Do Water Service Provision Contracts with Neighbouring Communities Reduce Drinking Water Risk on Canadian Reserves?

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Bethany Lipka: [Slide 1]: In this presentation I will be discussing a paper co-authored by myself, Bethany Woods, and Professor Brady Deaton in the Department of Food, Agricultural and Resource Economics and the University of Guelph. In this paper we investigate drinking water contracts or water infrastructure partnerships between First Nations and neighbouring non-First Nation communities, looking at factors motivating the emergence of these agreements, as well as their implications for water quality on First Nation reserves. Drinking water quality has been a persistent concern in First Nations communities in Canada for many years. In 2011 the Department of Aboriginal Affairs reported 39% of drinking water systems on reserves could be classified as ‘high risk’, meaning they are not equipped to safely deal with any sort of external stressor or adverse event, such as the infiltration of a pollutant. In recent years many First Nations have contracted out their drinking water services to neighbour communities. These contracts generally stipulate that a First Nation purchases some pre-negotiated quantity of treated water from that neighbour, to service all or a portion of its on-reserve population, and that they be charged monthly based on the average cost of what they consume. These agreements are generally referred to as ‘municiplal type agreements’, or ‘MTAs’; I will refer to them as MTAs for the remainder of this presentation, and they are currently encouraged by the Canadian federal government as well as many First Nations leaders for their potential for cost savings and water quality improvements. However to date there has been no research on the relationship between these contracts and water quality on reserves. Ours is the first study to investigate this.

[Slide 2]: This study was motivated by two key questions. The first question that we asked is what influences First Nations’ decisions to participate in MTAs? And we focus specifically on characteristics of reserves that we expect to influence the costs of participation, namely geographic remoteness, population, and population density. And I will elaborate later on as to why we expected these characteristics in particular to influence participation costs. The second question that we asked is whether MTA participation reduces the likelihood of a boil water advisory being present on a participating First Nation reserve. The motivation behind this question stems from differences in drinking water quality regulations that exist between First Nation and non-First Nation communities in Canada. I will discuss this in more detail later on, but the key difference is that there are no enforceable drinking water quality standards that exist for First Nations reserves that are comparable to those that exist for non-First Nation communities.

[Slide 3]: Our dataset consists of 804 water systems located on approximately 690 reserves across Canada in all Canadian provinces as well as the Yukon Territory. Of these 804 water systems 143 are distributing water that was treated off-reserve in a neighbouring community. There are 143 MTAs in our dataset. And this map shows the location of all of those MTA water systems. If you look at the clustering, you can see that there are a significant number of these contracts in the densely populated southern region of British Columbia along the border with the United States, in an area where many First Nations are located, many of which in close proximity to neighbouring non-First Nation communities. A number of these agreements have also sprung up around oilsands activities in Alberta. This may reflect the high cost of treating drinking water that is exposed to this type of activity, which may encourage neighbouring communities to cooperate on treatment initiatives.

[Slide 4]: With respect to our first research question, we expect First Nations’ decisions to participate in MTAs to be influenced by the potential for cost savings. And this potential arises due to the unique cost structure of water service provision, which results in economies of scale in drinking water treatment, and diseconomies of scale in distribution. The cost structure of water services can be broken down very simply into treatment costs and distribution costs. Drinking water treatment is characterized by very high initial fixed costs associate with plant construction, relative to low variable costs, resulting in economies of scale and encouraging the construction of very large treatment facilities. In contrast, drinking water distribution is characterized by relatively low initial fixed costs, and variable costs that increase exponentially as the distribution network expands. And this is due to both the additional infrastructure and energy costs associated with transporting treated water further from a treatment facility, to a larger number of connections. So based on this cost structure, we expect First Nations governing reserves with smaller populations to be more likely to pursue MTAs, in order to take advantage of economies of scale in drinking water treatment with their neighbours; but we only expect these contracts to emerge in cases where reserves are in relatively close proximity to a potential MTA partner, and have relatively large population densities. And that is because a distribution network transporting treated water from a single off-reserve source to all or a portion of on-reserve households would only be economically feasible if the off-reserve treatment facility was relatively close, and the reserve consumers were not greatly dispersed. And this again is due to the significant costs associated with distributing treated water across large distances to relatively few consumers.

