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The Columbia River Treaty Renegotiation from the Perspective of Contract Theory

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Abstract: This paper contributes to the literature on transboundary water agreements by analyzing the Columbia River Treaty renegotiation from the perspective of contract theory. Contract theory has become a powerful part of the economics toolbox but it is much less well known outside of the discipline than game theory. We demonstrate the importance of the concept of contract completeness in identifying efficient contractual arrangements that can consider the tradeoffs of increased flexibility. The limited objectives of the first treaty meant that it was possible to write a complete contract. Climate change and more complex stakeholder interests have moved any future agreement into the realm of incomplete contracts. Alternative types of incomplete contracts are considered as potential future treaty arrangements. The approach used in this study should provide a more general framework for working through potential treaty designs from an efficiency standpoint.

Keywords: *dam operations, flood control, hydropower, incomplete contracts, international river basin, transboundary water management*

The Columbia River Treaty (CRT), signed between Canada and the United States in 1961, led to the construction of three dams in Canada that provided benefits to the U.S. through increased hydropower production and flood control. However, the future of the CRT is uncertain. Either country can exit the agreement starting in 2024 with a ten year advance notice. There were extensive stakeholder outreach meetings in both Canada and the U.S. in the years leading up to 2014 which have attracted a great deal of interest and substantial interaction with a diverse set of interests reflecting the central position that the Columbia River plays in the region.

The objective of this paper is to assess the potential continuation of the existing treaty and alternatives from a contract theoretic perspective. Contract theory is a framework developed in economics for understanding the general nature of exchange. The existing literature on transboundary water management and agreements has almost exclusively used game theory (e.g., Rogers 1969; Frisvold and Caswell 2000; Kilgour and Dinar 2001), which was a significant improvement on the "mutual benefit" approach that ignored the role of strategic behavior (Dufournaud 1982). Game theory plays an important role within contract theory, but contract theory provides a more general framework that we find adds significant additional insights.

To pursue our objective, we start by economically characterizing why Canada and the U.S. were motivated to go to the trouble of negotiating the existing CRT. We then consider what has changed since the existing treaty was signed to understand how incentives may have changed for either country to seek an alternative contractual arrangement. We conclude by analyzing the performance of alternative contractual arrangements in terms of their efficiency and feasibility.

Two important events occurred in the Columbia River Basin (CRB) in the first half of the 20th Century that increased the economic value of water storage to the U.S. The first was a growing population in areas of the CRB that were prone

to flooding. The area at highest risk is around Portland, Oregon. A large flood occurred in 1948 resulting in 50 deaths and the complete destruction of the second largest city in Oregon at the time. The other factor was the construction of large hydroelectric dams on the Columbia River during the Great Depression. Given promising storage potential in Canada, the two countries initiated talks that led to the signing of the treaty and the construction of Mica, Duncan, and Keenleyside Dams which were completed between 1967 and 1973. The extent of the CRB is shown in Figure 1 where the lighter gray portion is Canada and the darker gray is the U.S. Figure 2 gives a sense of how the flow of the river was altered. It was common to see flows over 400,000 cubic feet per second before the CRT, compared to only one observation this high after the Canadian dams were completed.

The terms of the CRT are fairly simple. Canada receives half the value of the potential hydropower generation annually, which is referred to as the Canadian Entitlement. They are also on-call to mitigate flood risk when conditions arise. There is some disagreement across sources of the various

