Assessing the Effect of Food Retail Subsidies on the Price of Food in Remote Indigenous Communities: A Case Study of the Nutrition North Canada Subsidy Program

by

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ABSTRACT

Assessing the Effect of Food Retail Subsidies on the Price of Food in Remote Indigenous Communities: A Case Study of the Nutrition North Canada Subsidy Program

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Food retailers in remote communities in Nunavut are subsidized through the Nutrition North Canada program. A duopolistic food retail market in Nunavut has fuelled concerns that a lack of competition is eroding the benefit of the subsidy to consumers. Existing audits and reviews of the program have failed to determine the pass-through rate of the subsidy. I estimate the pass-through rate of this subsidy and find that it is fully passed on to consumers, although heterogeneity in pass-through rates exist between communities. I also find that the differences in subsidy pass-through rates between communities stems from differences in cost structure, rather than differences in competitive pressures.

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Chapter 1 Introduction

Do competitive pressures force duopolies to price as if they were in perfectly competitive markets? The answer to this question has theoretical and practical implications. Economists from Smith to Baumol have differed in their opinion on this matter. In my case study, it has substantial implications for evaluating the federal governments efforts to address food security in remote regions of Canada. Specifically, the Canadian government subsidizes food in a market which is best described as a duopoly in an effort to reduce food prices for individuals in remote communities, who are more likely to be food insecure. In Nunavut, my area of study, 52.3% of households are food insecure (Statistics Canada, 2016).

There are three main contributions of this thesis to the literature. First, to my knowledge, this is the only paper to empirically asses the extent of subsidy pass-through in the grocery retail sector. Second, there has been no empirical assessment of the pass-through rate of the Nutrition North Canada subsidy program, the primary method by which food in remote communities in Canada is subsidized. The pass-through rate is a key determinant of Nutrition North's efficacy. Third, determining the subsidy pass-through rate in a market that is characterized by a duopoly has implications for the ongoing debate as to what extent monopolistic behaviour can be described by the number of competitors in a market.

My study builds on previous work that examines pass-through rates of subsidies and their implications for market power in other contexts, such as agriculture (Kirwan and Roberts 2016), ethanol (Bushnell and Lade 2016), and solar energy (Pless and

Bentham forthcoming). In a seminal contribution, Sumner (1981) uses pass-through rates of state level excise taxes to test for, and reject, cartel like pricing behaviour in the cigarette industry. This study explores these issues in the context of the grocery retailing sector. Like Sumner (1981), I address the issue of the pass-through rate of the Nutrition North subsidy with particular attention to the potential for monopolistic behaviour. As discussed later, there are very few firms operating in the remote communities in Nunavut, which has raised concerns that monopolistic behaviour could be eroding the benefit of food subsidies in the region.

Finally, my orientation to this problem recognizes the debate in the literature over Baumol, Panzar, and Willig's (1982) theory of contestable markets. The theory predicts that the threat of entry, rather than the number of current competitors, will limit incumbent firms' abilities to set monopolistic prices.

Overall, I find that the Nutrition North subsidy is fully passed on to consumers. These results suggest that the duopolistic market structure in Nunavut is producing price outcomes that are not inconsistent with those of perfect competition, however some heterogeneity exists between pass-through rates in each community. Further, limited evidence suggests that heterogeneity in pass-through rates stems from differences in cost structures, rather than competitive pressures, such as the number of retailers in a community.

The remainder of this thesis proceeds with background information on the Nutrition North subsidy program and the grocery retail market in Nunavut. Then, I provide a structured approach for assessing the relationship between market structure and pass-through rates. Importantly, I identify the assumptions under which I would expect pass-through to be less than, equal to, or more than the legislated subsidy level. The following

two sections provide the data used, develop the empirical model and summarizes the key variables used. Finally, I present my empirical results and interpret the importance of the pass-through rates for understanding retail competition and the Nutrition North subsidy program in Nunavut. I conclude with a summary of the key insights from this thesis, implications for policy, and assessment of future research needs.

Chapter 2 Background

In this section, I provide an overview of the Nutrition North Canada subsidy program and the grocery retail market in Nunavut, my region of study.

2.1 Nutrition North Canada

Nutrition North Canada provides a subsidy to grocery retailers in geographically remote communities in Northern Canada. In the 2017 program year, the program paid $74 million in subsidies. Nunavut received just over $38 million, which is an average of $1,068 (Canada 2018). The grocery retailers who receive the subsidy are required to pass on the full subsidy to consumers, although the accounting standards of the program do not preclude the possibility that retailers can capture some portion of the subsidy through strategic pricing behaviour. To demonstrate that the subsidy is passed on, retailers must reduce the final sale price of a good by the subsidy amount at the point of purchase (Canada 2018). To capture some portion of the subsidy, retailers could simply charge a higher initial price before taking off the subsidy amount. Given the potential for strategic pricing and an inability to observe profit margins, Canada's Auditor General found that the program lacked the necessary information to determine whether the subsidy is actually being passed on to consumers - a finding that is confirmed in every publicly available compliance report performed by third-party auditors (Canada 2014). Since 2016, retailers have been required to report profit margins, but subsequent audits have still failed to verify the pass-through of the subsidy (Canada 2018).

In my study period, there are two levels of subsidy for eligible food - a high and low rate, called level one and two respectively. Typically, the most nutritious and perishable food receives the highest level of subsidy, while food that is less perishable or nutritious tends to receive the lower subsidy level. Not all food is eligible for the subsidy. Most non-perishable food is not subsidized. While it is not the focus of my thesis, it is important to note that the particular selection of foods covered by the subsidy may be highly relevant to achieving the desired food security outcomes in these remote communities. Subsidy rates vary between communities and have remained fixed from 2012 until 2019 (Canada 2018). See figure 8.1 in the appendix for subsidy values across communities.

Despite the importance of Nutrition North as the Canadian Government's primary tool to reduce food insecurity in remote northern communities, there have been very few reviews of the program and none that empirically assess the pass-through rate. Galloway (2014); Burnett, Skinner, and Leblanc (2015); Hill and Fitzgerald (2017); and Galloway (2017) all examine the program and share the conclusion that without observable profit margins of food retailers, it is impossible to determine what percentage of the Nutrition North subsidy is passed on to consumers. However, these studies share an underlying assumption that the small number of food retailing firms in each community result in low levels of competition and the resulting market power would allow retailers to capture the majority of the Nutrition North subsidy.

2.2 Nunavut and Market Structure

Nunavut is Canada's largest and northernmost territory. It is sparsely populated and contains only 25 communities, all of which receive the Nutrition North Canada subsidy. For most of the year, these communities rely solely on air transportation to supply them

with food. There is a very brief sea shipping season during the late summer, during which communities will typically receive a single shipment of goods. Table 8.1 in the appendix provides a list of the communities in Nunavut, their population, and distance to the closest service centre. A service centre is an area that would supply that community with food throughout the year. All 25 communities in Nunavut are extremely remote - no community is connected to anywhere else via roads, and the average distance that food is flown to reach these communities is almost 2,000 kilometres (Canada, 2018)[1]. In addition to remoteness, these communities tend to be small, with a median population of 900 people.

