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The Relationship between Airport Infrastructure and Flight Arrivals in Remote Northern Canadian Communities

Michael J. Widener,[1] Shoshanna Saxe[2] and Tracey Galloway[3]

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ABSTRACT. Much of Canada's northern population resides in communities that are inaccessible by road for a substantial portion of the year. Residents of these "fly-in" communities rely on aircraft to provide a wide range of social, economic, and transportation services. However, for numerous reasons, including the often extreme environmental conditions in the circumpolar regions of Canada, a substantial number of flights to these communities are cancelled or diverted. Using a dataset from two airlines that serve these regions with information about schedules, delays, and cancellations of more than 18 500 flights, we examined the links between airport infrastructure, flight arrival reliability, and a variety of socioeconomic variables in 23 northern communities. Results show that runway length has a significant impact on the reliability of flight arrival, but also that the reliability of flights may not affect the cost of food in the communities included in our analysis. These findings provide evidence that lengthening runways could improve air service in the Canadian North.

Key words: Canadian North; fly-in communities; airport infrastructure; air cargo; arrival reliability; food

RÉSUMÉ. Une grande partie de la population du Nord canadien réside dans des localités inaccessibles par voie terrestre pendant une grande partie de l'année. Les habitants de ces localités desservies par voie aérienne dépendent des avions pour une vaste gamme de services sociaux, économiques et de transport. Toutefois, pour maintes raisons, dont les conditions environnementales souvent extrêmes qui sévissent dans les régions circumpolaires du Canada, un grand nombre de vols à destination de ces localités est annulé ou dévié. En nous appuyant sur des données en provenance de deux sociétés aériennes qui desservent ces régions, données portant sur les horaires de vol, les retards et les annulations concernant plus de 18 500 vols, nous avons examiné les liens entre les infrastructures aéroportuaires, la fiabilité de l'arrivée des vols et un éventail de variables socioéconomiques propres à 23 localités nordiques. Les résultats ont permis de constater que la longueur des pistes exerce une grande incidence sur la fiabilité de l'arrivée des vols, mais aussi, que la fiabilité des vols n'a pas nécessairement d'influence sur le coût des aliments dans les localités visées par notre analyse. Grâce à ces constatations, nous pouvons soutenir que l'allongement des pistes pourrait améliorer les dessertes aériennes dans le Nord canadien.

Mots clés : Nord canadien; localités desservies par voie aérienne; infrastructure aéroportuaire; fret aérien; fiabilité des arrivées; aliments

Traduit pour la revue *Arctic* par Nicole Giguère.

INTRODUCTION

The Canadian North is home to numerous remote communities, dependent for much or all of the year on aircraft for transporting people and cargo into and out of the area. Given this dependency, it is important to understand the reliability of air service to these communities, as their residents rely on these flights for everything from routine services (e.g., food and postal delivery, primary and public health care, and legal services) to emergency medical transport. Regular air service to the Canadian North, which allows these communities to participate in the broader national system, is constrained by basic airport infrastructure, challenging environmental conditions such as inclement weather and extreme cold, and the high cost of moving people and goods.

This paper investigates the relationship between airport infrastructure and the reliability of service to communities in northern Canada, with a particular focus on selected airports in the circumpolar North (specifically fly-in communities in Nunavut, Nunavik, and the Northwest Territories). Using data provided directly from two airlines that served this area with more than 18 500 scheduled flights in 2015, we demonstrate the links between airport infrastructure, community-level variables (e.g., population and income), and the reliability of service. In addition, we used publicly available data on food costs in these remote communities to understand how airport infrastructure can

[1] Department of Geography and Planning, University of Toronto - St. George, 100 Saint George Street, Toronto, Ontario M5S 3G3, Canada; michael.widener@utoronto.ca
[2] Department of Civil Engineering, University of Toronto - St. George, 35 Saint George Street, Toronto, Ontario M5S 1A4, Canada
[3] Department of Anthropology, University of Toronto - Mississauga, 3359 Mississauga Road, Mississauga, Ontario L5L 1C6, Canada

affect the daily lives of residents. Through investigating these topics, we identify potential strategies that would allow airlines to provide improved service to the tens of thousands of people who live across the northern territories and provinces of Canada (henceforth referred to as "the North").

BACKGROUND

Canada's northern communities are scattered across a vast geography that represents approximately 60% of Canada's land mass. Most residents of these communities are Indigenous Canadians, whose territorial homelands constitute the majority of Canada's northern jurisdictions. Communities range in size from 313 in Chesterfield Inlet, Nunavut, to 6699 in Iqaluit, Nunavut. Many of these communities lack surface transportation and are accessible by marine routes only during the short (and highly weather-dependent) open-water season (August to October), when ice is not a barrier. Thus, residents must access the vast majority of services via commercial aviation. Airlines bring service providers to communities, and residents fly south to access many of their health, social, legal, and education services (Adelson, 2000; Mitton et al., 2011; Young and Chatwood, 2011).

Most of the limited number of airlines that serve these remote communities are partly or wholly owned by Indigenous organizations, as stipulated in a number of northern land-claim settlements that require territorial governments to prefer contracts for the supply of goods and services from corporations that are majority Inuit-owned (Nunavut Tunngavik Inc. et al., 2010). These airlines operate fixed-wing aircraft equipped to land on gravel or ice strips in remote locations (Canadian North, 2016; First Air, 2016a). Fleets are generally composed of combination aircraft, which can be modified to carry varying load configurations of both cargo and passengers.

