part of the water, and in Australia the government has the power to suspend allocation during shortage. Thus, even if you have the right to use it, you are not free to trade it.

In regards to water, no one was ever owner of the water and we see that as a strong argument for why trade has not evolved with water. As is clear from the empirical results of the existing water markets in the world, defining ownership of water and water rights is difficult.

As a conclusion of the “ownership” criteria we have distinguished that ownership *per se* might not be the most important but the structure of the ownership does need to protect the right to use.

5.7 STANDARDIZATION

As Bear & Saxon (1949) outlined in their characteristics for commodities, units need to be homogeneous and subject for standardization of grades and qualities. A common denominator is needed in order to measure value as to eliminate limitations in trade. A futures contract is specified in that aspect, which also gives it the ability to cancel out transactions.

Oil has a very clear system for standardization and grading. There are different types of oils produced in different areas, as well as a recognized grading system. Carbons are standardized and adapted with the present political climate. Rice, like oil, is produced in a wide variety of types, and has an extensive grading system.

Determinations of water rights appear to have disregarded the concept of quality which is something rather important since different water users have very different requirements when it comes to quality. Standardization is important to use as a benchmark for price determination. This is evident in the case of rice trade in India where high varieties in sorts and qualities makes it hard to fabricate a benchmark contract that futures trade not yet has been able to reestablish on the market.

In Chile each trade contract is negotiated in terms of price and time conditions specific for the particular purpose which has the advantage of giving the parties involved flexibility in design. However, we have seen that this can cause significant price dispersion. Another drawback on this is however the lack of standardization which makes the process more time consuming. The trade in Chile can be seen as forward contracts according to the cost-benefit theory of Telser & Higinbotham (1977) buyers might be faced with problems with sellers not fulfilling agreements.

The water rights in Chile are defined as liters per second as opposed to share of total allocation. This is advantageous since it clarifies volume to a greater extent. Contracts in Australia have, in response to this uncertainty, been standardized after a measure in reliability so instead of quality buyers can choose “seniority” depending on their risk appetite.

In Australia each jurisdiction has different standards and this has been noted as a barrier to trade between states. The Colorado Big-Thompson is an example of standardized trade. The homogeneity of the water has helped internalize effects on third parties. This is perfectly in accordance with Chang and Griffins (1992) findings that trade occur where the impact of externalities are not that extensive.

In the traded commodities we have seen a clear connection in that they are all subject to grading specification, thus making contracts easier to standardize. Even in 1954, Irwin stressed the importance of standardized contracts, which is why it is surprising to see that the countries which have conducted water trade not have embraced it. We assume, however, that this is a matter of the complexity which we have discussed in the text above. We do believe, though, that standardization of water contracts will help water trade to evolve.

A futures contract which is not standardized is a forward contract. These have to be renegotiated with each new trade. This imposes problems of trustworthiness between the parties, which according to Telser & Higinbotham (1977) can induce additional costs to one of the parties. This is due to the different information between the parties, and produces according to Akerlof (1970) a "lemon problem".

5.8 DEVELOPED INFORMATION SYSTEM

One fundamental driver of any efficient market is the access to information that is accurate and publicly available. Timely and transparent information has in fact been key for trading with commodities since ancient times. If well informed, participants of the exchange receive a higher degree of certainty regarding purchases and sales. The "lemon problems", discussed above, are also mitigated.

Information pertaining to the availability of water in local storage facilities would be necessary for buyers and sellers in order to determine the risk of water shortages and thereof also determine the price of the asset.

Australia has a developed a wide information system backed by a statutory framework with responsibilities to monitor, assess and forecast availability. We have identified this as important in order to comply with their system of water rights. Since owners are entitled a share of total allocation, supply needs to be well defined and accessible (especially from a risk perspective).

The variations in jurisdictions across states in Australia could, due to lack of compatibility have implications for the continued emergence of inter-jurisdictional trading. This also strengthens the importance of an internationally compatible standardization pointed out by Bear and Saxon (1949).

Deficiencies in the Indian information system for rice futures trade caused severe inflation in the underlying commodity so we can see that a proper system is also important to assure an accurate price. As noted earlier in the case of unstandardized contracts in Chile causing price dispersions it is evident that this is partly due to the lack of a proper information system. However a price registration function following the Water Code in 2005 has improved information about water right titles. Bear and Saxons agree that a price registration functions. Is fundamental from a risk perspective.