The food retailing sector that serves Nunavut's population is similarly small. The average number of grocery stores in each community is 2 (see table 8.1). The food retail market in Nunavut is largely dominated by two firms- the Northwest Company and the Arctic Co-operative, who operate 21 and 25 stores, respectively. Together, they account for 46 of the 52 food retailers in Nunavut (Canada, 2018). This extreme concentration fuels the concern of monopolistic competition expressed in the previously mentioned reviews of the Nutrition North program and provide a unique setting for this case study. For example, in a recent review of the Nutrition North Canada program, Galloway (2017) states that "the current structure of the NNC program - a market-driven retail subsidy - assumes a competitive marketplace that does not exist in the majority of northern Canadian communities". I explore the economic theory of pass-through rates in the next chapter and highlight how market power may erode the pass-through rate of the Nutrition North Canada program.

[1]Figure 8.4 contains a map of Nunavut

Chapter 3 Theory of Pass-through Rates

This section explores the theory of pass-through rates in order to motivate our empirical strategy that links the pass-through rate of the Nutrition North program to the competitive pressures in Nunavut's grocery retailing sector. There are two primary determinants of the pass-through rate of taxes or subsidies - market power and the relative elasticities of supply and demand. The theory presented in this section highlights that it is the combination of these two determinants that leads to the pass-through rate.

Specifically, the pass-through rate, ρ, of the Nutrition North subsidy is the marginal effect that each subsidy dollar, s, has on subsidized food prices in a community, P_c:

$$\rho = \frac{\partial P_c}{\partial s}. \tag{3.1}$$

The rest of this chapter presents the theoretical predictions for pass-through rates given two extreme forms of competition; perfect competition and perfect monopoly. These predictions form the bounds of our expected pass-through rate and demonstrate how the relative elasticities of supply and demand affect the pass-through rate under each type of competition.

3.1 Pass-through Under Perfect Competition

In a perfectly competitive market, Weyl and Fabinger (2013) show that the pass-through rate is

$$\rho = \frac{1}{1 + \frac{\varepsilon_D}{\varepsilon_S}}, \tag{3.2}$$

where ε_D and ε_S are the elasticities of demand and supply, respectively. Given a typical downward sloping demand for food, we can see that the pass-through rate will be less than 1 under perfect competition if marginal costs are increasing. If supply is perfectly elastic, the pass-through rate will be 1 (as $\frac{\varepsilon_D}{\varepsilon_S}$ would approach 0 as ε_S approached ∞). If an industry is characterized by decreasing marginal costs (such that $\varepsilon_S < 0$) then the pass-through rate will be greater than 1. This has important implications for interpreting our estimated pass-through rates to determine competitive conduct in the grocery retail sector of Nunavut. Even within a perfectly competitive market, the pass-through rate can vary based on the relative elasticities of supply and demand, and will only equal 1 under specific conditions.

3.2 Pass-through Under Imperfect Competition

The pass-through under a monopoly, also developed and presented in Weyl and Fabinger (2013), is

$$\rho = \frac{1}{1 + \frac{\varepsilon_D - 1}{\varepsilon_S} + \frac{1}{\varepsilon_{ms}}}, \tag{3.3}$$

where the term $\frac{1}{\varepsilon_{ms}}$ is the inverse of the marginal consumer surplus, and $\frac{1}{\varepsilon_{ms}} > 0$ when demand is log concave. I assume that demand for food in Nunavut is log concave over the relevant range, which holds as long as demand is no more convex than an exponential

function and covers many of the commonly assumed forms of demand functions (Cowan 2004). If marginal costs are increasing or constant, the pass-through rate will be less than 1 (as $\frac{\varepsilon_D - 1}{\varepsilon_S} \leq 0$). If marginal costs are decreasing, then the pass-through rate could theoretically be less than, equal or greater than 1. For example, if $|\frac{\varepsilon_D - 1}{\varepsilon_S}| \leq \frac{1}{\varepsilon_{ms}}$, then the pass-through rate will be greater than one. If $|\frac{\varepsilon_D - 1}{\varepsilon_S}| = \frac{1}{\varepsilon_{ms}}$, the pass-through rate will be equal to 1.

The expected pass-through rates for various cost structures and types of competition are summarized in table 3.1. Given these theoretical predictions, the empirically determined pass-through rate on it's own is not enough to assess the type of competition in Nunavut. Therefore, after estimating the pass-through rates of the subsidy in Nunavut, I explore factors relating to both market power and cost structure that may affect the subsidy pass-through in order to gauge whether competitive pressures prevail. Beyond assessing the efficacy of Nutrition North Canada to lower food prices, the type of competition present in Nunavut has implications for various theories of competition. For example, given the small number of firms in each community, Cournot-Nash competition would lead us to predict a state of imperfect competition. Conversely, Baumol, Panzar and Willig's (1982) contestable market theory would lead us to predict that the mere threat of entrants would lead to market outcomes equivalent to perfect competition, regardless of the number of retailers in a community.

Table 3.1: Theoretical pass-through rates

Competition	Marginal Costs	Pass-through Rate
Perfect Competition	Increasing	< 1
	Perfectly Elastic	$= 1$
	Decreasing	> 1
Monopoly Competition	Increasing	< 1
	Perfectly Elastic	< 1
	Decreasing	> 0

Anticipating my results, it is worth noting that a pass-through rate in excess of 100% has theoretical explanations beyond decreasing costs. Pless and Benthem (forthcoming) find that solar energy subsidies were more than fully passed on to some consumers. They list some theoretical explanations for this phenomenon: Giffen behavior, decreasing marginal costs, nominal pricing rigidities, and extreme convexity of demand. By ruling out the competing explanations of over shifting of the subsidy, Pless and Benthem (2017) conclude that the market for solar systems can be characterized by imperfect competition and extremely convex demand. In my study, I provide some evidence that declining marginal costs, rather than the alternative explanations, explain pass-through rates greater in excess of 1.

Chapter 4 Data

To estimate the pass-through rate of the subsidy, I use food price data provided by the Nunavut Bureau of Statistics (Nunavut 2019). This data contains prices for around 300 food items for each community in Nunavut for 2017 and 2018. The food items are a mix of subsidized and unsubsidized products. Most communities in Nunavut are supplied from a service centre in southern Canada, in either the Ottawa region or Winnipeg. To establish a base price for food leaving a service centre, I use the price of food in Ottawa as it is reported by the same price survey from the Nunavut Bureau of Statistics. Each price is converted into a $/kg price, as these are the units that the subsidy is measured and applied to. Summary statistics for these prices are presented in table 4.1. Additionally, community characteristics, such as population, distance to the closest service centre, and subsidy rates are collected and published by the Nutrition North Canada program and presented in table 8.1 (Canada 2018).