Community airports are maintained by the individual provinces and territories, with assistance from Transport Canada's Airports Operations and Maintenance Subsidy and Airports Capital Assistance programs (Transport Canada, 2016). Existing infrastructure is a combination of purpose-built facilities and legacy facilities built to serve Cold War airbases and surveillance stations such as the Distant Early Warning (DEW) line, a chain of 67 radar and communications centres stretching from Alaska to Greenland (Lajeunesse, 2007). For example, the airport in Cambridge Bay was originally built in 1955 to service a local DEW line radar station (Collier, 2012) that was decommissioned in 1985, but it continues to support the long-range radar component of the North Warning System, a joint defense initiative of Canada and the United States (Government of Canada, 2013).

One result of such arrangements is considerable variability among northern communities in airport infrastructure. In a 2013 report, the Canadian Chamber of Commerce (2013) articulated numerous challenges facing the northern transportation sector. One acute issue is the aging infrastructure that has not kept up with changes in technology, even simple improvements such as paving runways. The report notes that changing this situation would "entail a significant financial investment that industry, territorial and local governments simply are not capable of funding themselves" (Canadian Chamber of Commerce, 2013:1). The Northern Air Transport Association (2016) echoed these calls for increased federal support of airport infrastructure in a resolution passed at their 2016 annual conference.

While airport infrastructure varies, all communities under investigation in this study rely on the air network across the North. Larger hub communities (Yellowknife, Rankin Inlet, Iqaluit, Kuujjuaq) tend to be served by jet aircraft connecting with other hub communities or with southern cities such as Edmonton, Winnipeg, Ottawa, and Montreal (First Air, 2016b). Turbo-propeller aircraft fly to smaller communities, generally via circular routes that originate in hub communities.

The degree of dependence on aviation services cannot be overstated. Statistics Canada examined the annual number of passengers getting on or off aircraft as a proportion of the city's population and found that this ratio is much higher in northern hub communities like Iqaluit and Yellowknife than in southern cities, where alternative forms of transport exist. The ratio of passengers per capita is 15.1 in Yellowknife and 17.9 in Iqaluit (Dunlavy et al., 2009), compared to only 5.8 at Canada's busiest airport, Lester B. Pearson in Toronto. Passengers who must travel in the North include service providers (e.g., physicians and lawyers) flying to and from regional centres and remote communities, as well as residents flying to and from regional hospitals, treatment centres, schools, justice facilities, and other institutions and referral centres in southern cities (Browne, 2010; Canadian Polar Commission, 2014). In addition to northern communities, the resource-based industries that are prevalent throughout the region are highly dependent on reliable air passenger and cargo services. Further, outside the short open-water season, all mail, food, fuel, medical supplies, and other goods must be brought in and out by plane. A recent Conference Board of Canada report described the import of northern aviation: "Small airports are not only vital to their community's prosperity—ultimately, they may also determine whether or not a town or an industry is viable" (Gill and Raynor, 2013:26).

Perishable food is one example of cargo that is reliant on aircraft arrival and relates to both the well-being and health of residents in the North, as well as the economic viability of businesses in these communities (Sharma et al., 2010). Fresh fruit and vegetables, fresh and frozen meat, dairy products, and other perishable foods sold in retail stores arrive in remote northern communities as cargo shipments on commercial airlines. Given the significant value of these deliveries to communities, freight costs for many of these foods are subsidized under the Government of Canada's