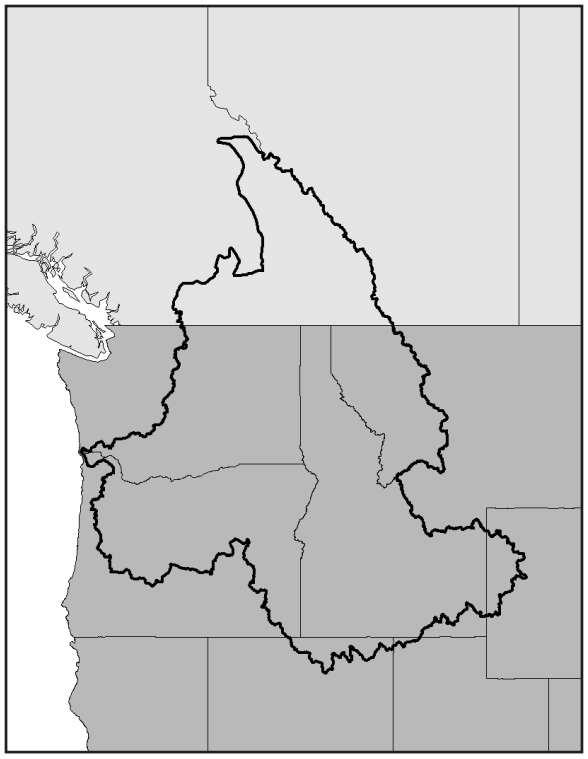

Figure 1. The boundary of the Columbia River Basin in Canada (light gray) and the United States (dark gray).

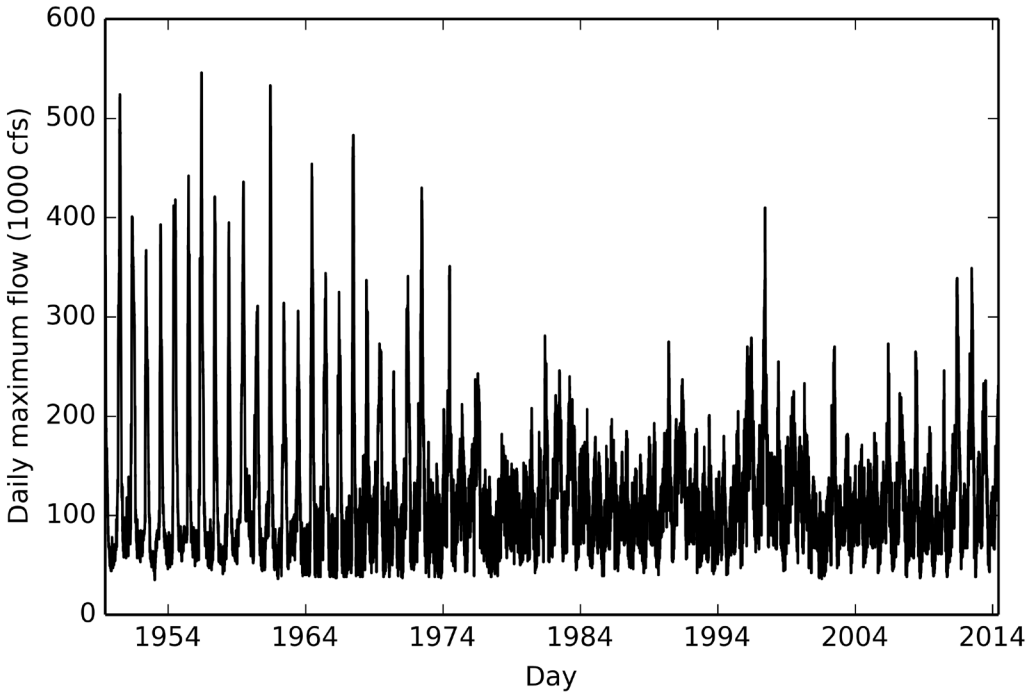

Figure 2. Average daily peak flows before and after storage dam construction (source: United States Geological Survey).

benefits of the CRT and it is beyond the scope of this paper to review them in detail, but a few numbers help put costs and benefits in perspective. Not needing additional electricity at the time, Canada sold their share of electricity to U.S. utilities for the first thirty years of the CRT at a value of $254 million. This covered the cost of construction for the three dams. Since 2004, Canada has received their share of power generation annually (U.S. Army Corps of Engineers and Bonneville Power Administration 2009). Benefits for hydropower and flood control vary each year, but are estimated to be in the hundreds of millions of dollars. The United States Army Corps of Engineers (2001) has estimated damages prevented by Columbia storage regulation during 1972, 1974, 1996, and 1997 at about $260, $306, $227 and $379 million.