[Slide 5]: This slide shows summary statistics that help to motivate two of our key hypotheses. So this first table shows the average distance from each reserve in our dataset to its closest neighbouring population centre, and this is broken down by MTA participants and non-participants. And a population centre is defined by the Canadian Census as a geographic area with a minimum population of 1000 and a minimum population density of 400 people per square kilometer. And this was the measure of geographic remoteness used in our study. You can see when comparing the means that the average distance for an MTA participate is approximately have the average distance for a non-participant, indicating that proximity may influence the likelihood of the emergence of these types of contracts. The second table shows the population density of each reserve in our dataset, again broken down by MTA participants and non-participants. And again comparing the means, you can see that MTA participants have a population density average that is approximately 4 times greater than the average for non-participants, helping to motivate our hypothesis that reserves with large population densities will be more likely to seek out MTAs.

[Slide 6]: So with respect to our second research question, we expect MTAs to influence water quality outcomes on reserves due to differences in water quality standards that exist between First Nation and non-First Nation communities in Canada. So this figure shows the governance of water safety in First Nation and non-First Nation communities in Canada, with the flow chart on the left for non-First Nation communities and the one on the right being for First Nation communities. And you can see three different levels of government are represented: local, provincial/territorial and federal. In Canada drinking water quality standards are set at the provincial level, and these standards do not apply to First Nation communities, as demonstrated by that red circle. And that’s because First Nation reserves are governed federally under the Indian Act, and so they don’t fall within provincial jurisdiction. There are federal guidelines for drinking water quality on reserves that exist under Aboriginal Affairs, to-date these are not legally enforceable. Canada is the only OECD country that currently does not have federally enforceable drinking water quality standards. And so what this means for reserves, is that in addition to not having enforceable standards that are applicable to them, they also don’t have access to water quality monitoring resources that are available through the provinces to non-First Nation communities. And so as a result, individual First Nation bands are responsible for implementing their own community-based water quality monitoring programs, or for hiring external monitors. And even with federal support, the cost of these measures can be substantial. And so its these differences in standards and monitoring capacity that we expect to influence differences in water quality outcomes between reserves that are independently treating and distributing water, and reserves that are distributing water from a neighbouring provincially monitored treatment facility.

[Slide 7]: And this slide again shows some summary statistics motivating our hypothesis. So these two pie charts show the prevalence of boil water advisories in MTA and non-MTA water systems in our dataset, and you can see that among MTA water systems the boil water advisory prevalence rate is approximately 13.5%, and that’s compared to 31.4% for non-MTA water systems.

[Slide 8]: Two probit models were used to evaluate our two research questions. The first evaluated the effect of reserve characteristics on the likelihood that a First Nation would participate in an MTA, where the dependent variable was equal to 1 in the case where an MTA was present and 0 otherwise. And we focus specifically on the three characteristics discussed earlier: our measure of geographic remoteness, distance to the closest population centre, and then reserve population and reserve population density. We also included a vector of climate variables: 10 year average temperature range and 10 year average total annual precipitation, as well as a vector of dummy variables indicating which province each reserve resided within. These provincial dummies were included to control for potential institutional differences that may exist between Provincial jurisdictions, that may influence the transaction costs associated with negotiating these types of contracts, and also to control for potential differences among First Nations themselves that may vary from province to province, that might make MTA participation more or less likely. To evaluate the effect of MTA participation on boil water advisory prevalency on participating reserves, we again used a probit model where our dependent variable was equal to 1 in cases where a boil water advisory was in effect for the water system. And our key variable of interest was this MTA variable, which is identical to the dependent variable from the MTA participation model, being equal to 1 when an MTA was in effect. And in an attempt to isolate the effect of MTA participation, we also included a variety of other variables that we thought may have an influence on water risk as well. This included things like source water for independent systems, water system characteristics such as the type of distribution whether it be piped or trucked, the population serviced as a measure of scale, and system age. And then we included the same measure of geographic remoteness, the same climate variables, and the same provincial dummies as were included in the MTA participation model. A key empirical challenge that we faced with this study is that an identification issue emerges if the MTA variable is correlated with the error term in the boil water advisory model. And this could result if there is some characteristic of First Nations that’s not controlled for in either model that influences both the likelihood of MTA emergence and the likelihood of a boil water advisory being present. In an attempt to assess this endogeneity concern, we first ran both models simultaneously as a recursive bivariate probit model. This is a model that’s used to jointly estimate two binary outcomes. We then examined the correlation between the error terms of the two model equations, conditional on the other covariates, and we conducted a Wald Test on this correlation to assess whether it was significant. And this table shows the results of that Wald Test. With this test the null hypothesis is that the correlation between the error terms is equal to 0, and a failure to reject the null indicates that endogeneity concerns are not significant enough to require joint estimation of the two models in order to produce robust estimates. And you can see that we failed to reject the null, indicating that our correlation was not significant, and so both of our models were estimated independently. And those are the results that I will share here.