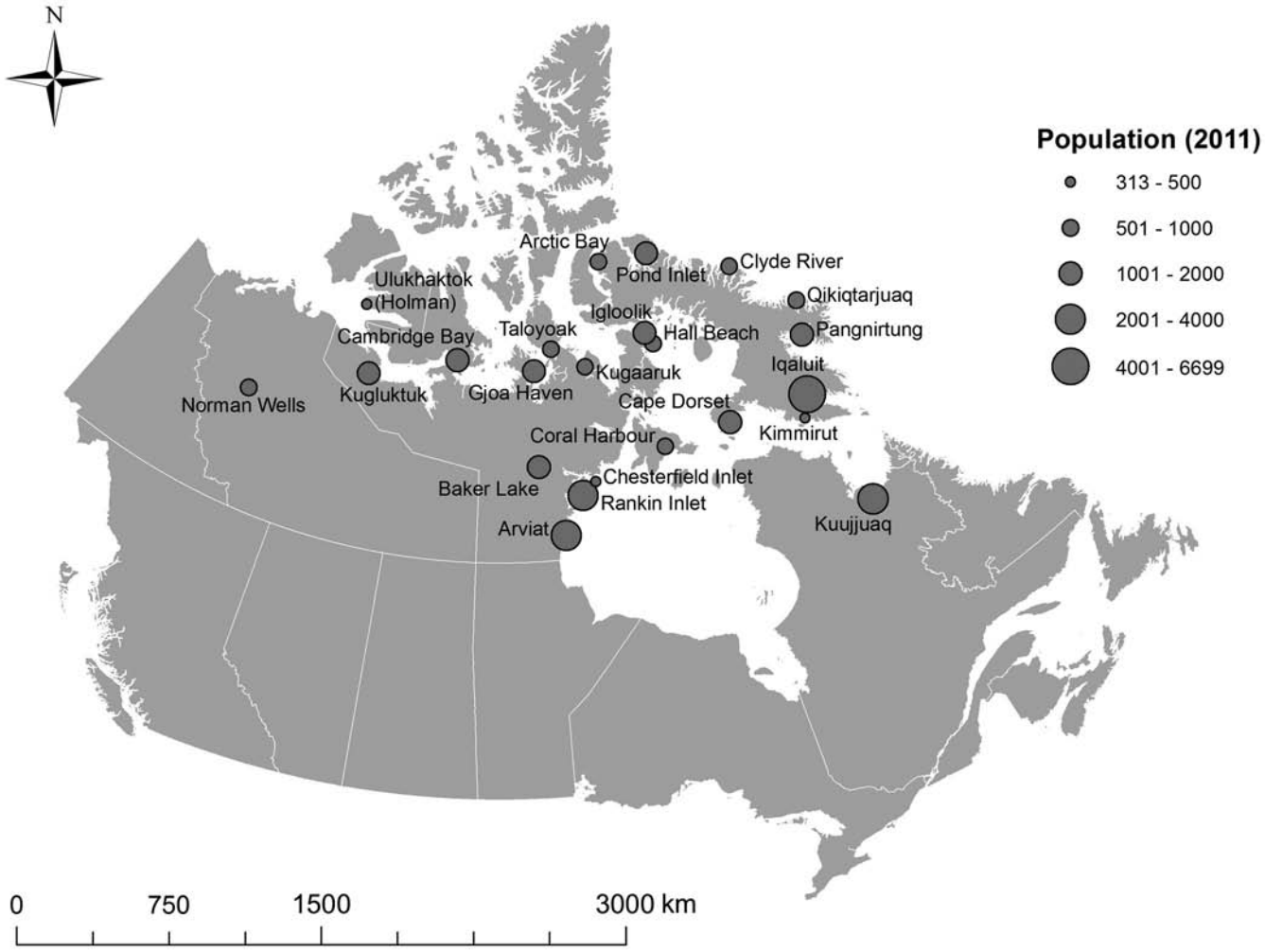

FIG. 1. Map of the 23 fly-in communities in the North examined in this study. Population values come from the 2011 Canadian Census (Statistics Canada, 2011).

Nutrition North Canada (NNC) retail subsidy program (Burnett et al., 2015; Government of Canada, 2016). Because of the consistent need for food products, nearly all flights to the North carry food cargo.

As a way to examine how airport infrastructure in the North affects the well-being and economies of residents and businesses in these communities, we focus on the link between runway length and the proportion of scheduled flights that arrived as scheduled in 2015. To have "arrived as scheduled," a flight must have taken off and landed at its scheduled destination anytime on the scheduled day. This criterion includes delayed flights, but not flights cancelled at their origin or diverted to another airport. Additionally, we explore the relationship between the reliability of air transport and food cost as a preliminary case study to illustrate the potential impact of airport infrastructure on the provision of essential services and, more generally, on overall social and economic viability in remote northern communities.

METHODS

We obtained data directly from two air carriers on northern flights scheduled during 2015, flights that arrived, and those that were cancelled or diverted. These carriers maintain extensive networks in northern Canada and are responsible for a substantial portion of the passenger and cargo traffic to and from northern communities. These flight data were processed, standardized, and combined for further analysis using a Python script that created a database documenting the number of flights scheduled and flights that arrived each day at each airport served. From the database, we calculated the percentage of scheduled flights that arrived in northern communities and were not diverted or cancelled. The dataset was reduced to a subset of 23 relevant communities that met the following criteria:

1) Each was a fly-in community, where access is restricted to air travel for more than six months of the year.
2) Each had at least 100 scheduled flights through the year. Some remote fly-in communities do not have scheduled service meeting this threshold serviced by the two

TABLE 1. The monthly and annual percentages of flights scheduled in 2015 that arrived at the 23 communities included in this study.

Airport code	Place	Runway (ft)	Jan%	Feb%	Mar%	Apr%	May%	Jun%	Jul%	Aug%	Sep%	Oct%	Nov%	Dec%	Weighted mean
YAB	Arctic Bay, NU	3935	91	94	91	96	100	100	94	100	98	73	88	95	94
YBB	Kugaaruk/Pelly Bay, NU	5000	75	86	90	90	89	80	95	97	86	81	97	88	88
YBK	Baker Lake, NU	4195	70	84	72	90	100	–	–	–	–	–	–	–	84
YCB	Cambridge Bay, NU	5076	83	95	90	98	94	91	94	96	91	96	94	98	93
YCO	Kugluktuk, NU	5502	84	82	87	96	95	95	98	95	89	98	92	97	92
YCS	Chesterfield Inlet, NU	3600	75	93	83	93	97	–	–	–	–	–	–	–	88
YCY	Clyde River, NU	3501	94	93	96	93	89	92	88	94	100	90	98	91	93
YEK	Arviat, NU	4000	73	73	78	91	93	–	–	–	–	–	–	–	81
YFB	Iqaluit, NU	8605	94	89	95	93	87	87	76	91	92	89	88	87	89
YGT	Igloolik, NU	4095	91	91	89	93	87	86	59	92	88	86	89	80	85
YHI	Ulukhaktok/Holman, NWT	4300	100	79	94	100	93	88	100	100	93	100	81	93	93
YHK	Gjoa Haven, NU	4400	87	90	93	95	88	90	93	97	84	90	77	87	89
YIO	Pond Inlet, NU	4006	93	92	92	100	92	87	90	91	100	86	97	95	93
YLC	Kimmirut, NU	1899	88	87	89	71	65	76	59	83	82	74	71	75	75
YRT	Rankin Inlet, NU	6000	75	79	86	87	98	94	87	100	99	98	82	81	88
YTE	Cape Dorset, NU	3988	81	83	90	85	85	73	44	81	84	92	75	72	80
YUX	Hall Beach, NU	5410	84	82	85	90	85	82	55	91	93	98	90	84	84
YVM	Qikiqtarjuaq, NU	3803	91	90	89	86	66	57	76	69	88	90	86	86	80
YVP	Kuujjuaq, QC	6000	98	104	102	100	102	100	98	100	102	100	98	96	100
YVQ	Norman Wells, NWT	5998	99	98	93	97	97	100	98	100	98	98	97	98	98
YXP	Pangnirtung, NU	2920	86	89	92	82	70	56	70	80	94	93	85	88	81
YYH	Taloyoak, NU	4009	85	92	96	94	91	85	98	96	85	78	83	90	90
YZS	Coral Harbour, NU	5006	85	86	78	89	94	100	25	92	83	93	64	69	84
		Mean	87	88	91	92	89	86	80	92	92	90	87	88	