Carbon emissions are hard and expensive to monitor since it is very difficult to measure how much carbon companies are actually emitting. We can identify strong similarities with water since hard to measure water and very hard to monitor if a user uses the share she has been entitled.

A developed information system is linked with knowledge, both within countries and worldwide. Increased knowledge of trading rules among irrigators was a contributing factor to the upswing in trading activities in Australia subsequent to the 1994 CoAG reform. Internet provides people with readily available information every day.

In 1954 the marketing of butter and eggs were facilitated through organized trade. Therefore, we recognize organized trade as a way for water as an economic good to be put on the market. In addition, a well functioning information system seems to us to be an efficient way of keeping participants in the market well informed. With that, we identify the “developed information system” as an important criteria for trade to arise.

5.9 INFRASTRUCTURE

Transportation and communication has been a requirement for trade a long time back in history of trading. It has equally been observed as a limiting factor in all out regions.

Water is bulky and the relative value of water is small if you compare it with oil. Therefore oil infrastructure has been widely developed but, although similar in that they are both liquid, the same techniques could be applied to water in the same extensive way.

Trade with carbon emissions is virtual, leaving the infrastructure as only important in the case of collecting information. Australia has a well functioning operational system with dams, storing facilities and distribution networks for individual water entitlements.

Storage of the commodity is important if seasonal surplus varies, in the case of rice we have seen that storage opportunities facilitated rice trade to develop. Similarly in California we have observed that the mismatch in time of precipitation providing for the annual supply and demand which makes storage facilities highly important.

The fact that water supply infrastructure is extremely capital intensive and predominated of economies of scale, this often creates a need for collective action in financing that generally does not arise with other commodities. The Chilean Water Code was established in order to promote development in infrastructure. Equally trade in Australia arose because of aging infrastructure and high maintenance costs. This can be connected as measures to prevent the “free water dilemma” and is discussed further in the next section covering out final criterion: price.

We can see strong patterns that a developed infrastructure network is inevitable but that the public characteristic of water as noted by Hanemann (2005) makes trade with water more complex since it involves public expenses. A market for water would help users capitalize on the asset in order to expand the infrastructural network.

5.10 PRICE

The conclusion of all of the above criteria should result in a price, since price is the one criterion that in some degree is affected to all of the other. There is also the debate of a fair market price, which we believe is more aggravated when it comes to water prices, than for prices on other commodities.

Prices on all compared commodities have been very volatile. The recent years price volatility in oil prices depend to a large extent on the decline in dominance of large organizations active in oil

price stabilization. As mentioned above, demand and supply levels on oil has been relatively stable over the last couple of years. This, of course, is connected with the price volatility Oil shows strong market efficiency. The market is clearing which makes for very volatile prices but supply and demand are in equilibrium and relatively constant

In the case of rice volatility in price has been identified as correlated with changes in precipitation. We have also identified a price correlation between oil and rice and this is

Opportunity cost of water is hardly reflected in the price, even less scarcity. We can only speculate what would happen if water were to remain free. The “free water dilemma” is a good illustration and can be connected to higher investment risk in for example utility companies. As already mentioned we have in our countries for comparison identified that one of the reasons for trade has been to set an accurate price on water to finance water related structural problems such as infrastructure.

6. DISCUSSION

In the final chapter we will discuss the issues we identified in the introductory chapter along with the knowledge gained throughout the process of this thesis. We will present our conclusion and our own thoughts of the subject. Lastly, we will provide some recommendations of further research.

6.1 RECONNECTING THE BACKGROUND

The value of water in use, as Adam Smith illustrated it in 1776, is yet today greater than for any other substance known, and the most important element on our planet. In Smith's paradox, diamonds had scarce any value in use, but a large value in exchange. Diamonds probably have a greater value in use today, than it had in 1776. In the same sense, many substances' scope of use has increased as time has passed and innovations and globalization has evolved. For water, this is true in the sense that as the world has become more industrialized, demand for water in industrialized use has increased. As the population has grown, more people have become dependent on water and clean water supplies. This has, in turn, led to an increase in demand of water used in the agricultural industry, which already uses more than 70 percent of existing freshwater supplies.