Table 4.1: Summary statistics

Statistic	N	Mean	St. Dev.	Min	Max
Price	5,796	18.115	19.856	0.877	225.385
Ottawa	5,796	10.456	12.813	0.736	153.590
Subsidy	5,796	2.161	2.775	0.000	16.000

Chapter 5 Empirical Strategy

I use the following model to estimate the pass-through rate of the Nutrition North subsidy across all communities in Nunavut:

$$P_{ic} = \beta_1 S_{ic} + \beta_2 P_{iO} + C_{FE} + e, \tag{5.1}$$

where P_{ic} is the observed per kilogram price of food i in community c, S_{ic} is the subsidy that applies to food i in community c, and P_{iO} is the per kilogram price of that food in Ottawa. C_{FE} is a fixed effects term for each community. Additionally, since each price observation is a yearly average for that product, and not an individual sale, I weight each price observation by the relative population of the community the price is collected in to serve as a rough proxy for the quantity weighted average price of a food in Nunavut[2]. I present results from both unweighted and weighted regressions, for which the significant findings are the same, and discuss possible biases from using average prices instead of individual sales observations in the next chapter. Finally, standard errors are clustered at the community level.

My main variable of interest is β_1, which describes the pass-through rate, ρ. Recall that the pass-through rate of the Nutrition North subsidy describes the marginal effect of a subsidy dollar on the price of food in a community, $\rho = \frac{\partial p_c}{\partial s}$, and note that $\beta_1 = \frac{\partial p_{ic}}{\partial S_{ic}}$. Fixed effects for each community control for many of the unobservable factors that

[2]Sumner (1981) uses state level quantity weighted average cigarette prices in his study of cigarette tax pass-through, and outlines the assumptions under which they will produce an unbiased pass-through estimate, namely that firms in a single region have the same market power and face similar marginal costs of production

determine food prices in a community, such as the per kilogram transportation costs of shipping food to a specific community.

I also model the subsidy pass-through rate for each community individually, dropping the fixed effects term for each community and population weights. As discussed previously, the pass-through rate alone is not enough to determine competitive conduct within a market. In order to assess the competitive pressures that are present in Nunavut, I regress the estimated pass-through rates from the individual community level regressions on community characteristics, such as the number of stores in a community, population, and distance to the closest service centre. If market power is driving the difference in pass-through rates between communities, then pass-through rates for each community should depend on the number of stores present in that community, accounting for other determinants of the pass-through rate, such as cost structures.

Chapter 6 Results

In this section, I present my primary results, which estimate a subsidy pass-through rate for Nunavut as whole. I then present individual pass-through estimates for each community and explore potential causes of the heterogeneity in these pass-through rates with particular attention to market power and cost structure characteristics.

6.1 Primary Results

I report my primary findings, along with additional model specifications, in table 6.1. Model 1 is a simple OLS regression that does not include community level fixed effects. Model 2 introduces community level fixed effects, and model 3, my primary specification from above, includes both fixed effects and population weights.

Model 1 estimates that the pass-through rate of the subsidy is only 0.539, which means that every subsidy dollar decreases the price of subsidized food in Nunavut by \$0.539. This estimate is significantly lower, in absolute terms, than the specifications that include fixed effects. Because the fixed effects control for differing transportation costs between communities, omitting them will bias my estimated pass-through rate downwards, as prices in a community and subsidy levels both increase with transportation costs.

Model 2 introduces fixed effects for each community, and the estimated subsidy pass-through rises, in absolute terms, to .907, or 90.7%. Without weights though, this model treats each price observation equally, which is problematic if two observations represent

vastly different quantities of food sold. For example, the price observation for food A in Grise Fiord might represent 100 kg of food shipped in a year, while the observation for the same item in Iqaluit might represent 5,000 kg of food. Including weights to try to account for these differences, which I do in model 3, is important to understanding the average pass-through rate experienced by consumers in Nunavut. A potential limitation to this weighting method though is that it assumes equal quantities of each food sold within a community. A more detailed data set that included quantities of food sold would further increase the accuracy of the pass-through estimate.

Finally, model 3, which includes both fixed effects for each community and population weights, estimates an average pass-through rate of %112.5, which is not statistically significantly different than %100 at the 5% level. These results were also insensitive to yearly dummies, likely because the effects of inflation are present in both the price of food in each community and the price of food in Ottawa. These results indicate that the Nutrition North program is reducing the price of food at least as well as intended. Based on the theoretical predictions in table 3.1, this result on its own is not enough to determine whether retailers are exerting market power. One of two possibilities would lead to pass-through rates of %100. The first is that food retailers face constant marginal costs, and price food in a perfectly competitive manner. The second is that a combination of decreasing marginal cost structures and market power on behalf of the retailers is present. From a policy perspective, no matter which scenario is true, it appears that the Nutrition North subsidy is, on average, fully passed on.

While I find that the Nutrition North Subsidy is fully passed on, further research is warranted to examine why rates of food insecurity still remain high in Nunavut. One possible explanation may have to do with the selection of foods that are subsidized.

Huet, Rosol and Egeland (2012) found that food insecure households in Nunavut were less likely to consume fresh fruits and vegetables, dairy, and grain products than food secure households, while also being more likely to consume sugary drinks and prepared foods. As the food survey used by Huet, Rosol and Egeland (2012) was conducted before the Nutrition North Program started, these trends may no longer persist. If they do persist though, it may be the case that households that are food insecure are less likely to benefit from the Nutrition North program as it subsidizes products like fresh fruits, vegetables and dairy while excluding many prepared foods.

6.2 Community Level Regressions

Table 6.2 presents pass-through estimates for individual communities. I interpret these results cautiously, as the explanatory power of these regressions is low relative to the primary results for Nunavut as a whole. This is due to fewer observations for each community than the region as a whole, and very little variation in subsidy rates within a single community. For example, Cambridge Bay has 3 subsidy rates; 0, $0.05 and $1.80. The variance in the subsidy rates observed for Cambridge Bay is only 0.73, whereas the variance in subsidy rates across Nunavut as a whole is 7.70 (see table 4.1). This low variation in subsidy rates only affects communities with relatively low subsidy rates. With those caveats in mind though, there are still quite a few statistically significant pass-through estimates, with 4 communities below 1 and 8 above 1.

As noted previously, pass-through rates greater than 100% have multiple theoretical explanations. In order to support the idea that decreasing marginal costs are present in supplying communities in Nunavut with food, alternative sources of over shifting of the pass-through rate must be examined. Following Pless and Bentham (forthcoming),

Table 6.1: Pass-through rates for Nunavut

	Dependent variable:		
	Food Price		
	(1)	(2)	(3)
Subsidy	-0.539^{***}	-0.907	-1.125
	(.166)	(0.129)	(.177)
95% Confidence Interval	$(-0.615, -0.463)$	$(-1.161, -0.653)$	$(-1.473, -0.778)$
Ottawa	1.397^{***}	1.389^{***}	1.412^{***}
Constant	4.673^{***}		
Community Fixed Effects	No	Yes	Yes
Weighted Regression	No	No	Yes
Observations	5,796	5,796	5,796
R^2	0.832	0.842	0.863
Adjusted R^2	0.832	0.841	0.862

Note: Standard errors are clustered at the community level. *p<0.1; **p<0.05; ***p<0.01