Before proceeding to the technical discussion in the next section, it is worth considering why the current agreement is being considered for renegotiation given that the hydropower and flood benefits are large compared to the costs of constructing the storage dams in Canada. Among stakeholder groups in the U.S., the hydropower industry has argued most vociferously that the Canadian Entitlement should be based on *actual* rather than potential hydropower production. They argue that the gap between the two is wider than was expected at the time the CRT was negotiated because of constraints on operations due to the influence of the Endangered Species Act and flow augmentation for ecological benefits (U.S. Entity 2013). Second, flood control mainly benefits the Portland region, while costs are imposed on electricity rates throughout the Pacific Northwest, and Seattle in particular. Hydropower interests state that the cost of flood control should be borne at the Federal level by the U.S. taxpayer in accordance with general flood policy for the Federal government (U.S. Entity 2013).

The other source of contention over the existing treaty is the narrow scope of benefits and costs. The population of Washington grew from 2.3 million in 1950 to about 7 million currently (U.S. Census Current Population Survey). This has brought a number of new interests that extend beyond hydropower and flood control to the table. The attractiveness of the region to migrants is in part driven by environmental amenities (Schmidt and Courant 2006). This increases the value of ecosystem services like fisheries, which have been directly harmed by dam operations. Tribal groups in both the U.S. and Canada have also become much more politically active in seeking to exert their senior fisheries rights. Recreation activities like boating are also often at odds with flow management for hydropower and flood control. Drawing down reservoirs in the winter allows for additional storage capacity in the spring if it is needed to prevent flooding. However, lower river levels impede fish passage. Low lake levels can persist into the mid-summer if snowmelt is late, which hurts boating recreation. The Columbia Basin Project provides irrigation to almost 700,000 acres of agricultural land in Washington State, and irrigation interests have expressed dissatisfaction with operating reservoir levels for flood control. Finally, climate change has significantly increased uncertainty over future flood and drought conditions, drawing the efficacy and equity of the existing treaty into question as well.

The consequence of these developments is that the management of the Columbia River has become much more complex due to the increase in the scope of stakeholder interests. As we describe in the next section, from the perspective of contract theory this takes us from the realm of a complete to an incomplete contract. The degree of contract completeness is a critical component to consider when assessing the feasibility and efficiency of potential agreements. For a consideration of the effect of increased uncertainty on the renegotiation of the CRT from a legal perspective see Cosens (2010).

A Contract Theoretic Analysis

In this section we define contracts as a framework for exchange, and characterize the relationship between the structure of information, the structure of contracts, economic incentives, and the distribution of economic outcomes. We then characterize various alternative contract designs in the context of the CRT.

Contracts as a Model of Exchange

While the term "contract" is commonly used in the vernacular, it has a specific meaning in

economics, and is defined as "a statement of the rights and obligations of each party to a transaction or transactions" (Bannock et al. 2004, 72). There are a number of familiar situations that require what can be thought of as a formal contract, such as an apartment rental agreement or the leasing of farmland. However, these provide a limited view of the role that contractual agreements actually play in the world. In fact, almost every economic transaction can be viewed as a type of contract. Most people do not think of themselves as being a party to a contract when they buy apples at the grocery store, but the concept of the market as a basis for allocating scarce resources is just a particular type of contract.

Contract theory has developed a powerful taxonomy that provides substantial guidance in thinking about the forces influencing the characteristics of an exchange. Economists use this to compare contracts in terms of efficiency, which simply refers to the net benefits generated by the terms of the exchange. Part of this analysis is the explicit consideration of whether a contract is amenable to all parties. Another important use of this taxonomy is that by observing what types of contracts are used in certain situations we can better understand the nature of the exchange, the objectives of transacting parties, and the supporting institutions that facilitate exchange. For example, historically most farmland leases were informal without any written terms, but increasingly they are formal written contracts. Evidence suggests this increase is due to the fact that more lessors are now retired farmers who are somewhat removed socially and geographically from farming. Traditional informal contracts with lessees that are harder to monitor and enforce with distance are becoming less desirable than those with legally binding formality (Allen and Lueck 1992).

This raises an interesting question. Given the costs of negotiating and the restrictions of operating under the CRT, why didn't the U.S. and Canada simply develop an informal, flexible process of managing the river rather than entering into a relatively precise 50 year contract?