We can therefore identify that while the value in use (and demand) for water has increased with innovations and globalization, the importance of it should be virtually the same as when Smith introduced the paradox. What has changed remarkably, though, is the value in exchange for water.

People of today are better informed on what the world look like and what resources that are available to us on a sustainable basis. Thus, the overall picture of water supplies and water usage has improved vastly during the last centuries. Today, people are aware of the fact that water is a finite resource which we should not waste.

Still, people do waste water and use more than necessary. Especially in developed countries, where forces of habit of always having enough water induces this behavior. Even though this sort of individual waste is only a fraction of the damage contaminations and natural disasters can cause. Whole freshwater supplies of countries can be at risk if contaminations occur, and not all countries have emergency water reserves. The climate change can also impact the amount of precipitation that an area receives, thus affecting the water supplies in that area.

It is very obvious to us that the need for water innovations is large. After all, about 70 percent of the earth's surface is covered by water. Innovations on how we can use salt water, is a complex matter and the lack of solutions proves how difficult it is. However, if it could be done, water supplies would drastically increase.

The other alternative available is to better allocate the existing water supplies in order to make optimal use of the resource. Most commodities that are traded on an exchange let the variables of supply and demand naturally allocate the resources in an optimal way. Water has more complex characteristics and when allocating water there are several important factors to take into consideration.

Transportation, storage and grading of water are complicated as it is with international water trade today. In order for trade with water contracts to evolve, these factor is of yet greater relevance. Transportation and storage of water is a challenge because of the unusual characteristics water as a substance demonstrates. Grading is important in the standardization of contracts. In turn, standardization is a basic prerequisite in order for organized trade to develop on a commodity.

As most commodities also need strong regulations to be traded on contracts, water is no exception. Even trade with water as a commodity will probably also have to be strongly regulated. This is because of the complexity of water as an economic good and as a concept. Water is controversial and there are a lot of political and ethical issues that arei vägen... Since water is something everyone need, allocations have to be made in order for everyone to actually receive it. A water trade market existing under the conditions that some companies or individuals earns a lot of money on it would probably be subject to heavy debates.

The same complexity can be found in the quest for a right price for water. Which variables should be taken into consideration and what is actually a right price? Or, rather, a fair price?

However, we should not see it as value enhancing in a measure of profits, but rather as value enhancing in measure of improving living standards and optimal resource allocation. If do not have these thoughts in mind there is a great chance that water supplies will end sooner, rather than later.

6.1 CONCLUSION

Trade between countries should naturally occur. According to the theory of international trade countries should trade when they have a comparative advantage in the production of a product, thus leading to an optimal allocation of resources. Water seems like a resource that naturally will adapt to this theory, if traded internationally, due to the large differences in availability between countries and areas.

However, what may be optimal in theory may not be optimal in practice. What has become clear during the process of this thesis is that water is such a complex resource that for it to trade successfully a number of criteria have to be fulfilled. We have, throughout the work with this thesis, worked against finding the most important ones.

In the previous chapter we analyzed the ten criteria that we outlined from our theoretical framework. They are all important; however, two of them are fundamental in development of water trade and water futures contracts. These are demand and supply. Need is connected to demand in the way that there has to be a need for a commodity or contract in order for demand to grow.

Demand and supply are the two factors that theoretically decide price. Thus, the result that demand and supply should be the most important factors in organized trade is no surprise to us.

These results may not be applicable in all areas of the world, however they may act as a measure as to trade. Again, all ten criteria are important, but these are basic and the starting off point in order for there to even exist an exchange.

6.2 Suggestions to further research

Water trade is developing as we are writing these words and being such an interesting subject suggestions for future trading are without limits. This is only a master thesis and in the limitation of time and resources we have only covered the tip of an iceberg. We can therefore suggest to, with our identified criteria as a framework, dive deeper into the complex and fascinating subject of water trade.