Table 6.2: Pass-through rates for each community

Community	Pass-through Rate Relative to 100%	Pass-through Rate	Ottawa	Constant	N
Arctic Bay	−	-0.524^{***}	1.523^{***}	5.334^{***}	250
Arviat	+	-2.123^{***}	1.377^{***}	4.438^{***}	253
Baker Lake	+	-1.621^{**}	1.505^{***}	4.083^{***}	260
Cambridge Bay	1	−1.721	1.252^{***}	5.015^{***}	246
Cape Dorset	1	−1.239	1.477^{***}	6.248^{***}	248
Chesterfield Inlet	1	−1.220	1.187^{***}	6.281^{***}	218
Clyde River	+	−1.360	1.665^{***}	7.902^{***}	234
Coral Harbour	1	−1.164	1.420^{***}	5.640^{***}	259
Gjoa Haven	1	−1.243	1.559^{***}	4.261^{***}	262
Grise Fiord	−	-0.388^{***}	1.312^{***}	8.680^{***}	85
Hall Beach	1	−0.950	1.521^{***}	5.189^{***}	245
Igloolik	1	−1.235	1.615^{***}	6.237^{***}	247
Iqualuit	+	-2.680^{***}	1.427^{***}	5.664^{***}	265
Kimmirut	1	−1.242	0.752^{***}	12.625^{***}	203
Kugaaruk	1	−1.294	1.337^{***}	7.736^{***}	138
Kugluktuk	+	-1.838^{**}	1.325^{***}	5.358^{***}	250
Pangirtung	+	-1.471^{*}	1.531^{***}	5.430^{***}	244
Pond Inlet	−	-0.511^{***}	1.461^{***}	5.179^{***}	255
Qikiqtarjuak	1	−1.003	1.137^{***}	8.310^{***}	251
Rankin Inlet	+	-2.024^{***}	1.379^{***}	3.605^{***}	264
Repulse Bay	1	−1.085	1.328^{***}	5.706^{***}	244
Resolute	−	-0.420^{***}	1.652^{***}	5.862^{***}	177
Sanikiluaq	+	-2.492^{***}	1.285^{***}	6.258^{***}	246
Taloyoak	1	−1.031	1.382^{***}	5.938^{***}	246
Whale Cove	1	−1.161	1.283^{***}	5.029^{***}	181

Note: *p<0.1; **p<0.05; ***p<0.01

we would have to rule out extreme convexity in the demand function for food, Giffen behaviour, and nominal pricing rigidities. Giffen behaviour is extremely unlikely as I am estimating a pass-through rate across all foods, not just foods that could be considered inferior goods. Nominal pricing rigidities are ruled out by noting that the nominal prices of food have increased in Nunavut over the last 5 years (Nunavut 2019). Finally, more detailed analysis of food demand in Nunavut would be needed to rule out extremely convex demand curvature with full certainty, however typical demand forms for food are assumed to be log concave (Cowan 2004). Further, assuming log concavity in the demand for food seems relatively safe given the inelastic nature of the demand for food.

6.3 Determinants of Pass-through Rates

To explore the effects of market and cost structure on the pass-through rates of each community, I regress the pass-through estimates from each community on the number of stores in a community, population and distance to the closest service centre. Table 6.3 presents these results.

Two specifications are used to describe the level of competition in a community. The first is the number of stores, and the second is a dummy variable that is equal to 1 if a community contains a single retailer. Neither effect is statistically significant, which fails to support models of competition that are based on the number of sellers in a market. Additionally, it fails to reject a key prediction of contestable market theory which predicts that the threat of entry, and not the actual number of participants, produces competitive pricing. In both cases however, it is hard to draw strong conclusions given the small sample size of 25 communities. Alternatively, it might suggest that the potential threat of enforcement for violating the subsidy pass-through requirements are

Table 6.3: Determinants of pass-through rates

	Dependent variable:	
	Pass-through Rate	
	(1)	(2)
Number of Retailers	−0.202	
	(0.169)	
One Retailer		0.113
		(0.231)
Population (000's)	−0.200**	−0.268***
	(0.085)	(0.060)
Distance (000's km)	0.371***	0.354***
	(0.095)	(0.097)
Constant	−1.360***	−1.673***
	(0.328)	(0.227)
Observations	25	25
R^2	0.684	0.666
Adjusted R^2	0.639	0.619
Note:	*p<0.1; **p<0.05; ***p<0.01	

forcing retailers to price competitively, even in the absence of competitors or evidence of previous enforcement.

The effect of population is significant in both models. An additional 1,000 people in a community increased the pass-through rate by .20 to .26. This is equivalent to a consumer capturing an additional $.20 to $.26 of every subsidy dollar. This effect may be caused by the substantial economies of density involved in air transportation (Caves, Christensen, and Tretheway 1984). Appendix 8.2 goes further into depth on the potential sources of economies and diseconomies of scale involved in air transportation in Nunavut. The importance of potential economies of density may be very relevant for Nunavut, which contains both small communities that receive air service from small turboprop planes and larger communities which have populations and airports that support jet planes that achieve much lower per unit transportation costs (Nunavut, 2008). Finally, distance to the closest service centre was also significant. An additional 1,000 km from a service centre decreased the pass-through rate by .35 to 37 percentage points. This is potentially a result of increasing marginal costs associated with long range air transportation. Burzloff (2017) demonstrates that as flight distance increases, fuel efficiency decreases. This decreased fuel efficiency occurs because planes must take off with more fuel, often resulting in reduced cargo capacity and more energy spent carrying the increased fuel supply.

Bearing in mind the small sample size of 25 communities, these results constitute only limited evidence that cost structures, and not the number of competitors in each community, account for the heterogeneity in pass-through rates. More detailed analysis of these cost structures would be informative and interesting, as Pless and Benthem (forthcoming) note that empirical evidence of markets with decreasing short-run marginal cost

structures is extremely rare.

Chapter 7 Conclusions

In this thesis, I estimate the pass-through rate of the Nutrition North Canada food subsidy in Nunavut. Overall, I find that despite a small number of retailers in Nunavut, the subsidy is fully passed on to consumers. From a policy standpoint, the program appears to be operating as intended with regard to food prices in remote communities, with every subsidy dollar lowering the cost of subsidized food by $1.12. This also suggests that the increased subsidy levels announced for the 2019 program year are likely to have the intended price effect (Canada 2018).

I also find heterogeneous pass-through rates between communities. While it appears that the difference in pass-through rates stem from cost structure characteristics, rather than the number of grocery stores in a community, these results must be interpreted cautiously due to the small number of communities studied. A more thorough examination of the cost structures of grocery retailing in Nunavut would be necessary to make more definitive conclusions about the nature of grocery retail competition in the territory.

While I find that the Nutrition North Subsidy is fully passed on, further research is required to examine why rates of food insecurity still remain high in Nunavut. One possible explanation may have to do with the selection of foods that are subsidized. As previously discussed in the results section, food insecure people may be less likely to purchase the types of food that are currently subsidized under the Nutrition North Canada program. It may also be that the subsidy levels are not high enough to produce the desired food security effect. Exploring these issues, as well as other potential reasons that food insecurity still remain high in Nunavut, would be productive avenues for future

research.

Bibliography

Bailey, E., D. Graham, and D. Kaplan. 1985. *Deregulating the Airlines*. MIT Press.

Baumol, W.J., J.C. Panzar, and R.D. Willig. 1982. *Contestable Markets and the Theory of Industry Structure*. Harcourt Brace Jovanovich.