We will leave this question unanswered momentarily to first define a contract more formally. Following Bolton and Dewatripont (2005, Ch. 11), abbreviated as BD from here on, we define a contract to be between two parties that only have an option to contract with each other over n potential services abbreviated by a_i where $i = 1,\ldots, n$. Canada is the seller of water storage related services and the U.S. is the buyer of these services. The assumption that there are no other potential parties to contract with is often a convenient simplification, but in the case of the CRT it is perfectly reasonable. Variation in weather that affects run-off timing and magnitude is a source of stochasticity, which we will think of as creating a set of possible states of the world. The state of the world at the point in time where the service is provided is not known when the contract is defined. Denote the potential states of the world by θ_l for $l = (1,\ldots, N)$. The price paid, P_i, by the buyer for the service that goes to the seller is a function of the service provided. The seller incurs some cost that depends on which service is provided and the state of the world it is provided in, which is represented by $\gamma(a_i, \theta_l)$. The net benefit to the seller from the transaction is $P_i - \gamma(a_i, \theta_l)$. For the buyer there is also the potential to make an investment I ex ante that increases the benefit they receive from water storage services. The payoff to the buyer from the transaction is $U(a_i, \theta_l, I) - P_i$, where $U(.)$ is assumed to be increasing at a decreasing rate as a function of investment level. As will be demonstrated, the efficiency of alternative incomplete contracts is completely driven by the buyer's ex ante investment choice, which leads us to the concept of completeness of a contract.

The ability to write a contract also depends on observability and enforcement ex post. Many economic transactions are plagued by problems of non-observability and non-enforcement, but this is not one of them. It is easy for the U.S. to observe that the service that Canada states they will provide is indeed provided, for obvious reasons. There is no uncertainty over the quality of the product. There also does not appear to be a problem with enforcement. This cannot always be taken for granted with agreements between countries, as can be seen by the number of disputes taken to the World Trade Organization for mediation.

Contract Completeness

A critical dimension over which a contract is evaluated is in terms of its completeness. A

complete contract is one where the contract specifies (a, P) for every possible θ. This simply means that every potential state of the world can be described ex ante and the parties can specify terms of trade for every possible θ. An incomplete contract is one where it is prohibitively costly for the buyer and seller to write a contract that specifies service and price for all potential states of the world. The distinction is important because a complete contract prevents efficiency loss that occurs from opportunistic behavior ex post. A strict dichotomy between complete and incomplete contracts is often used in theoretical work for simplification, but it is probably unrealistic to assume that any actual contract can be fully complete. It is more realistic to think of a contract as being nearly complete, or to compare two contracts where one is more incomplete than the other. For simplicity, we use the definition of a complete contract from Hart and Moore (1999) who consider the parties to be boundedly rational: *A complete contract is one in which the contract has not failed to specify terms for any obvious potential future scenarios relevant under the contract.* How can we distinguish between a more or less complete contract? For practical purposes, one observable ex post indicator is whether or not there have been legal actions brought by one party in response to the other party. Lawsuits are costly and will only be carried out if there is some ex ante uncertainty about the outcome, implying imperfect specification of rights and responsibilities under the contract, which in turn is an indication of contract incompleteness.

For the original treaty negotiation, the uncertainty over the state of the world in any given year was due to weather variability that affected the amount of water storage the U.S. would demand. The solution was to write a contract stating that Canada would operate dams to maximize potential hydropower production with the additional provision that flood prevention services were to be provided on-call at the request of the U.S. Is this a fully complete contract? There could have been a scenario where Canada deviated from the agreed upon water storage services, or where the U.S. reneged on their payment of the Canadian Entitlement. Either country could have tried to make the case that the state of the world was outside of the bounds of what was considered possible when the treaty was signed. While there has been opposition to how the river has been managed, neither country deviated from the terms of the treaty, nor have there been extreme years over the lifetime of the treaty with flood conditions and droughts. Therefore, it makes sense to think of the current CRT as a functionally complete contract.

We can now formally state what we think is the major change in the nature of the treaty negotiations today compared to fifty years ago. The original CRT is a functionally complete contract in relation to its stated goals, but any future agreement will almost certainly be incomplete because of climate change and the increased dimensionality, heterogeneity, and informational uncertainty of stakeholder interests. Take climate change first. While the science behind climate change is well established, there is an ever growing appreciation of the uncertainty over the rate of greenhouse gas emissions and subsequent changes in climate (Dufresne et al. 2013). As a result, the U.S. and Canada cannot realistically define all potential states of the world, particularly from a probabilistic standpoint.