BIBLIOGRAPHY

2030 Water Resource Group. 2009. *Charting our water future*. Economic Framework to Inform Decision Making.

ACIL Tasman, 2003. Water Trading in Australia, Current and Prospect Products, Report prepared for the Water Reform Working Group, ACIL Tasman Economic Policy Strategy

Akerlof, G., A. (1970). The market for “lemons”: Quality uncertainty and the market mechanism. *The quarterly journal of economics*, 84(3), pp.488-500.

Aquastat. (2000). *FAO's Information System on Water and Agriculture* [online] Available at: <<http://www.fao.org/nr/water/aquastat/main/index.stm>> [Accessed 8 May 2011].

Baer, J., B. and Saxon, O., G. (1949). *Commodity exchanges and Futures trading*. New York: Harper.

BFSC (Barcelona Field Studies Centre S L). (2011). *Geography Fieldwork, Water supply in the Barcelona region*. [online] (Last updated 26 February 2011) Available at: <<http://geographyfieldwork.com/barcelonawatersupply.htm>> [Accessed 16 March 2011].

Bauer, C. J. (2004). Results of Chilean water markets: Empirical research since 1990, *Water Resour.*

Bauer, C. (2008). *The Experience of Chilean Water markets*. Expo Zaragoza.

Baumeister, C. & Peersman, G. (2009). *Sources and the Volatility Puzzle in the Crude Oil Market*. Ghent University.

BBC. (2011). *BP oil spill: The environmental impact on year on*. [online] 20 April. Available at: <<http://www.bbc.co.uk/news/science-environment-13123036>> [Accessed 9 may 2011].

Betsill, M. & Hoffmann, M., J. (2011). The contours of “Cap and Trade”: The evolution of emissions trading systems for greenhouse gases. *Review of Policy Research*, 28(1), pp. 83-106.

Bjornlund, H., 2003. Water Markets as Risk Management and Adjustment Tools within Irrigation Communities – Some Australian Experiences, World Water Congress, Madrid October 2003.

Bureau of Reclamation. (2011). *Colorado-Big Thompson Project* [online] (Last updated at 18 April 2011). Available at: <http://www.usbr.gov/projects/Project.jsp?proj_Name=Colorado-Big+Thompson+Project> [Accessed 20 April 2011].

Brewer, J., Glennon, R., Ker, A., and Libecap, G. (2007). Water Markets in the West: Prices, Trading, and Contractual Forms, International Center for Economic Research, Working Paper Series.

Bryman, A. (2008). *Social research methods*. 3rd ed. Ort: Oxford University Press.

Bryman, A. & Bell, E. (2005). *Företagsekonomiska forskningsmetoder*. Malmö: Liber Ekonomi.

Calpe, C. (2002). *Status of the world rice market in 2002*. (in Sustainable rice production for food security, FAO Corporate Document Repository). [online] 23-26 July. Available at: <<http://www.fao.org/DOCREP/006/Y4751E/y4751e03.htm>> [Accessed 25 April 2011].

CIA (Central Intelligence Agency). (2009). *The World Fact Book, Country comparison, Oil production*. [online] Available at: <<https://www.cia.gov/library/publications/the-world-factbook/rankorder/2173rank.html>> [Accessed 9 may 2011].

Chang, C. & Griffin, R., C. (1992). Water Marketing as a Reallocative Institution in Texas. *Water Resources Research*, 28 (3), pp. 879-90. Texas A&M University.

Chisholm, H. (1911). *Petroleum*. In *Encyclopædia Britannica*. 11th ed. 21, pp. 316–322. Cambridge: Cambridge University Press.

CBOT (Chicago Board of Trade). (2006). *The Chicago board of trade handbook of futures and options*. McGraw-Hill.

Clubley, S. (1998). *Trading in oil futures and options*. Cambridge: Woodhead Publishing Ltd.

Coase, R. (1960). The problem of social cost. *Journal of Law and Economics*, 3(1), pp. 1-44.

Colby, B. (1995). Regulation, imperfect markets, and transaction costs: the elusive quest for efficiency in water allocation. *Handbook of environmental economics*, Vol(No), pp.475-502, Cambridge USA: Blackwell

Colby, B. Crandall, K. and Bush, D. (1993). Water right transactions: market value and price dispersion. *Water Resource Research*, 29, pp. 1565-1572.

