Subsidies, cost shocks and heterogeneous pass-through: Evidence from Nutrition North Canada's product-level price data

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Abstract

Nutrition North Canada pays subsidies to retailers to offset freight costs for certain foods shipped to remote, mainly Indigenous communities provided they promise to pass these subsidies on to consumers. But these communities are mostly retail monopolies or duopolies, and the lack of credible punishment for non-compliance may provide incentives to capture some of the subsidy through higher margins. We build on our previous analysis (Galloway and Li, 2023) using confidential product-level price data for each store and month, confirming that average pass-through of a subsidy increase is incomplete in both the short and the long-run and ranges from 57 to 78 cents per dollar. We also document substantial heterogeneity across products, retailers, communities, and subsidy reform episodes. Pass-through of subsidy changes is higher than pass-through of national price increases and is increasing in the size of subsidy changes, suggesting that program compliance measures may provide discipline that pushes retailers towards full pass-through. But we also find evidence of price-setting consistent with profit-maximization by firms with market power, such as retailers actively raising before-subsidy prices when subsidies increase, and lower subsidy pass-through when markups and retailer market share are higher or unregulated (national price) pass-through is lower.

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1. Introduction

Nutrition North Canada is a federal subsidy program administered by Crown-Indigenous and Northern Affairs Canada that was introduced in 2011. The program pays subsidies directly to Northern retailers on a $/KG basis for shipping food by air freight to remote communities that are eligible due to a lack of year-round surface (road/rail/water) transit (Government of Canada, 2022). These communities are small and low income by Canadian standards, spanning the Northern regions of the provinces and territories, with about 94% of the population identifying as Indigenous. Due in part to their small scale and remoteness, these communities face among the highest food prices in the world and the highest rates of food insecurity in Canada (Leblanc-Laurendeau, 2020). They also feature limited retail competition, with most communities served by a retail monopoly or duopoly and prohibitively expensive individual travel and freight costs that limit arbitrage with other communities (Burnett et al., 2017). The leading retailer – the Northwest Company – is the direct descendant of the Hudson Bay Company, a government-sanctioned, profit-maximizing trading monopoly that played a critical role in Canada's expansion and relations with Indigenous nations. As the profitability of the fur trade declined, the Hudson Bay Company Northern Stores division became more dependent on retail sales for profit, with government transfers replacing declining income from the fur trade as an important source of purchasing power. Burnett and Hay (2023) describe the long history of government support for Canada's remote Indigenous communities that – incidentally or intentionally – supported the profitability of retail monopolies, beginning before family allowances were introduced in the 1940s and continuing through direct subsidy payments to retailers under the Nutrition North Canada program.

Given this context, understanding the extent to which Nutrition North subsidies are captured by retailers or passed-through to increase the affordability of nutritious food is of critical importance. In order to receive the Nutrition North subsidy, retailers sign a compliance agreement with the Government of Canada promising to fully pass-through the subsidy to consumers; they also agree to provide some price data to the government, submit documentation on shipments, list the subsidies clearly, and agree to potential audits by third-party private firms to ensure complaince. Critics of Nutrition North have long contended that these measures are insufficient to ensure accountability and full pass-through, as the program lacks a mechanism to prevent retailers from raising "before-subsidy" prices to offset the effect of subsidies (Gal-

loway, 2014; Burnett et al., 2015; Galloway, 2017). Some retailers do not submit price data to the government for prolonged periods, if ever. Program audits appear to be mostly focused on aspects of program compliance that are easier to measure than pass-through, such as labeling/advertising of subsidies and invoicing. The methodologies they use for assessing pass-through that are not made available to the public. The consequences for non-compliance are also unclear. Given that loss of subsidies would be harmful to vulnerable communities under any pass-through greater than zero, particularly when there is a monopoly, loss of subsidy eligibility may not be a credible threat. To date there have been some citations for non-compliance but no legal or financial penalties.