[Slide 9]: Three key data sources were used to characterize each of the water systems in our dataset. The first and most important is this National Assessment of First Nations Water and Waste Water Systems, published in 2011 by the engineering firm Neegan Burnside. And this is the most extensive survey of First Nations water systems to date. This report was commissioned by Aboriginal Affairs and Northern Development Canada. All but 4 First Nations in Canada participated in this study, and out of all of the participating First Nations all active water systems on their reserve lands were surveyed; with a water system being defined as any system that had received funding from Aboriginal Affairs, and could be as small as a well servicing a minimum of 5 people. This report contains very detailed data on water system characteristics, as well as a variety of quality and risk indicators, and it provided both of the dependent variables used in this analysis. So it identified when a water system was an MTA water system, and if a boil water advisory was in effect at the time of the survey. Additional characteristics of the reserves on which each water system was located were taken from the 2006 Canadian Census Aboriginal Population Profiles, as well as Environment Canada historic climate date. Our measure of proximity was calculated using 2006 Canadian Census boundary files for reserves and population centres, and GIS software.

[Slide 10]: And now on to the results.

[Slide 11]: This table shows results of our first model, the MTA participation model. And you can see that our measures of remoteness, reserve population and reserve population density were all found to be statistically significant with the expected signs. So we found that as the distance between a reserve and its closest neighbouring population centre was increased by 1 kilometer, the likelihood of an MTA emerging was reduced by approximately 0.1%. We found that as reserve population was increased by 100 people, the likelihood of an MTA emerging was reduced by approximately 1%. And as reserve population density increased by 100 people per square kilometer, we found the likelihood of an MTA emerging to increase by approximately 3%.

[Slide 12]: And this table shows the results of our second model, the boil water advisory prevalency model. And just focusing on our key finding, we did find MTA participation to reduce the likelihood of a boil water advisory being present on a reserve by approximately 16%. And this was when compared to independent water systems drawing from surface water sources.

[Slide 13]: And this table just shows some additional results from that second model.

[Slide 14]: So what are the implications of these findings? Well of the 654 water systems in our dataset that were not MTA water systems, we found that approximately half of these fall within a feasible distance to a neighbouring population centre, where they could be taking advantage of this type of agreement. Defining that feasible distance to be below the mean distance for the subset of MTA participants.

[Slide 15]: Looking at just the province of Ontario, this map shows the location of all the reserves in Ontario - all of the red, green and blue dots – as well as all of the population centres in Ontario buffered to that feasible distance. And all of the blue dots on the map, all of the blue reserves, are those that fall within this feasible distance to a neighbouring population centre that are not currently taking advantage of this type of contract. And there are 47 of these reserves. To date there are only 12 active MTAs in Ontario, represented by the green dots. And so you can see that there is quite a potential for these types of contracts to emerge even just within this province.

[Slide 16]: So in conclusion we’ve found that participation in an MTA does drastically reduce the probability of a boil water advisory being present on a reserve, and that the decision to participate in an MTA is influenced by reserve characteristics that affect participation costs. The fact that more First Nations are not taking advantage of these types of contracts likely indicates the presence of transaction costs. So there is a need for future research to illuminate the contract negotiation process, and to look more closely at the terms of these contracts, in order to identify areas where transaction costs can be reduced so that more First Nations can benefit from these types of agreements in the future.