Commodity Online. (2011). FMC rules out immediate return of rice futures trade in India. [online] 3 February. Available at: <<http://www.commodityonline.com/news/FMC-rules-out-immediate-return-of-rice-Futures-trade-in-India-36179-3-1.html>> [Accessed 27 April 2011].

Dawe, D. (2001). How far down the path for free trade? The importance of rice price stabilization in developing Asia. *Food policy*, 26, pp. 163-175.

Dow Jones Newswires. (2008). *India suspends futures trading in 4 more commodities*. Newsbeat Commodities.

Dupuit, J., 1844. De la Mesure de l'Utilite des Travaux Publiques. *Annales des Ponts et Chaussées*, 2nd Series, 8 Reprinted in translation (1952) as "On the Measurement of the Utility of Public Works", in *International Economic Papers*, 2: 83-110

Elting, J. T. (2000). *Energy futures: Trading Opportunities*. 3rd ed. Tulsa: PennWell Corporation.

Encyclopædia Britannica, (2011). *Fossil fuel properties*. [online] Available at: <<http://www.britannica.com/EBchecked/topic/20073/American-Petroleum-Institute-gravity-scale>> [Accessed 30 March 2011].

Encyclopædia Britannica, (2011). *Water* [online] Available at: <<http://www.britannica.com/EBchecked/topic/636754/water>> [Accessed 9 May 2011].

Eriksson, N. & Strömbäck, C. (2011). *Water taste sensitivity test*, 27 April 2011.

IBM. (2010). *Smarter water management*. [online] Available at: <http://www.ibm.com/smarterplanet/us/en/water_management/ideas/index.html> [Accessed

15 March 2011].

IRRI (Asia Society and International Rice Research Institute). (2010). *Never an empty bowl: Sustaining food security in Asia*. Asia Society and International Rice Research Institute Task force report.

Hanemann, W. M. (2005). The economic conception of water. In *Water Crisis: Myth or Reality*, ed. P Rogers, MR Llamas, LM Cortina, pp. 61–92. London: Taylor & Francis

Hearne, R., R. & Easter, K., W. (1998). *Economic and financial returns from Chile's water markets*. In Easter, et al. (Ed.), *Markets for Water: Potential and Performance*. Boston: Kluwer.

Hesler, C. (2008). *No substitute for crude oil*. [online] 6 September. Available at: <http://www.forbes.com/2006/08/09/canetic-crude-oil-in_ch_0809soapbox_inl.html> [Accessed 10 May 2011].

Holden, P., & Thobani, M., 1996. *Tradable Water Rights; A Property Rights Approach to Resolving Water Shortages and Promoting Investment*, The World Bank, Latin America and the Caribbean Technical Department, Economic Adviser's Unit

Homer-Dixon, T., F. (1999). *Environment, Scarcity and Violence* Princeton. Princeton University Press, pp. 100-

Howe, C., Scurmeier, D. and Shaw, W. (1986). *Innovative approaches to water allocation: The potential for water markets*. *Water Resources Research* 22

Howitt, R. & Hansen, K. (2005). The Evolving Western Water Markets. *Choices Magazine*. [online] 1st quarter. Available at: <<http://www.choicesmagazine.org/2005-1/environment/2005-1-12.htm>> [Accessed 24 april 2011].

Hyne, N., J. (Årtal) *Nontechnical guide to petroleum geology, exploration, drilling and production*. 2nd ed. Publisher: Pennwell Books.

ICWE (International Conference on Water and the Environment). (1992). *The Dublin Statement and Report of the Conference*. *International Conference on Water and the Environment: Development Issues for the 21st century*. Dublin, 26-31 January Publisher.

Irwin, H. (1954). *Evolution of futures trading*. Madison: Mimir Publishers Inc.

Jacobsen, D., I. (2002). *Vad, hur och varför? Om metdoyal i företagsekonomi och andra samhällsvetenskapliga ämnen*. Lund: Studentlitteratur.

Keeley, G. (2009). Barcelona forced to import emergency water. *The Guardian online* [online] 14 May. Available at: <<http://libweb.anglia.ac.uk/referencing/harvard.htm>> [Accessed 3 February 2011]

Jayne, T., S. (1993). *Sources and effects of instability in the world rice market*. MSU International Development Paper no 13. Department of agricultural economics, East Lansing: Michigan state university.