Even more consequential is the expansion of both the number and heterogeneity of stakeholder interests at the table in contract negotiations. This large diversity of interests has made it essentially impossible for each country to define an optimal water storage service for their constituents that addresses the dizzying array of possible future states of the world pertinent to a CRT contract. For Canada, it is difficult to define the costs of water storage services in terms of lost fishery benefits. For the U.S., how are all of the various interests to be weighted? How will those weightings change over time? In other words, what enters into the utility function of the U.S., and how do these dimensions relate to each other? This is a difficult political economy problem that is essentially impossible to definitively answer (as shown by Kenneth Arrow's famous "Impossibility theorem" (Arrow 1950)). The existing CRT considered both hydropower and flood control, but that was relatively simple. Storage services were optimized for hydropower until flood conditions arose, which then took priority.

When considering the feasibility of a complete contract, the question is not whether it is technically impossible to characterize all states of the world and agree to terms in each case that leads to a contract being incomplete, but that the cost of writing the contract is greater than the ex post inefficiencies that arise from incompleteness (Crocker and Reynolds 1993). Overlay climate change with a diverse array of interests that have varying political influence over time and it is nearly impossible, or at least enormously costly, to write a complete contract.

Investment Decisions and Hold-Ups

Before examining the effect of incompleteness on a renegotiated treaty, we use our description of a complete contract to consider why it made sense to agree to a treaty in the first place. An important time-invariant characteristic of the basin is that there is greater storage potential in Canada than the United States simply due to the characteristics of the landscape. Had most of the storage potential been in the U.S. there would likely be no need for a contract between the two countries given that Canada is upstream.

Another factor that made a treaty more likely were required investments. There is substantial theoretical and empirical support for the idea that long-term contracts arise when an investment is required for the seller to produce the good, or to increase the value of the service to the buyer. To be clear on terms, a long-term contract is one that establishes terms of repeated transactions ex ante (Joskow 1985). Canada had to build the storage dams in order to supply the U.S. with water storage services, but the absence of a long-term agreement would be a problem because there is no other potential buyer. Canada would seek to avoid a hold-up problem that arises because the sunk investment generates quasi-rents that would put the U.S. in a stronger negotiating position (Klein et al. 1978). However, this type of strategic investment without a guaranteed agreement with a buyer is not unusual. Governments and private firms often make investments strategically to lure companies to their region without a formal contract specifying this as a condition. The aspect of the CRT that is important here is that the U.S. is the only potential buyer of water storage services. This is what Oliver Williamson (1983) called a "dedicated asset" and defined to be an investment made by a supplier who can only sell the resulting product to a specific buyer. It is also referred to as a relationship-specific investment. Joskow (1985) hypothesized that a prediction of Williamson's model is that the buyer and seller will agree to longer term contracts that avoid repeated bargaining, for which he found empirical support in the context of the coal industry. Therefore, the requirement of a relationship-specific investment provided a strong incentive for a long-term contract like the CRT.

Hold-up problems can also arise for buyers, which is why it is interesting that the U.S. built the hydroelectric dams before the CRT. Our contract theoretic model would predict that the negotiating position of the U.S. is weaker now than in the initial negotiations because the dams have already been constructed. Is there evidence of this? One way to view the Canadian Entitlement is that the allocation of 50% of potential hydropower production, rather than actual production, is simply an easier way of incorporating flood control benefits into the price. The split of 50% of net benefits is an important benchmark because it is the Nash equilibrium for this type of game (Binmore et al. 1986; Frisvold and Caswell 2000). However, an alternative case can be made that the gap between actual and potential that goes to Canada was due to the stronger negotiating position resulting from the U.S. having already made the hydropower investments.

Alternative Incomplete Contract Designs

Given that any future agreement will be incomplete, we now consider feasible contractual arrangements in general terms, assess their relative efficiency, and evaluate their durability.