In this paper, we use confidential product-level data on retail prices that have only recently been made available to academic researchers to provide a more comprehensive understanding of subsidy pass-through under the Nutrition North Canada program. We build on our previous analysis in Galloway and Li (2023), where we used the publicly available version of these prices which are aggregated across 67 products and multiple stores in each community to derive the price of a specific food basket at the community by quarter level (the "Revised Northern Food Basket" or RNFB described later). We estimated the subsidy content of the food basket for each community and period and analyzed the plausibly exogenous variation in subsidies generated by reforms that increased subsidy content of the food basket by more for some comunities than others in October 2016 and January 2019. Galloway and Li (2023) found average pass-through of 67 cents per dollar and evidence for heterogeneity, as pass-through was significantly lower in communities with a retail monopoly and not significantly different than zero for communities with local competition. Our analysis here takes advantage of the much richer product-level price data underlying the publicly available RNFB price data. These data are at the product by store by month level, extend to important retailers excluded from the public RNFB calculations (Arctic Co-op Ltd., the second largest retailer in the region), and allow us to study pass-through of the third and also the largest subsidy increase since the program's inception, which occurred in May 2020. The richness of these data allow for more robustness to omitted variables, more statistical power to assess heterogeneous pass-through, more insight into high frequency product-level price dynamics changes, and a more in-depth understanding of the role of market power.

Our analysis confirms the main finding of Galloway and Li (2023) that average

pass-through of subsidy increases for RNFB products was incomplete, ranging from slightly below (around 57 cents per dollar) to slightly above (78 cents per dollar) our earlier estimate of 67 cents, depending on how we specify the counter-factual price change. Because subsidy increases due to the reforms in October 2016, January 2019 and May 2020 account for almost half of the current $130 million a year of subsidy expenditure, our findings imply that a large share of the subsidy is currently not being passed-through to consumers. We show that there is substantial heterogeneity in pass-through along major dimensions – province/territory, retailer, and product group – but that average pass-through is incomplete across most of these dimensions.

We then turn to the question of what explains incomplete pass-through and pass-through heterogeneity in this setting, focusing on the role of textbook economic forces (i.e. price setting by profit-maximizing firms with market power) and the specific context of the Nutrition North program (i.e. subsidies with a full pass-through mandate and some accountability/compliance mechanisms). We show that both of these factors appear to play an important role in shaping pass-through of subsidy changes. Pass-through is increasing with the size of subsidy rate changes, which suggests that retailers may be partly constrained by the desire to avoid the appearance of non-compliance for subsidy changes that are more salient and easily detectable. The pass-through of subsidy changes also appears to be higher than pass-through of national price changes that reflect wholesale costs, suggesting that program accountability/compliance mechanisms may provide some (albeit incomplete) constraints on pricing. At the same time, price-setting by profit-maximizing firms with market power clearly affects subsidy pass-through in this setting. We show that retailers are more likely to raise before-subsidy prices when subsidies increase, thereby offsetting some of the effect of higher subsidies. Subsidy pass-through across products and stores is correlated with pass-through of (unregulated) national prices, suggesting that fundamental economic incentives play an important role in pass-through differences across products. We show that two variables associated with market power – the markup of a product's before-subsidy price relative to its national average price, and a retailer's quantity share of subsidized goods shipped to a market – are associated with lower pass-through, consistent with standard economic models of oligopolistic price-setting. Thus our exploration of heterogeneous pass-through leads us to conclude that incomplete pass-through of subsidies should be expected in this setting given the extreme degree of market power, and that the mandate that re-

tailers fully pass-through subsidies appears to moderate this effect but is insufficient to ensure full pass-through under current program parameters.