studied airlines, but the data show an increased number of landings due to diversion; these communities are not considered in the analysis.

3) Each was eligible for a full NNC subsidy, which permits the use of food cost as an outcome measure of the reliability of air transportation.

Of the 23 communities selected for analysis, 20 are in the Canadian territory of Nunavut (NU), two are in the Northwest Territories (NT), and one is in northern Quebec (QC) (Fig. 1). We excluded Old Crow, Yukon, from the analysis because during the study year it had an ice road for several months and because it is served by a separate, Yukon-based airline from which we had no data.

With the study communities established, we used the Python script to compute the percentage of scheduled flights that arrived for every month of 2015, calculated as the total number of flights that arrived at an airport in a given month divided by the total number of flights scheduled to arrive at that airport in the same month. We then made the same calculation for the entire year (Table 1). In a few cases, the percentage of arrivals is greater than 100% because of unanticipated arrivals of flights diverted from other airports. Despite the "noise" introduced by diverted flights, these proportions capture the general reliability of service given the large total number of flights arriving at the study airports. If there was no service during a month, there is no monthly percentage calculation, and the yearly arrival percentage is calculated using only the months that have service.

In addition to flight arrival data, we collected data on socioeconomic status via the 2011 Census of Canada (Statistics Canada, 2011) and on airport infrastructure (represented by runway length) from the March 2016 NAV CANADA Canadian Airport Charts document (NAV CANADA, 2016). Finally, food costs were acquired from reports on the Revised Northern Food Basket (RNFB) published by the NNC subsidy program (Government of Canada, 2017). The RNFB is a 67-item instrument designed to monitor the average cost of food for a family of four for one week. It is used as a benchmark for subsidy efficacy in the North since the majority of food items in the RNFB are perishable foods delivered by air. Retailers in 91 northern communities report RNFB costs quarterly, in March, June, September, and December (Government of Canada, 2014; Galloway, 2017). We used data from 2014 RNFB reports because at the time of our analysis, data were available for only the first quarter of 2015. Basic descriptions of variables are presented in Table 2, and maps of median income, RNFB cost, runway length, and the percent of scheduled flights that arrived are shown in Figure 2. While the data come from different years, the values of these variables change relatively little from year to year. Therefore, we assume that the signal provided by each data source is relevant to our analysis.

In order to establish the relationships between arrival reliability, airport infrastructure, and community

TABLE 2. Descriptive statistics for the six variables examined in 23 northern communities.

	N	Mean	SD	Minimum	Maximum
Runway length (feet)	23	4576.00	1336.74	1899	8605
Number of scheduled flights (2015)	23	816.35	963.10	142	4968
Arrivals as percentage of scheduled flights (2015)	23	0.88	0.06	0.75	1.00
Population (2011)	23	1428.65	1304.70	313	6699
Median income (2010)	19	27028.21	14400.00	16080	67082
Average RNFB cost (2014)	22	434.40	29.20	377.590	475.998