Burnett, K., K. Skinner, and J. LeBlanc. 2015. "From Food Mail to Nutrition North Canada: Reconsidering Federal Food Subsidy Programs for Northern Ontario." *Canadian Food Studies* 2:141–156.

Burzlaff, M. 2017. "Aircraft Fuel Consumption - Estimation and Visualization." Harvard Dataverse.

Canada. 2014. *2014 Fall Report of the Auditor General of Canada*. Office of the Auditor General of Canada, Ottawa.

—. 2018. "Nutrition North Canada." https://www.nutritionnorthcanada.gc.ca/eng/.

Caves, D.W., L.R. Christensen, and M.W. Tretheway. 1984. "Economies of Density versus Economies of Scale: Why Trunk and Local Service Airline Costs Differ." *The RAND Journal of Economics* 15:471.

Fitzgerald, M., and F. Hill. 2017. "Nutrition North Canada: Real Change s Yet to Come." *Northern Public Affairs* 5:5.

Galloway, T. 2017. "Canada's Northern Food Subsidy Nutrition North Canada: A Comprehensive Program Evaluation." *International Journal of Circumpolar Health* 76:1–19.

—. 2014. "Is the Nutrition North Canada Retail Subsidy Program Meeting the Goal of Making Nutritious and Perishable Food More Accessible and Affordable in the North?" *Canadian Journal of Public Health* 105:395–397.

Graham, D., and D. Kaplan. 1984. "Competition and the Airlines: An Evaluation of Deregulation." *Journal of Travel Research* 23:41.

Holloway, S. 2003. "Straight and level: Practical airline economics, Second Edition." *Straight and Level: Practical Airline Economics, Second Edition*, pp. .

Huet, C., R. Rosol, and G.M. Egeland. 2012. "The Prevalence of Food Insecurity Is High and the Diet Quality Poor in Inuit Communities." *The Journal of Nutrition* 142:541–547.

Kirwan, B. 2009. "The Incidence of U.S. Agricultural Subsidies on Farmland Rental Rates." *Journal of Political Economy* 117:138–164.

Kirwan, B., and M.J. Roberts. 2016. "Who Really Benefits from Agricultural Subsidies? Evidence from Field-level Data." *American Journal of Agricultural Economics* 98:1095–1113.

Lade, G.E., and J. Bushnell. 2019. "Fuel Subsidy Pass-Through and Market Structure: Evidence from the Renewable Fuel Standard." *Journal of the Association of Environmental and Resource Economists* 6:563–592.

Nunavut. 2008. *Lets Get Moving; Nunavut Transportation Strategy*. Department of Economic Development Transportation.

—. 2019. "Nunavut Bureau of Statistics." http://www.stats.gov.nu.ca/en/Economic.

Pless, J., and A. van Benthem. Forthcoming. "Pass-Through as a Test for Market Power: An Application to Solar Subsidies." *AEJ: Applied Economics*, in press.

Roberts, M.J., B. Kirwan, and J. Hopkins. 2003. "The Incidence of Government Program Payments on Agricultural Land Rents: The Challenges of Identification." *American Journal of Agricultural Economics* 85:762–769.

Statistics Canada. 2016. "Canadian Community Health Survey, 2015-2016."

—. 2018. "Table: 23-10-0017-01, Itinerant movements, by weight group and type of power plant."

Sumner, D.A. 1981. "Measurement of Monopoly Behavior: An Application to the Cigarette Industry." *Journal of Political Economy* 89:1010–1019.

Transportation Canada. 2019. "Canadian Civil Aircraft Register."

Weyl, E.G., and M. Fabinger. 2013. "Pass-Through as an Economic Tool: Principles of Incidence under Imperfect Competition." *Journal of Political Economy* 121:528–583.

Wold, H., J. Smith, L. Jureen, and J. Fourth. 3004. *Nutrition North Canada*. Nowhere: Some Publisher.

Chapter 8 Appendix

8.1 Community Characteristics

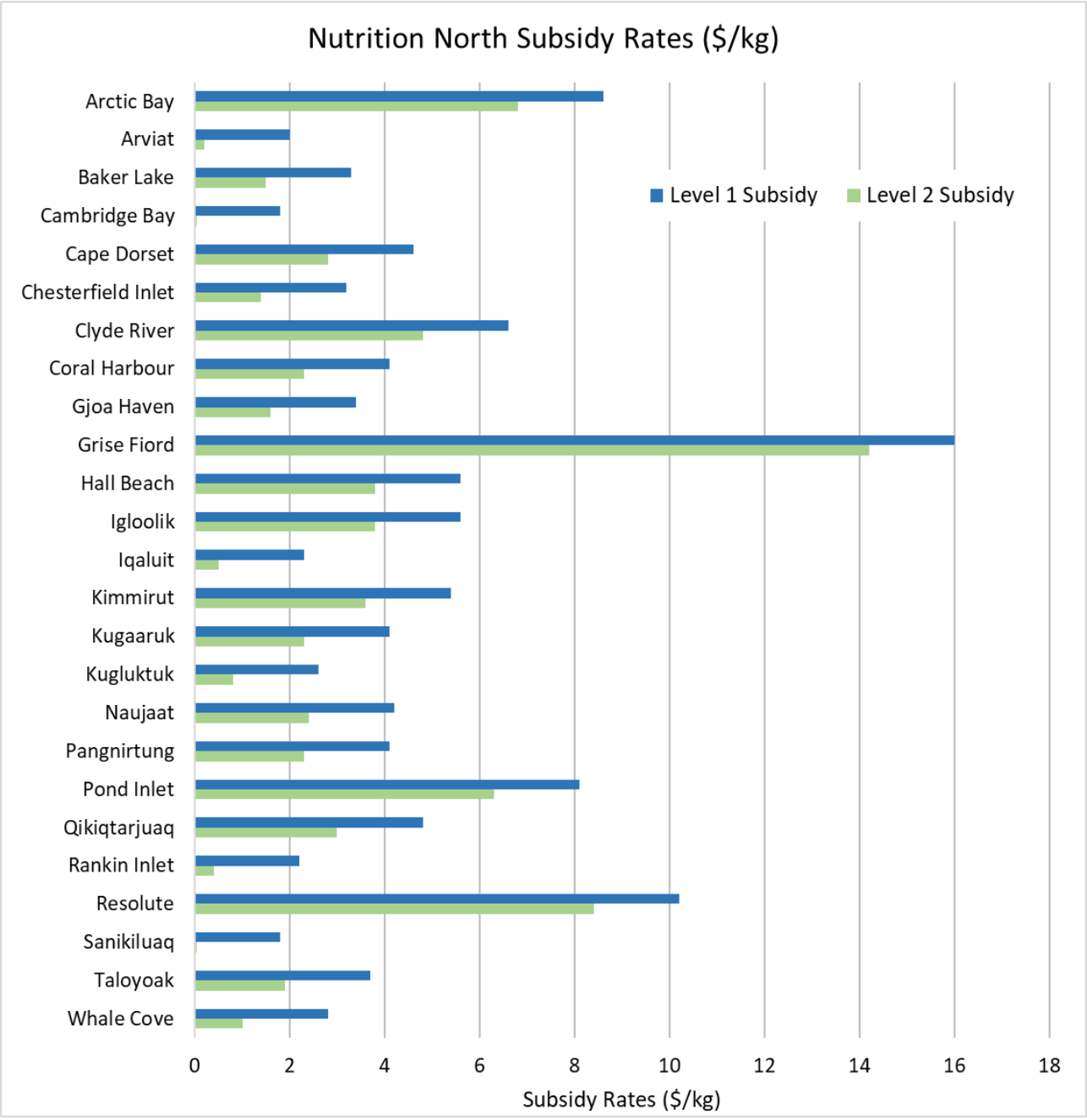


Figure 8.1: Subsidy rates in each community for the 2017 and 2018 program year. Source: Canada (2018).