Jordan, C., 2007. In Donoso, G., 2008. *Water Use Rights Markets and Water Allocation: The Chilean Case*

JP Morgan. (2008) *Watching Water - A Guide to Evaluating Corporate Risks in a Thirsty World*. JP Morgan Chase & Co. Washington: Worlds Resources Institute

Landais, E. (2007) Emergency water reserves on the decline. *Gulf News* [online] 21 September. Available at: <<http://gulfnews.com/news/gulf/uae/environment/emergency-water-reserves-on-the-decline-1.201796>> [Accessed 3 May 2011]

Leurig, S. (2010). *The ripple effect, water risk in the municipal bond market*. Ceres Report.

Marshall, A. (1879). *The pure theory of (domestic) values*. London School of Economics.

Marshall, A. (1890), *Principles of Economics*. 1st ed. London: Macmillan.

Mc Mahon, T. (2011). *Monthly Crude Oil Prices*. [online] Available at: <http://inflationdata.com/inflation/inflation_rate/historical_oil_prices_chart.asp> [Accessed 10 May 2011]

Mentor, J. (2001). *Trading Water, Trading Places: Water Marketing in Chile and the Western United States*. Publisher

Morgan Stanley-Smith Barney (MS-SB). (2010). *Water: The Perfect Storm*. Thematic Investing Report June 2010, Ort: Morgan Stanley

NWC (förkortningen utskriven). (2011). *National Water Commission* [online] Available at: <<http://www.nwc.gov.au/>> [Accessed 28 April 2011]

Oilprices.org, (2010). *Types of crude oil – Classifications of crude oil*. [online] Available at: <<http://www.oilprices.org/types-of-crude-oil.html>> [Accessed 30 March 2011]

Olson, M. (1956). *The logic of Collective Action: Public goods and the theory of groups*. Harvard University Press

OPEC (Organization of Petroleum Exporting Countries). (2011). *Brief history*. [online] Available at: <http://www.opec.org/opec_web/en/about_us/24.htm> [Accessed 31 March 2011].

People's Online Daily. (2009). China hopes early rice futures contract means bigger global price role. Tidning [online] 20 april. Accessed at: <<http://english.peopledaily.com.cn/90001/90778/90857/90861/6640954.html>> [Accessed 25 April 2011].

Purt, J. (2011) UK sends emergency drinking water to Japan. *The Interdependent*, [online] 28 March. Available at: <<http://www.independent.co.uk/news/uk/home-news/uk-sends-emergency-drinking-water-to-japan-2255488.html>> [Accessed 3 May 2011].

Reuters Africa. (2011). *India's exchanges not ready for rice futures relaunch*. Journal [online] 2 February. Available at: <<http://www.suite101.com/content/leading-rice-export-countries-a50965>> [Accessed 8 May 2011].

Reuters Africa. (2011). *Tokyo grain to set details of rice contract end-Feb*. Journal [online] 15 February. Available at: <<http://af.reuters.com/article/idAFTOE71E05Y20110215>> [Accessed 27 April 2011].

Reuters Africa. (2011). *Japan eyes rice revival after 72 years*. Journal [online] 8 March. Available at: <<http://af.reuters.com/article/metalsNews/idAFTOE72706H20110308>> [Accessed 8 May 2011]

Ricardo, D. (1817). *On the principles of political economy and taxation*. 3rd ed. Town: John Murray, Ablemarle-Street (1821)

Rice Today. (2007). No futures for Indian rice. *International rice research institute*. April-June 2007, 6(2) Publisher

Ríos Brehm, M. & Quiroz, J. (1995). *The Markets for Water Rights in Chile*, Technical Paper Number 285, Washington D. C., World Bank

Rosegrant, M. & Gazmuri, R. (1994). *Reforming Water Allocation Policy through Markets in tradable Water Rights: lessons from Chile, Mexico and California*. Town: International Food Policy Research Institute

Sampath, R. (1992). Issues in Irrigation Pricing in Developing Countries, *World Development*, vol 20 (7), pp. 967-977. HÅR ÄR JAG

Savenije, H. and Van der Zaag, P., 2000. *Towards Improved Management of Shared River Basins*. Publisher