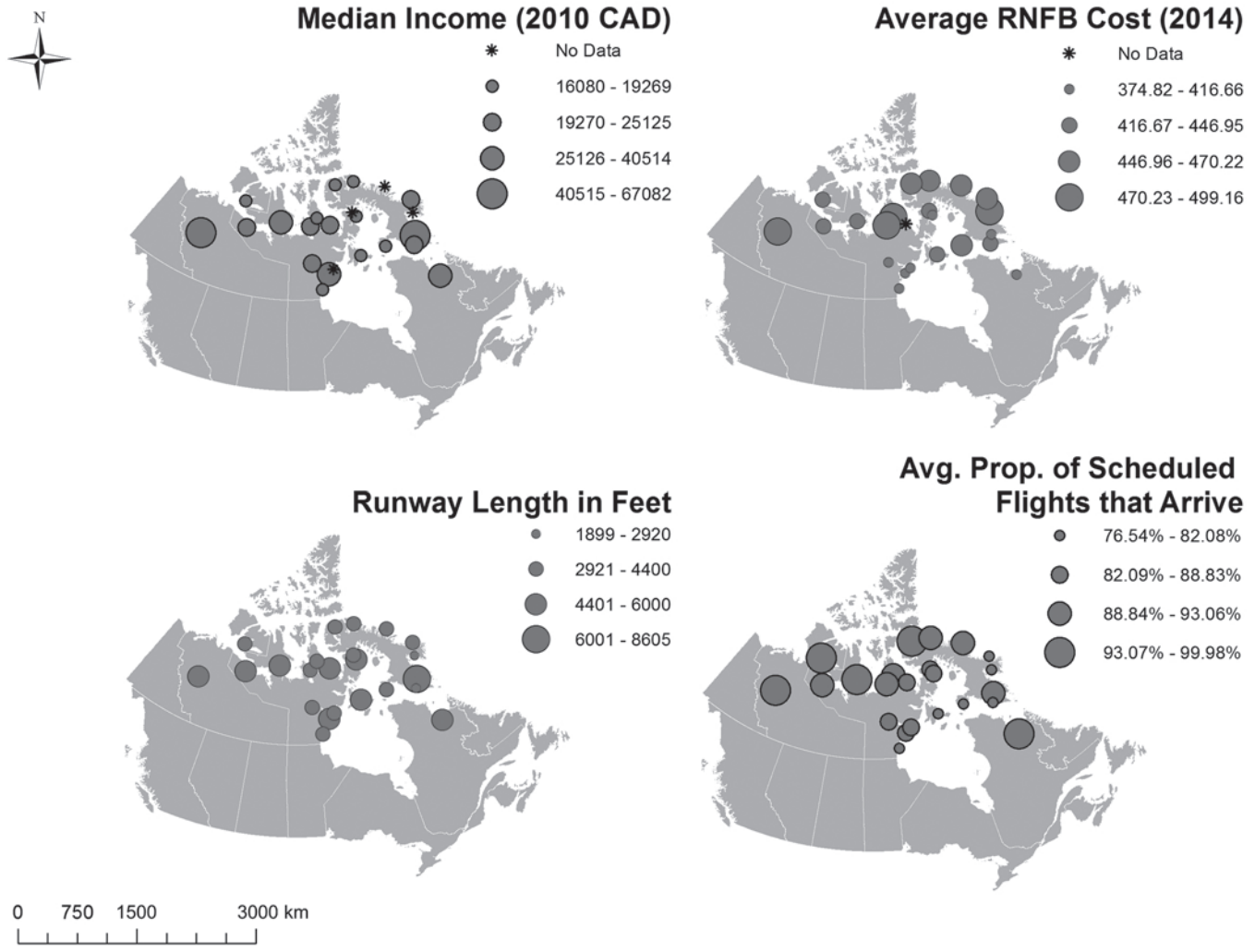

FIG. 2. Maps of income, food basket cost, runway lengths, and percentage of arrivals.

socioeconomic variables, we constructed correlation matrices and ordinary least squares regression models in R 3.3.1 (R Development Core Team, 2015) using the data described above. It is important at this point to mention the uniqueness of the community of Iqaluit, NU, which is substantially larger than the other communities studied. With 6699 residents, it is 2.8 times the size of Kuujjuaq, the next largest community (2375 residents). The runway at Iqaluit airport (YFB) is also substantially longer (8605 feet) than those in other communities considered for this study (average length: 4576 feet). The larger population and longer runway are a result of Iqaluit's having served as a major military airbase for the United States during the mid-20th century (Eno, 2003). Given Iqaluit's outlier status, we discuss our results both with and without the Iqaluit data.

RESULTS

Preliminary Analysis of Arrival Data

In examining the monthly percentage of flights that arrived as scheduled (Table 1), we found that, in general, more than 80% of all scheduled flights had arrived as planned. Comparable statistics on southern Canadian