Table 8.1: Communities in Nunavut

Community	Population (2011)	Distance to Service Centre (km)	Level 1 Subsidy	Level 2 Subsidy	Number of Stores	Northern Store	Arctic Co-operative
Arctic Bay	823	1,672	$8.60	$6.80	2	•	•
Arviat	2,318	1,263	$2.00	$0.20	3	•	•
Baker Lake	1,872	1,607	$3.30	$1.50	3	•	•
Cambridge Bay	1,608	887	$1.80	$0.05	2	•	•
Cape Dorset	1,363	2,101	$4.60	$2.80	2	•	•
Chesterfield Inlet	313	1,543	$3.20	$1.40	2	•	•
Clyde River	934	2,808	$6.60	$4.80	3	•	•
Coral Harbour	834	1,788	$4.10	$2.30	2	•	•
Gjoa Haven	1,279	1,088	$3.40	$1.60	2	•	•
Grise Fiord	130	3,471	$16.00	$14.20	1		•
Hall Beach	546	2,625	$5.60	$3.80	2	•	•
Igloolik	1,454	2,695	$5.60	$3.80	2	•	•
Iqaluit	6,699	2,096	$2.30	$0.50	4	•	•
Kimmirut	455	1,982	$5.40	$3.60	2	•	•
Kugaaruk	771	1,307	$4.10	$2.30	1		•
Kugluktuk	1,450	599	$2.60	$0.80	2	•	•
Naujaat	945	1,952	$4.20	$2.40	2	•	•
Pangnirtung	1,425	2,390	$4.10	$2.30	2	•	•
Pond Inlet	1,549	3,045	$8.10	$6.30	2	•	•
Qikiqtarjuaq	520	2,562	$4.80	$3.00	2	•	•
Rankin Inlet	2,577	1,470	$2.20	$0.40	2	•	•
Resolute	214	3,396	$10.20	$8.40	2		•
Sanikiluaq	812	1,271	$1.80	$0.05	2	•	•
Taloyoak	899	1,219	$3.70	$1.90	2	•	•
Whale Cove	407	1,402	$2.80	$1.00	1		•
Average	1,287.9	1,929.6	$4.84	$3.05	2.08	21/25	25/25

8.2 Economics of Air Transportation

The heterogeneity in pass-through rates found in different communities in Nunavut may be attributed to differences in cost structures associated with supplying each community with food. One of the most substantial cost drivers in food retail in Nunavut is the cost of air transportation, which is the primary method of supplying a community (Nunavut 2008). The economics of airline transportation are fairly nuanced; economies and diseconomies of density, scale and scope have all been demonstrated in the literature on airline economics. Consequently, the particular nature of each community's airline infrastructure, population and physical location may be highly relevant to the cost of supplying additional food in that community.

The results exploring the heterogeneity in pass-through rates between communities are presented in Table 6.3. Both population and distance were statistically significant determinants for the pass-through rate. I believe that this is due to the effects that both of these factors have on the cost structure of air transportation.

8.2.1 Economies of Density

As the number of people in each community increases, the estimated pass-through rate for that community also increases (See table 6.3). Economies of density and scale are likely behind this finding. According to Holloway (2003), economies of density describe declining unit costs as the volume of traffic over an unchanged network increases. In our setting, this would mean an increase in the amount of food flown to an unchanged network of communities. This seems to be plausible, as a report on the Nutrition North Canada program states that "between 2011 and 2016, the average volume of eligible items shipped to northern isolated communities increased by approximately 25

percent"(Canada 2018). Economies of density in airline transportation have been found in empirical settings by Graham and Kaplan (1984); Caves, Christensen, and Tretheway (1984); and Bailey, Graham and Kaplan (1985), among others. In Nunavut, I believe that the two main drivers of these declining unit costs as density increases are the ability to use larger planes and the ability to achieve a higher load factor on flights.

Larger planes are able to achieve lower unit costs than smaller ones, as many of the fixed costs of transporting cargo or passengers are either similar or increase slowly as planes get larger. Figure 8.2 shows block hour operating costs per pound of cargo for many of the common planes used to transport food in Nunavut. Block hours refer to the time after a plane removes its wheel blocks and starts to taxi until it lands and puts the wheel blocks back in place. Essentially, block costs are the costs of carrying cargo, but not loading it, or paying airport fees, etc. The variety of planes registered in Nunavut can be found in the Canadian Civil Aircraft Register (Transport Canada 2019), maximum payloads are collected from manufacturer's websites, and the cost data are presented in a World Bank (2009) report on air freight. Figure 8.2 demonstrates that larger planes achieve lower block operating costs per unit of cargo. While larger planes may have lower unit costs, not every community would have a population large enough to support large planes or use them efficiently.

Figure 8.3 shows differences in the size of planes used for a few communities in Nunavut. Arctic Bay, displayed in panel a, is a medium sized community of 823 people, while Grise Fiord and Iqaluit represent the smallest and largest communities, with populations of 130 and 6,699 respectively. Panel b shows that almost all flights in and out of Grise Fiord are on small planes with payloads under 6,000 kg, while almost half of all flights in and out of Iqaluit, shown in panel c, have payloads in excess of 18,000 kg.

Figure 8.4, published by the Nunavut (2008) Department of Economic Development and Transportation, details the air transportation network in Nunavut and corroborates the trends in figure 8.3. It is worth noting that not every flight path is serviced by the same size of jet. These differences in air transportation service may have significant impacts on the elasticity of supply of food, and consequently the subsidy pass-through rates, for each community in Nunavut.

The second source of economies of density involved in air transportation come from the relationship between load factor and fuel efficiency. Load factor refers to the ratio between a plane's current cargo weight and it's maximum payload. Typically, holding the size of plane and trip distance constant, marginal fuel costs increase at a constant rate per kilogram of cargo (World Bank, 2009). Because the fuel cost of transporting the empty air frame, regardless of how full a plane is loaded, are fixed, the closer a plane is to it's maximum payload, the more fuel efficient it becomes per unit of cargo. Figure 8.5, published by The World Bank (2009), displays this relationship between fuel consumption and load factor. The curves labelled .5, .55, and .6 refer to the weight of the plane's air frame relative to its maximum payload. Fuel efficiency is very important for determining transportation prices, as the same report estimated that fuel costs account for 43-60% of operating costs. Thus, holding the size of plane constant, the marginal cost per kilogram of cargo decreases as planes are more fully loaded.