Our paper relates to a small quantitative literature estimating pass-through of food subsidies in remote Canadian communities, including our earlier paper cited above (Galloway and Li, 2023). Glacken and Hill (2009) and Indigenous and Northern Affairs Canada (2009) study the price effects of changes in subsidies for three communities under the Food Mail program that existed prior to Nutrition North. These studies find incomplete pass-through of subsidy changes but have limited data to study mechanisms and heterogeneity. Naylor et al. (2020) consider pass-through of Nutrition North subsidies using a different, cross-sectional product-level data set (the Nunavut Price survey) and a different methodology, and do not reject full pass-through. We discuss how Galloway and Li (2023) and the methodology of Naylor et al. (2020) relate to our findings and data in separate Appendices.

Our paper also relates to a larger literature on pass-through and market structure. Weyl and Fabinger (2012) show that the theoretical relationship is ambiguous in general and depends on the nature of the demand function facing a firm, but that conditional on observing incomplete pass-through we expect less competitive conduct to result in lower pass-through.The empirical literature has generally supported this ((Hong and Li, 2017; Miller et al., 2017; Campos-Vazquez and Medina-Cortina, 2019; Muehlegger and Sweeney, 2022; Genakos and Pagliero, 2022)) but some uncertainty remains given the complexity of measuring market structure and competition, cleanly measuring and identifying exogenous cost shifters, and accounting for pricing interactions for multi-product firms (see also theoretical contributions by Alexandrov and Spulber (2017), Armstrong and Vickers (2017), and Ritz (2022)). Although our setting allows us to address some of these challenges, and provides some of the first evidence on differences in pass-through across products for multi-product retailers, an important difference is that pass-through in our setting may not be entirely driven by standard firm profit-maximization and competition forces due to the full pass-through mandate and regulatory oversight. Thus our setting is not ideal from the perspective of testing and quantifying the effects of market power on price setting. Instead, it highlights the importance of understanding the interaction between market power and government oversight and accountability in a context where a high degree of market power is natural and perhaps unavoidable but policy-makers seek mechanisms to transfer real resources to historically marginalized populations.

We proceed by first describing the context of Nutrition North Canada subsidies and the three reforms we consider, then presenting the methodology and estimates of average pass-through, followed by an analysis of pass-through heterogeneity and some concluding comments.

2. Context and data

Nutrition North subsidy levels are set in $/KG terms and vary across products and communities. Community eligibility depends on remoteness – only communities lacking year-round surface access (road, rail or marine) are eligible for the full subsidy year-round – and initially also depended on usage of the Food Mail program that Nutrition North replaced. More remote communities with higher historical freight costs receive higher subsidy rates. The program also has a nutritional objective and features higher subsidies for foods deemed healthy. At inception there were two subsidy levels per community with a higher level for products like fruits and vegetables, milk, cheese and bread a lower subsidy for products like butter, cooking oil, juice, crackers, ice cream, and bacon; non-perishables goods, which are usually shipped during the seasonal surface transit window (late summer for communities with a sea-lift and winter for communities with ice roads), are mostly not eligible.

The total value of the subsidy was about 15 million Canadian dollars per quarter at inception but by March 2021 it had more than doubled. Figure1 shows that this increase in subsidy expenditure was mostly driven by three specific reforms (denoted by vertical lines) in October 2016, January 2019, and May 2020. The details of these reforms are summarized in Figure 2. The October 2016 reform made 37 additional communities eligible for the full subsidy, upgrading 12 that had previously only had access to a nominal, partial subsidy ($0.05/KG) and adding 25 more. Rates were otherwise unchanged. This resulted in an expansion in the subsidy along the extensive community margin but did little to change the subsidy amount per KG shipped. The January 2019 created a new higher category of subsidy for milk and frozen fruits and vegetables, and raised rates to varying degrees for the other subsidy levels in some communities. This reform increased the subsidy mostly along the intensive margin of previously subsidized communities and products, although a few products became newly eligible. The May 2020 reform, introduced in part in response to the coronavirus pandemic, further increased subsidy rates for previously subsidized products

and made many non-perishable goods like canned fruits and vegetables and meats subsidy eligible for the first time.