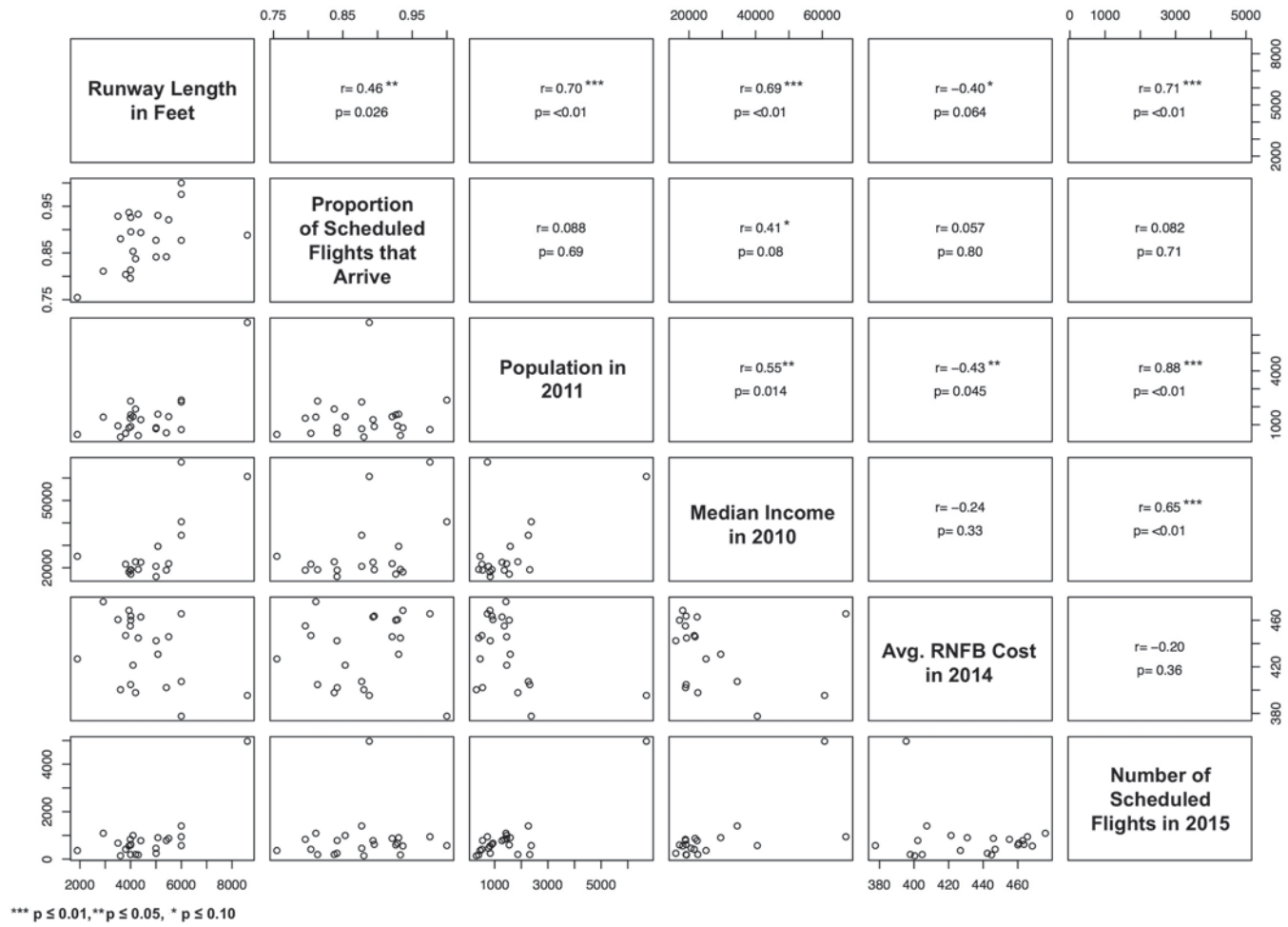

FIG. 3. Correlation matrix between variables with Iqaluit (YFB) included. The magnitude of values is provided on the respective row or column of a given variable. The units of a row or column are provided along the diagonal of the figure.

airports could not be found; however, as an example for comparison, the arrival rate at Chicago O'Hare International Airport in 2014 was 95% (Morris, 2015). A noticeable drop in arrivals at many study airports (e.g., YZS, YTE, and YUX) during July 2015 is likely related to particularly difficult weather conditions that plagued Nunavut during that month (Bell, 2015; Momin and Statham, 2015). When calculated for the entire year, the mean percentage of flights that arrived as scheduled was 88% (SD = 6%), with individual airports reporting averages as low as 75% (Kimmirut) and as high as 100% (Kuujjuaq).

Correlation Analysis

The two correlation matrices computed are displayed in Figure 3, which includes Iqaluit, and Figure 4, which excludes this outlier. In both figures, the boxes above the diagonal show the Pearson's correlation coefficient (r) and the significance levels between the corresponding variables, while those below the diagonal display the scatter plots between the two variables. It is immediately apparent that the inclusion of Iqaluit results in many more significant correlation coefficients, with eight correlations significant at $p \leq 0.05$ and 10 at $p \leq 0.10$. The correlation matrix that excludes Iqaluit shows only eight significant correlations, three at $p \leq 0.05$ and five at $p \leq 0.10$. Given the great influence Iqaluit has on these measures, we used only the results displayed in Figure 4 for interpretation.

Median income (a variable meant to capture social capital) is significantly and positively correlated with three other variables: runway length, the proportion of flights that arrive as scheduled, and the total number of scheduled flights. In addition to these relationships, runway length is significantly and positively associated with the proportion of flights that arrive as scheduled, and population size is significantly and negatively correlated with food costs.

These correlations all make intuitive sense, but it is interesting to point out two other findings from this matrix. First, the total number of scheduled flights to the study area airports was not correlated with the proportion of these flights that arrived as scheduled. This means that airports with more flights do not necessarily see more reliability in air traffic. Second, there is a strong and highly significant correlation ($r = 0.59$, $p \leq 0.01$) between runway length and the proportion of flights that arrive as scheduled. This correlation is important because it implies that investments