The simplest type of incomplete contract to consider is a spot contract. The attractive feature of a spot contract is that the parties do not have to incur the cost of thinking through and negotiating over potential future states of the world ex ante. The parties to a potential contract simply observe the state of the world (including their expectations for the future) and negotiate contract terms a and P for a one-time transaction, where a and P are the contracted service rendered and the price for that service as previously defined. The problem with a spot contract is that it may lead to an inefficient

level of investment by the buyer. We will first show this generally and then in the context of the CRT. Following the simplification described in BD, we discretize benefits and costs of three potential outcomes: $U(a_i, \theta_l, I) \in \{0, \phi(I), \Phi(I)\}$ and $\gamma(a_i, \theta_l) \in \{0, c, C\}$, where conditional utility levels $\phi(I) < \Phi(I)$ and costs $c < C$ are defined such that outcomes in terms of high/low benefits/costs are $0 < \Phi(I) - C < \phi(I) - c < \Phi(I) - c < \Phi(I) - 0$. Any positive amount of service incurs some cost and the highest value service requires the highest possible cost. This means that the maximum surplus is realized by $\Phi(I)$ at a cost of c ($\Phi(I) - c$). There is always a service option ex post that makes this outcome achievable, but the rightmost value, high benefits without service costs ($\Phi(I) - 0$), is infeasible.

This set-up makes the buyer's ex ante investment decision the sole determinant of the contract's efficiency. Why should investment decisions be so important looking ahead given that the hydropower dams on the U.S. side and the storage dams in Canada have already been built? It comes down to the net benefits of potential investments in the U.S. that would be chosen in the absence of Canadian storage services provided under the CRT. Investing in infrastructure for water storage, flood control, and fish passage in the U.S. has an opportunity cost equal to the investment in some alternative infrastructure. There is a significant amount of discussion of these types of investments in the U.S. stakeholder feedback documents.

The spot contract can be shown to lead to a less efficient level of investment compared to what is globally optimal by specifying the optimization problem in each case. Normalizing the cost of investment so that $\kappa(I) = I$, the following maximization problem for the buyer identifies the most efficient level of investment, $I^*, max_{I \geq 0}\{\phi(I) - I\}$. This problem is solved where the marginal return on investment equals 1: $\phi'(I^*) = 1$, which can be shown by differentiating the objective function, $\phi(I) - I$, with respect to I and setting equal to zero.

For the spot contract, the surplus is split evenly between the buyer and seller so that each receives $(\phi(I) - c) / 2$). The optimal investment level for the buyer can be found by solving $\max_{I \geq 0}\{(\phi(I) - c) / 2 - I\}$, which gives $\phi'(I^*) = 2$. Investment is subject to diminishing marginal returns due to concavity of the objective function, so an outcome with a higher marginal return implies lower investment. Because the marginal return on investment is higher under the spot contract than under the efficient contract, it follows that the spot contract induces underinvestment by the buyer.

If there is a loss in efficiency with the spot contract from not being able to specify terms ex ante, it makes sense to consider a contract that addresses this problem. One possibility is a contract where the buyer and seller agree to a particular service at a set price ex ante that will be provided no matter the state of the world that is realized. This is often called a sales contract. In the CRT context this could be thought of as a specific plan for dam operations at a particular price under any given foreseeable state of the world. If river flows are such that these dam operations are optimal, then the contract is executed. If not, there is an incentive for both parties to want to renegotiate. Renegotiation may not seem like a problem, but as Hart and Moore (1988) showed in a landmark paper the most efficient contract is not achievable when the two parties make relationship-specific investments and there is an incentive for renegotiation. The reduced efficiency occurs because the potential for renegotiation is recognized ex ante at the time the buyer makes their investment decision. Assuming that the two parties are assumed to evenly split the additional surplus for the renegotiated contract relative to the original contract, and making some additional assumptions on the probability distribution of the stochastic process that the parties face, it can be shown that the sales contract also leads to underinvestment relative to the complete (efficient) contract, but it outperforms the spot contract.

Two other alternative, incomplete contracts that are mirror images of each other are the *buyer-employment* and the *seller-employment* contract. Their common element is that they try to build in flexibility to avoid renegotiation by allocating control over which service to provide ex post to one of the parties. The original motivation for the buyer-employment contract was the firm-employee contractual relationship. The firm pays the employee's salary, and then within agreed upon limits that can be defined as the set of acceptable services A where $a \in A$, specifies the services for

the employee to provide ex post under the contract. With the seller-employment contract the seller gets to choose a from A ex post while the contract is in force.