Our analysis of subsidy pass-through is based on price data collected from retailers as a condition for receiving the subsidy; however price data are not consistently reported by all retailers and many of the small/independent retailers do not report any data into the system. Retailers that register for the program are obligated to report the price of the 67 items that are part of the Revised Northern Food Basket (RNFB) between the 12th and 18th of each month. The RNFB is a food basket that was devised by a nutrition consultant in collaboration with Indigenous and Northern Affairs Canada to reflect local food preferences as well as a nutritionally adequate diet for a family of four over one week (Affairs and Development, 2007). The individual product prices are recorded and are aggregated (using fixed basket quantity weights) to produce a publicly available RNFB cost that is averaged across reporting stores and reported for each community and quarter on the Nutrition North Canada website. These data are intended to be part of the monitoring/accountability mechanism built into the program. The aggregated, public RNFB data were previously analyzed by Galloway and Li (2023).

Subject to a non-disclosure agreement that prevents us from revealing any information that would identify individual retailers or prices in particular stores, officials at Nutrition North Canada provided us with the product-level data underlying these calculations. Our data span the period from April 2013 to March 2021 and are at the product by month by retail store level. The data include several chains – the North West Company, Arctic Co-op Ltd., Federation Co-operative du Nouveau Quebec, Stanton – as well as a few independent stores, but excludes some stores that receive the subsidy. The data were provided to us in two versions. The first is unprocessed and represents the data directly provided to NNC by retailers. These data include the price and "before subsidy" price for a large number of products that are in, or similar to, the RNFB, as well as some products that are unrelated to the RNFB. Products are identified only by an unstructured text string that is sufficient to identify brand, flavor, and size, but the data are otherwise not classified and the text strings are non-standard over time and across retailers (with over 37,000 in total).

The second data set is "cleaned" and aggregated to include only the price per KG of the 67 RNFB items, along with some product classifications (five product groups, perishable/non-perishable). The exact procedure used to convert the raw data into

this form is unknown to us and may involve some averaging across multiple products (brands, pack sizes) and use of similar products when product prices are missing; however we believe that substantial effort goes into selecting a consistent sample of products. These are the data that are used to construct the public quarterly RNFB costs (likely with some additional data cleaning and imputation for missing products). For the RNFB products we merge the official subsidy rates to each item to calculate the actual price and the "before subsidy" price.

Figure 2 shows that we observe 15,000 distinct changes in subsidies for products in the RNFB price data and over 56,000 using the unprocessed data. Relative to previous estimates of pass-through of Nutrition North subsidies, this provides us with a large amount of statistical power to analyze average pass-through and heterogeneity along multiple dimensions. We supplement the price data with information about quarterly quantities of subsidized goods shipped by retailer and community, which allows us to construct retailer market shares; importantly these data include "registered Southern suppliers" which are Southern retailers or wholesalers that can receive the subsidy for shipping directly to individuals and institutions in NNC eligible communities. We also consider some community characteristics from the NNC website such as the presence and identity of local retailers, median household income and population. Finally, we precisely match 36 RNFB products to monthly national average price provided by Statistics Canada (using the data underlying the Canadian CPI).

3. Average pass-through estimates

The key challenge to analyzing subsidy pass-through is formulating an appropriate counter-factual – what prices would have been observed in the absence of subsidies? Our analysis focuses on the subsidy changes that occurred due to the reforms discussed and we focus on two main approaches.