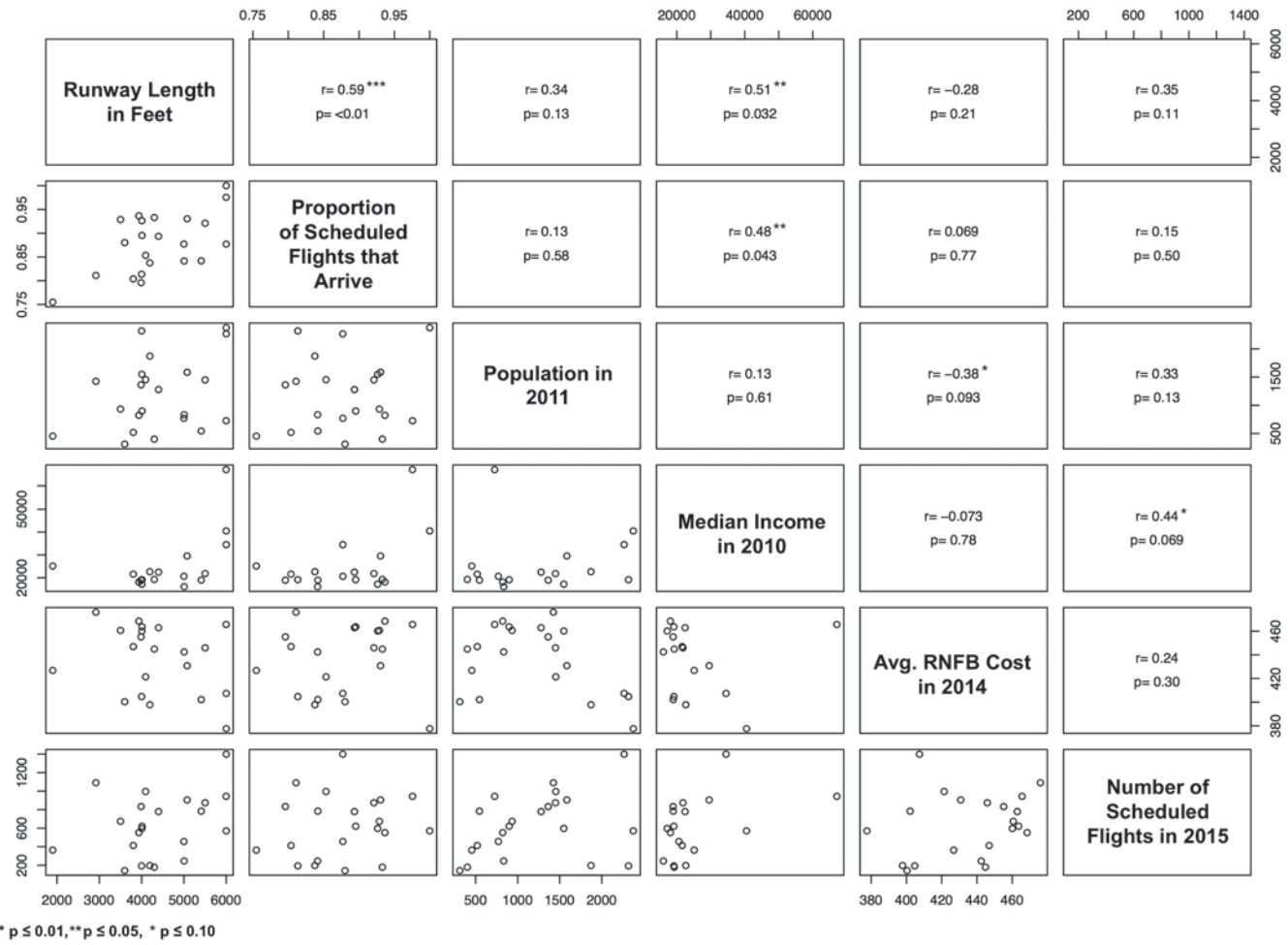

FIG. 4. Correlation matrix between variables with Iqaluit (YFB) excluded. Details as in Figure 3.

in lengthening runways may improve service to these remote communities.

Regression Analysis

Of four regression models, Models 1 and 2 (Table 3) explore the relationship between the dependent variable "average proportion of scheduled flights that arrive" and independent variables population, median income, runway length, and the total number of scheduled flights from 2015. Median income and population are included in the models to control for any general demographic and socioeconomic differences in communities. Models 3 and 4 (Table 4) explore the relationship between the dependent variable food cost and independent variables "average proportion of scheduled flights that arrive," population, median income, runway length, and the total number of flights scheduled in 2015. The communities of Chesterfield, Clyde River, Igloolik, and Pangnirtung were excluded from all models because there were no data on 2010 median incomes, while Kugaaruk was excluded from Models 3 and 4 because of missing data on food costs. Only Models 1 and 3 include Iqaluit.

Models 1 and 2 both have F statistics that indicate they represent moderately significant ($p < 0.10$) relationships between the dependent and independent variables. The r^2 value for both models also suggests that more than 40% of the variance in the proportion of scheduled flights that arrived is explained by the independent variables. However, the only significant predictor in both models is runway length: an increase in runway length of 1000 feet is associated with a 4% increase in the number of flights that arrive as scheduled.

Models 3 and 4 are included in order to demonstrate the link between a ubiquitous social need (food), airport infrastructure, and arrival reliability. Again, residents in northern communities have multiple social, health, and institutional needs, but we used food cost as an example, controlling for previously discussed socioeconomic variables, because of the large amount of data available on the topic from the Government of Canada and because the cost of food affects all residents.

Models 3 and 4 both have a significant F statistic, indicating there is an overall significant relationship between the dependent and independent variables, and the r^2 values of 0.602 for Model 3 and 0.555 for Model 4

TABLE 3. Results from regression models exploring arrival reliability. Standard errors are presented in parentheses beneath their corresponding beta coefficients.