Despite the additional flexibility there is still an incentive for renegotiation. With the buyer-employment contract, the buyer will choose a corresponding to the high service for any predetermined price because $\Phi(I) - P > \phi(I) - P$. For the seller-employment contract the seller will choose a corresponding to $\gamma(a_l, \theta_l) = 0$ no matter what price is pre-specified. In both cases each can be convinced to renegotiate because there is an alternative service and price that leads to a larger total surplus of $\phi(I) - c$ that would be split equally leaving both better off. Again, foreseeing the potential for renegotiation causes the buyer to make an inefficient ex ante investment decision.

Implementation of the buyer-employment contract is fairly easy to envision as a form for a new CRT. The U.S. would pay Canada the same amount every year, or a lump sum that corresponds to the present value of this stream of equal valued payments, and in return the U.S. tells Canada exactly how to operate their dams. The obvious concern for Canada is that there may be some state of the world where the dam operations preferred by the U.S. impose significant costs due to potential impacts on fisheries or recreation. If that state were to occur, then Canada would likely renegotiate to some different operation schedule. The U.S. would agree because the additional cost relative to its most preferred operation is less than the amount transferred from Canada. However, this likely affects the investment decision for the U.S. It is more difficult to conceive of a seller-employment contract as an outcome due to concerns over catastrophic events like flooding around Portland that would limit the set A that the U.S. would agree to allow Canada to choose from.

Could either the buyer-employment or seller-employment contract outperform the sales contract, and are any of these choices realistic contractual arrangements for a renegotiated CRT? While the content of the position reports are clearly strategic, they do provide some useful information on how each country views the feasibility of the alternative contract designs we have discussed. Canada believes that if the existing CRT were terminated, the outcome would be the spot contract based on the statement *"If the two countries cannot agree on changes within the Treaty framework, there is almost no hope that an entirely new Treaty could be negotiated."* (BC Ministry of Energy and Mines 2013, 21).

The U.S. does not take the same position. Consider the statement *"The minimum duration of the Treaty post-2024 should be long enough to allow each country to rely on the Treaty's planned operations and benefits for purposes of managing their long-range budgets, resources plans, and investments, but adaptable enough to allow responses to new information and changing conditions."* (U.S. Entity 2013, 3). There are a number of other references to moving to an incomplete contractual arrangement such as *"The strategy for adapting the Treaty to future changes in climate should be resilient, adaptable, flexible…"* (U.S. Entity 2013, 3). The general tenor of the U.S. report is to move to an arrangement generally fitting into the buyer-employment contract where the U.S. chooses the service ex post and Canada receives compensation at a price reflecting the high cost service, such as *"identify reasonable compensation to Canada for economic losses and operating costs"* which refers to the provision of flood control (U.S. Entity 2013, 5).

While it is beyond the scope of this study to make a definitive assessment of efficiency, there is clearly value in considering the sales contract design as a potential compromise. It is likely that it would be more efficient than the spot contract and more politically feasible than the buyer-employment design promoted by the U.S. One caveat is the possibility that a spot contract repeated over time would lead to the adoption of informal terms that develop between the two countries that allow them to have flexibility in the most efficient way possible. This type of arrangement is referred to as a relational contract. Relational contracts have been shown to perform well in some contexts when two parties have repeated interactions without a finite horizon on the relationship (Baker et al. 2002). The point we hope to have demonstrated is that considering how to incorporate flexibility into a new long-term arrangement is very complicated when trying to compare alternatives, but this can be greatly simplified through the use of contract theory.

Conclusion

The intent of this paper is to contribute to the literature on transboundary water agreements by analyzing the Columbia River Treaty renegotiation from the perspective of contract theory. Contract theory has become a powerful part of the economics toolbox, but it is much less well known outside of the discipline than game theory, which has been the primary tool for analyzing these types of agreements to date. Game theory is nested within contract theory, but the latter provides additional insight. Our analysis starts from the position that the fundamental change in the current renegotiation compared to the original treaty negotiation is that any future agreement will be more incomplete than the existing agreement due to the increased complexity of stakeholder interests and climate change. Alternative types of incomplete contracts are identified in the literature and applied in the context of managing the flows of the Columbia River. The approach used in this study should provide a more general framework for working through potential treaty designs from an efficiency standpoint.

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