First, we consider "short-run" pass-through where we assume that the appropriate counter-factual price when a subsidy changes is the price of the same product in the same store in the previous month. This is a simple and intuitive measure that accounts for all of the factors that affect the price level chosen by retailers for different products sold in remote, uncompetitive communities. However, it could be biased by any anticipatory or delayed price changes, and by correlated supply and demand

shocks. For example, if subsidy increases occurred during a month with large increases in wholesale or freight costs, or positive local demand-shocks, pass-through of subsidy increases might be biased downward. In our view this bias is unlikely to be large relative to the size of subsidy changes, as the periods we consider generally feature low and stable inflation – for food prices and overall – and most of the goods we study have high perishability/shipping frequency, with prices observed 12-18 days after subsidies kick in. Our short-run pass-through equation regresses price (P) on subsidy (S) and looks like:

$$P_{ijt} = \alpha_{ij} + \beta S_{ijt} + \epsilon_{ijt} \tag{1}$$

where i indexes products, j indexes stores, and t indexes month, with the α_{ij} term representing item-store fixed effects. We estimate this equation using only the month before and after the subsidy change. A coefficient of $\beta = -1$ implies full pass-through – the price in the month after fell by exactly the amount of the subsidy increase.

Table 1 presents the short-run pass-through estimates. We find moderate pass-through overall – we can reject full pass-through in every specification and can also reject zero pass-through for almost every specification. Panel A presents results for the 67 RNFB products in the cleaned data. Pass-through is higher for the January 2019 reform and not significantly different than zero for the October 2016 reform. Our pooled short-run estimate is 57 cents per dollar, or 48-50 cents per dollar when weighting observations by the community population or the total annual quantity of subsidized products shipped to a specific store. Panel B considers only the 33 highly perishable RNFB products and finds lower pass-through for these products. Panel C uses the unprocessed data which gives us the most products, and finds the lowest pass-through overall, although the October 2016 reform now has pass-through significantly different than zero.

Second, we consider "long-run" pass-through using a two-way fixed effect analysis (similar to a difference-in-difference) where we allow counter-factual prices to change over time for reasons other than subsidy increases. We estimate equations like:

$$P_{ijt} = \alpha_{ij} + \beta S_{ijt} + \gamma_{it} + \eta_{jt} + \epsilon_{ijt} \tag{2}$$

where γ_{it} and η_{jt} are fixed effects that capture common trends at the product level and store level respectively. Intuitively, the choice of which fixed effects terms to

include determines the counter-factual path of prices as well as the nature of the subsidy variation used to identify the pass-through coefficient β. For example, including γ_{it} means that we control for any common factor affecting a product's retail prices over time, such as national wholesale or energy prices, and pass-through is identified based only on differential changes in subsidy rates for the same product *across communities.* Similarly, including η_{jt} means that we control for any common factor affecting the price of all products in a community at a given time, such as community-level freight costs, electricity, income and labor costs, and pass-through is identified based only on differential changes in subsidy rates across products *within communities.* Note that the choice of which products are included in the sample is important in this case not only due to potential heterogeneity in pass-through across products but also because the product sample affects the counter-factual. Because subsidy changes varied across products within communities and across communities within products, we can potentially include both of these fixed effect terms.

Table 2 presents the long-run pass-through estimates, with similar panels for the three sets of goods considered earlier (all RNFB products, highly perishable RNFB products, all products in the unprocessed data). Columns 1 through 4 use different combinations of time fixed effects to consider different counter-factuals and sources of subsidy variation, while columns 5 and 6 apply population and quantity weights for the specification with product-time and community-time fixed effects. Pass-through is higher in some cases but not others. For all RNFB products, we find much higher pass-through than the pooled short-run estimates, ranging from 74 to 79 cents per dollar with little sensitivity to the choice of fixed effects and slightly higher pass-through when applying weights. For perishable RNFB products we find lower pass-through than the pooled short-run estimate, except when using both product-time and community-time fixed effects; this pass-through is also lower than the "long-run" pass-through for all RNFB products in Panel A. Using the unprocessed data with all products, we find higher pass-through than the short-run pooled estimates when including product-time fixed effects but not otherwise. Overall, these long-run results point to somewhat higher pass-through but still significantly different than the -1 coefficient that would imply full subsidy pass-through.