8.2.2 Distance and Pass-through

In Nunavut, I that found communities that are farther away from service centres had lower subsidy pass-through rates (see table 6.3). Increasing marginal costs will reduce subsidy pass-through, regardless of competitive pressures, and may explain the negative

relationship between distance and subsidy pass-through. I believe that there are at least three sources of increased marginal costs associated with transporting perishable food to more remote communities.

The first is that longer trip stages may result in planes flying with less than full payloads and additional fuel, as discussed previously in my results section (Burzloff 2017). The second is that fuel costs for flights in remote regions in Nunavut will be higher. Aircraft fuel in Nunavut must either be flown in or shipped in, both of which are expensive. For example, consider figure 8.4. While a flight from Resolute Bay to Grise Fiord is relatively short, the cost of transporting fuel to Resolute Bay is likely very high, and must be factored into the fuel costs for that trip. Finally, shipping food to the most northern communities typically involves frequent stops. For example, food travelling from a southern service centre can be flown straight to Iqaluit (see figure 8.4). Food flown even further, for example, to Qikiqarjuaq, will involve multiple stops, where cargo is unloaded[3]. Because there are increased fuel costs involved with taking off and landing, in addition to increased costs of handling cargo, these additional stops increase the per unit costs of getting perishable food to more remote communities in Nunavut[4].

[3]Unloading cargo will also reduce the load factor on the remaining stages of a flight, which further reduces fuel efficiency as discussed in section 8.2.1.

[4]It is important to note that many of these additional costs may be lessened in the case of non-perishable food, which can be flown less frequently and in higher volumes because they can be stored in a community.

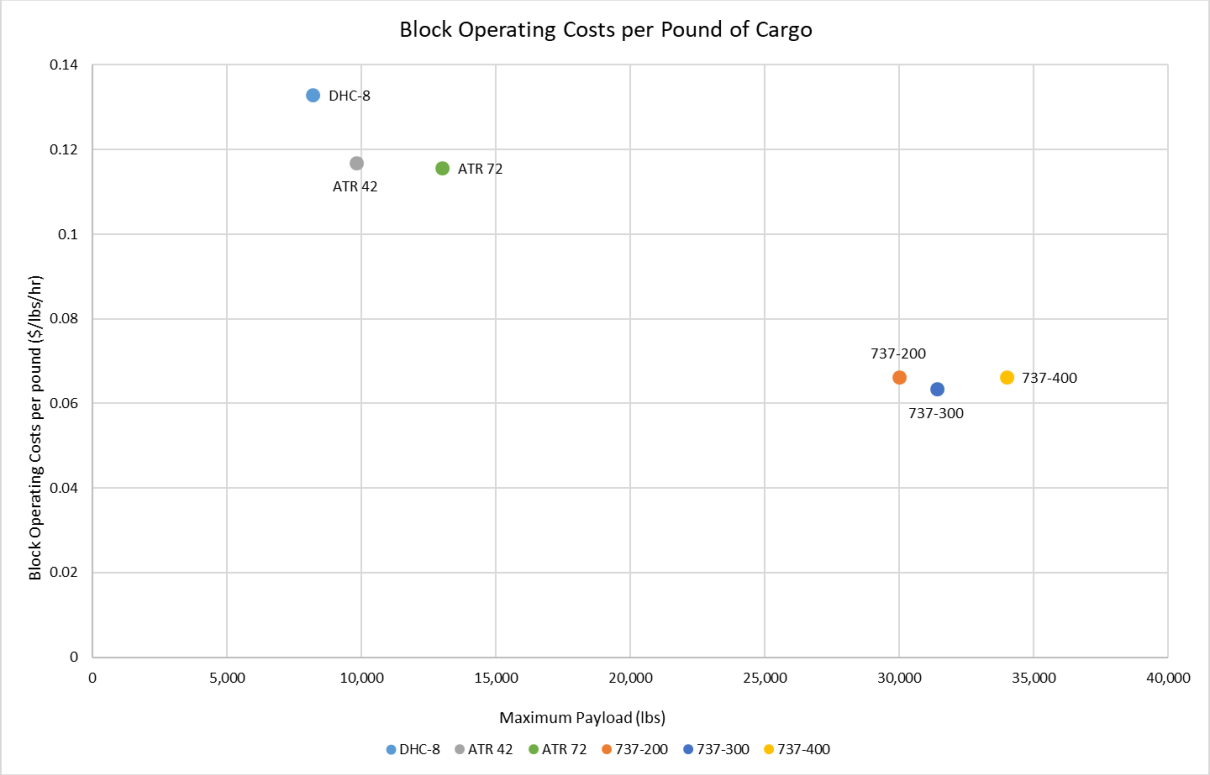
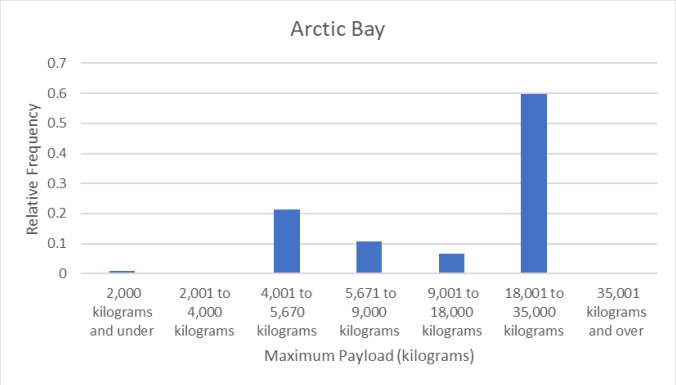
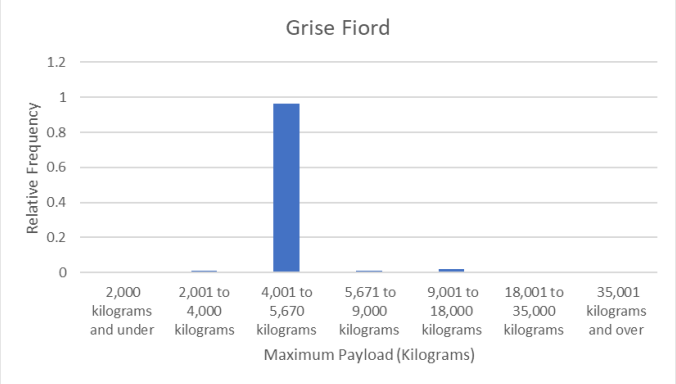


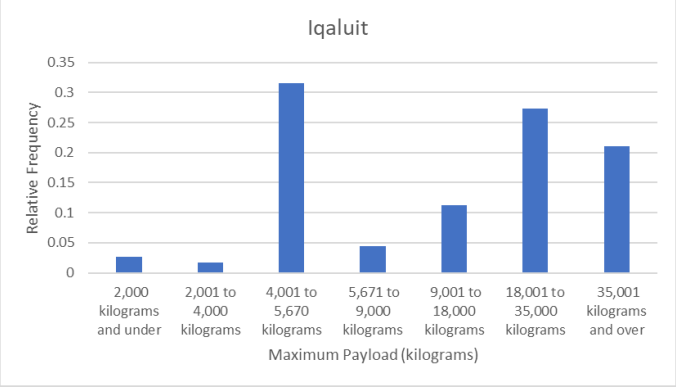
Figure 8.2: Block hour operating costs per pound of cargo.