Dependent variable: Average proportion of scheduled flights that arrive		
	Model 1 (with Iqaluit)	Model 2 (without Iqaluit)
Population (2011)	0.00000 (*0.00002*)	0.00000 (*0.00002*)
Median income (2010)	0.00000 (*0.00000*)	0.00000 (*0.00000*)
Runway length (ft)	0.00004** (*0.00002*)	0.00004* (*0.00002*)
Number of scheduled flights (2015)	−0.00004 (*0.00003*)	−0.00002 (*0.00010*)
Constant	0.698*** (*0.061*)	0.695*** (*0.063*)
Observations	19	18
r^2	0.437	0.441
Adjusted r^2	0.276	0.269
Residual SE	0.055 (df = 14)	0.056 (df = 13)
F statistic	2.715* (df = 4, 14)	2.566* (df = 4, 13)

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

TABLE 4. Results from regression models exploring food cost. Standard errors are presented in parentheses beneath their corresponding beta coefficients.

Dependent variable: Average RNFB cost 2014		
	Model 3 (with Iqaluit)	Model 4 (without Iqaluit)
Average arrival proportion	215.717* (*106.689*)	214.706* (*111.639*)
Population (2011)	−0.023** (*0.008*)	−0.022** (*0.009*)
Median income (2010)	−0.0004 (*0.001*)	−0.0004 (*0.001*)
Runway length (ft)	−0.014* (*0.008*)	−0.015 (*0.009*)
Number of scheduled flights (2015)	0.035** (*0.012*)	0.038 (*0.021*)
Constant	326.809*** (*78.060*)	327.117*** (*81.509*)
Observations	18	17
r^2	0.602	0.555
Adjusted r^2	0.436	0.352
Residual SE	21.664 (df = 12)	22.611 (df = 11)
F statistic	3.625** (df = 5, 12)	2.738** df = 5, 11)

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

suggest that the independent variables can account for more than half of the variability in food costs. The average proportion of scheduled flights that arrive ($p < 0.10$) and the population in 2011 ($p < 0.05$) are significant predictors ($p <$ 0.10 or less) for both models, while runway length ($p < 0.10$) and the total number of scheduled flights in 2015 ($p < 0.05$) are significant in the model including Iqaluit.

The direction and magnitude of the beta coefficients are consistent across both models. A positive relationship exists between arrival reliability and food costs, with both models indicating that a 1% increase in the proportion of scheduled flights that arrive corresponds to an increase of approximately $2.00 in food costs. Both models also show a negative relationship between population size and food costs: an increase of 100 people corresponds to a reduction in food costs of approximately $2.00. Finally, Model 3 also shows a significant negative relationship between runway length and food costs and a significant positive relationship between the total number of flights and food costs.

Summary of Findings

Overall, the correlation and regression analyses indicate that there is a link between airport infrastructure, as represented by runway length, and the average proportion of scheduled flights that arrive in the North. These findings suggest that the lengthening of runways in northern communities could lead to improved overall service, a particularly important outcome for residents, who rely on air travel for a large number of social and economic services. Longer runways not only allow for larger aircraft, but also for heavier aircraft (i.e., more cargo) and safer operations in poor weather conditions (Transport Canada, 1996; Federal Aviation Administration, 2005; St. John's International Airport Authority, 2015).

A second and important finding relates to the impact of runway length and the proportion of scheduled flights that arrive on the cost of food in northern communities. Interestingly, the models presented in Table 4 suggest a positive association between arrival reliability and food costs, but a negative association between runway length and food costs, controlling for population size, median income, and the total number of flights. Similar results are found in the correlation matrices. It makes intuitive sense that food costs would decrease with longer runways, as longer runways can handle larger aircraft with more cargo, allowing for more food deliveries. However, the positive association with arrival reliability is more difficult to explain. Our analysis actually demonstrated that food prices are higher in places where flight arrivals are relatively more reliable. It is worth noting that recent work (Galloway, 2014) has found little evidence that the NNC subsidy program (which the author critiques for a lack of transparency in how rates are calculated) is efficiently and effectively achieving its goal of providing available and affordable healthy foods. The intersection of retail and policy sectors could potentially lead to this counterintuitive finding. An additional confounding factor is weather. Airport operations may be impeded by extreme cold, precipitation, fog, and high winds. Future investigation will include a

more nuanced approach to understanding the northern air transportation environment, including policy, human services, and weather patterns in study communities.

CONCLUSIONS

This research examined the relationships between airport infrastructure, socioeconomic variables, and the proportion of scheduled flights that arrive in the Canadian North, a region where residents are highly dependent on air transportation for cargo and a broad range of social, economic, and institutional services. Using a unique data source from two airlines that service dozens of airports in the North, we show that there is a significant and positive correlation between runway length and the reliability of scheduled flight arrivals. As northern communities are so dependent on air travel, the national and regional governments should consider investing in lengthening runways as a way to improve multiple facets of northern residents' lives. A second interesting finding is that there is conflicting information about how food costs, an economic consideration for every northern resident, are affected by air service and airport infrastructure. While longer runways were significantly associated with lower food costs, more reliable air service was significantly associated with higher food costs. This second, counterintuitive finding requires follow-up, as a more comprehensive analysis is required to understand how infrastructure, environmental conditions, and government subsidies affect food costs.

This paper is the first, to our knowledge, that explicitly explores how transportation infrastructure affects both air service reliability and a number of socioeconomic factors in remote, northern communities. Since economic pressures make maintaining these services difficult, it is critical that more research on this topic be conducted to improve our understanding of how to make air transport more efficient and effective.

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