Savenije, H. and Van der Zaag, P., 2002. *Water as an Economic Good and Demand Management*. Water International, Volume 27, Number 1, Pages 98-104

Smith, A., 1776. *An Inquiry into the Nature and Causes of the Wealth of Nations*. 1st ed. W. Strahan and T. Cadell, London

Stavins, R., N. 2001. Experience with market-based environmental policy instruments. Discussion paper 01-58. Resources for the future

Svenning, C., 1999. *Metodboken*. 3rd ed. Lorentz Förlag

Szabo, P. 7 june 2010. BP Gulf Oil Spill – Impact on America’s Environment and Economy. [online] Retrieved at: <http://www.suite101.com/content/bp-gulf-oil-spill--impact-on-americas-environment-and-economy-a246061> Accessed at: 9 may 2011

Szydlowski, J.C, 2011, Interview with J.C. Szydlowski, Worlds Fresh Waters, 21 February

Takatsuki Yasuo, 2007, The formation of the efficient market in Tokugawa Japan, Discussion Paper 06-28-Rev.2, Graduate School of Economics and Osaka School of International Public Policy (OSIPP) Osaka University

The Australian. 8 nov 2010. Rice exchange in Singapore to safeguard the world's poor. Retrieved at: <http://www.eco-business.com/news/rice-exchange-singapore-safeguard-worlds-poor/>
Accessed at: 8 may 2010

The Coca-Cola Company, Our Water Conservation Goal [online] Available at:
http://www.thecoca-colacompany.com/citizenship/water_pledge.html [viewed: 27 April 2011]

The Economist, 2010, A Special Report on Water, 20 May

Tisdell, J., Ward, J., Grudzinski, T., 2002. *The development of water reform in Australia*, Cooperative Research Center for Catchment Hydrology. Location Technical Report 02/5 2002

Tisdell, J., and Ward, J., 2003, 'Attitudes toward Water Markets: An Australian Case Study' *Society and Natural Resources* 16: 61-75.

Turrall, H. N. 2005, Water trading at the margin: The evolution of water markets in the Murray-Darling Basin, *Water Resources Research*, vol. 41, W07011

UN/WWAP, 2003, UN World Water Development Report: Water for People, Water for Life. Paris: UNESCO

UNESCO, 2009. *The united nations world water report 3; Water in a changing world*. (UNESCO ISBN: 978-9-23104-095-5) Paris/London: UNESCO publishing.

United Nations Environment Programme (UNEP), 2002. *Global environment outlook 3*. (ISSN: 1366-8080) United Kingdom/United States: Earthscan

University of Michigan, 2000. *Human appropriation of the world's fresh water supply*. [online] (Last updated 1 April 2006) Available at:
<http://www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html> [Accessed 3 February 2011].

Voß, J-P. 2007. Innovation processes in governance: the development of “emissions trading” as a new policy instrument. *Science and public policy* 34(5)

Wailes, E., J.2005. Rice: Global trade, protectionist policies, and the impact of trade liberalization. S.177-194 (chapter 10) in *Global agricultural trade and developing countries*, The world bank US Rice Producers (USRPA) 2011 Accessed at:
http://www.usriceproducers.com/calendar?task=view_detail&agid=69&year=2011&month=03&day=28 April 24, 2011

Wakita, S. 2001 Efficiency of the Dojima rice futures market in Tokugawa-period Japan. *Journal of Banking & Finance* 25 (2001) 535±554

West, M., D. 2000. Private Ordering at the world’s first futures market exchange. *Michigan Law Review*. Vol 98, no 8

Wharton Universia. (2006). Brazil exploits ethanol as a substitute for petroleum. [online] 22 February. Available at:
<<http://www.wharton.universia.net/index.cfm?fa=viewfeature&id=1109&language=english>>
[Accessed at: 10 May 2011]

Williams, J., C. 1982. *The origins of futures markets*. Ej klar

Wolfe, S. & Brooks, D. (2003). Water scarcity: An alternative view and its implications for policy and capacity building. *Natural Resources Forum* 27, p. 99-107.

Workman, D. 16 april 2008. Leading rice export countries. Suite 101. Retrieved at:
<http://www.suite101.com/content/leading-rice-export-countries-a50965> Accessed at:8 may 2011