(a) Arctic Bay, Nunavut



(b) Grise Fiord, Nunavut



(c) Iqaluit

Figure 8.3: Relative frequency of itinerant movements (flights from one airport to another) by plane size. Source: Statistics Canada (2018)

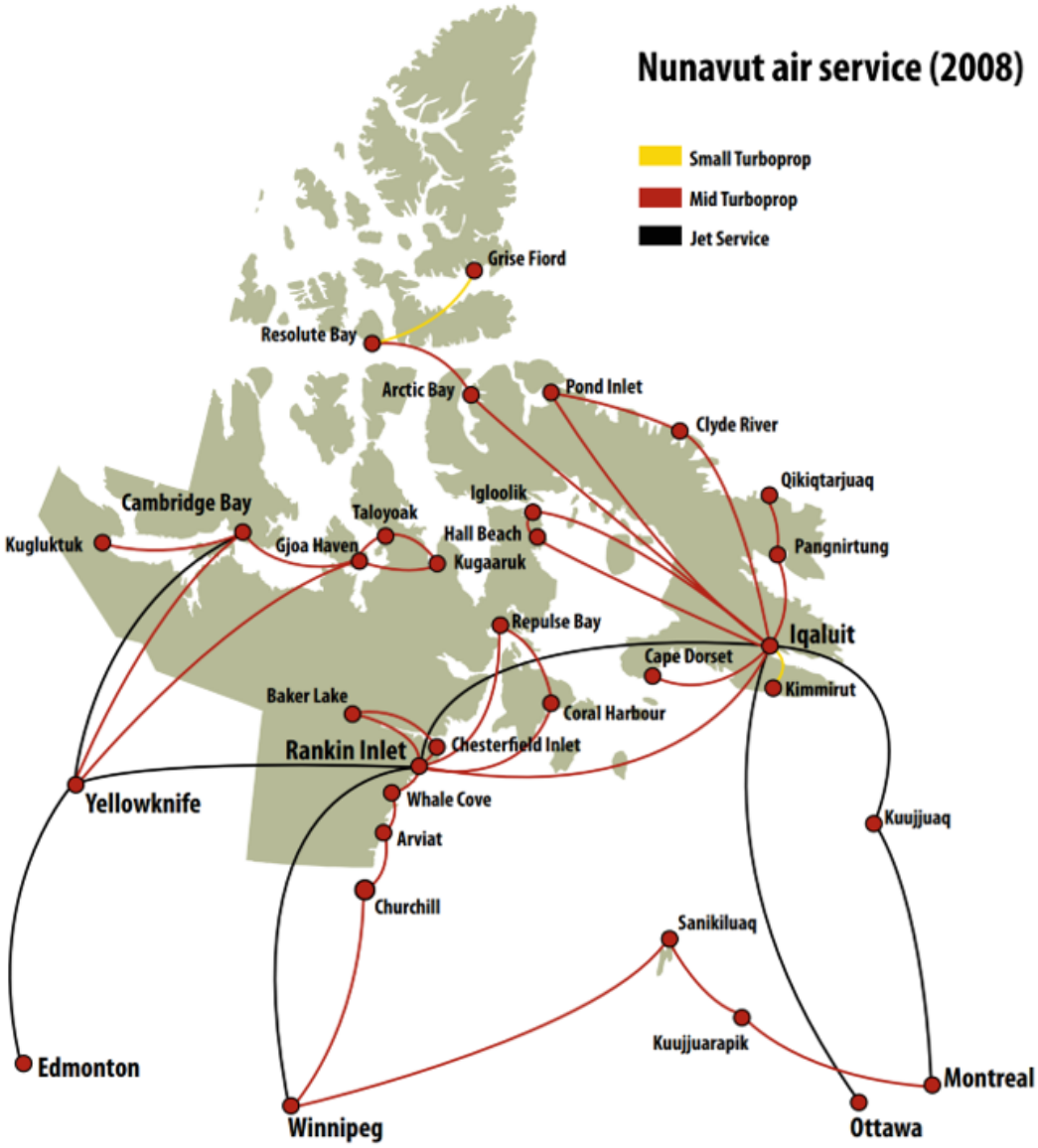


Figure 8.4: Air service in Nunavut. Source: Reproduced from Nunavut (2008)

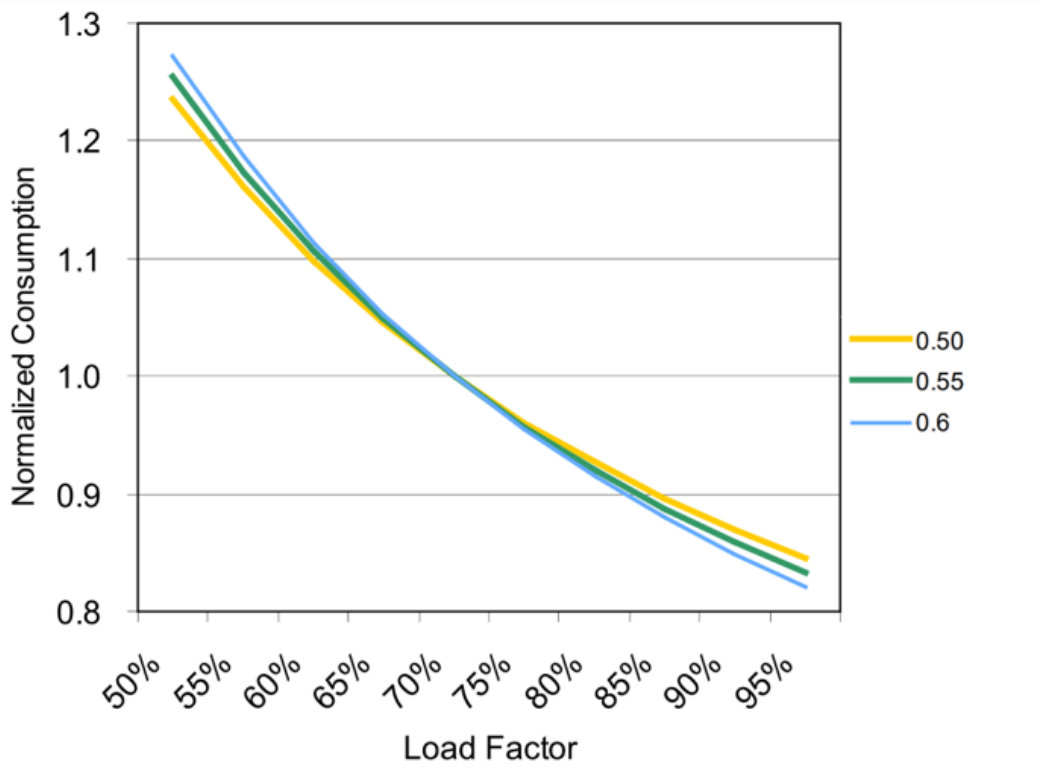


Figure 8.5: Load factor and normalized fuel consumption. Each line represents a different air frame weight to maximum take off weight ratio. Source: Reproduced from World Bank (2009).