Note that while including more fixed effects accounts for more potential factors that could bias our pass-through estimates, it also uses different variation to identify the pass-through coefficient than our short-term methodology and may not be supe-

rior. If subsidies changes result in spillover price changes to other products and/or stores (e.g. if retailers raise the price of a product in all stores/communities in response to an increase in its subsidy), this method may also lead to a biased estimate of subsidy pass-through with a direction of bias that is unknown.

The main threat to identification using either short-run or long-run methodologies is that subsidy changes were targeted (deliberately or accidentally) at products/communities that would have experienced differential price changes anyway, e.g. if targeted at products/communities with higher than average upward price trends this would bias pass-through downward. The October 2016 and January 2019 reforms do not appear to have been motivated by any particular economic shocks; although the reasons why some communities and products received subsidy increases are unclear to us, the motivation appears to have been largely equity (including communities previously excluded from the program in October 2016, and somewhat equalizing subsidy rates across existing communities in January 2019) and nutrition (higher subsidies for milk and frozen fruits/vegetables in January 2019). The May 2020 reform was explicitly motivated by the coronavirus pandemic, which did lead to a number of economic shocks including supply shocks (e.g. issues with freight and logistics) and demand shocks (COVID cash benefits and changes in consumer behavior, although in the communities we study there is not much "food away from home" and there were few mobility restrictions within communities). To assess whether there were any "pre-trends" in prices leading up to the subsidy reforms, and assess the dynamics of pass-through – including any delayed or anticipatory pass-through – we consider dynamic pass-through regressions like:

$$P_{ijt} = \alpha_{ij} + \sum_{m=n-6}^{n+12} \eta_m d_m + \sum_{m=n-6}^{n+12} \beta_m \Delta S_{im} * d_m + \epsilon_{ijt} \tag{3}$$

where d_m is a dummy equal to 1 if $t = m$ and ΔS_{im} is the change in subsidy for store i at time m. We use 6 months before and 12 months after each subsidy reform, and omit the period immediately before the subsidy reform which serves as the reference period.

Figure 3 plots the coefficients and 95% confidence interval for each of the subsidy reforms, using all RNFB products (top panels) or all unprocessed products (bottom panels). The figures show little evidence of confounding pre-trends – price changes for a product in the 6 months leading up to the reform do not seem to be correlated

with the magnitude of the subsidy changes – and suggest that pass-through is immediate and stable. The only exception is that the 2016 reform seems to have resulted in one month delayed pass-through for RNFB products, but not for all products. Note that these estimates correspond most closely to the short-run estimates earlier, except they are estimated over different horizons and allow for a common (across all products and stores) time-varying cost shifter, so pass-through is high for RNFB products during the January 2019 reform, low for RNFB products for the 2016 reform (and for all unprocessed products during any reform), with May 2020 being in-between.

An important caveat to our findings is that the notion of average pass-through we estimate, under any specification, applies specifically to the sample and subsidy variation we study. First, while we observe some communities going from effectively zero to moderate subsidies (i.e. the communities affected by the October 2016 reform) one should be cautious when extrapolating for other communities where we never observe a near-zero subsidy rate. Second, while our estimates are similar when weighted by community population or the quantity of subsidized foods shipped by the retailer to a specific community, we do not observe the quantity of goods shipped of each product in our data; accurately assessing the pass-through of each dollar increase in subsidy would require observing these quantity weights and applying the relevant pass-through coefficient product-by-product. Third, our estimates only apply to the goods in our sample. While the RNFB products include many important staples, they are only a small subset of the subsidy eligible products sold in these communities, and it is plausible that pass-through is higher for these products given that retailers are required to report them to the government and know that they will be publicly reported in some form. The much lower pass-through rates we estimate using the unprocessed data, which includes many non-RNFB products, suggests that this is a possibility. With these caveats, we believe these are the most comprehensive and rigorous estimates of subsidy pass-through possible given the currently available data.

In Appendix A and B, we compare our pass-through estimates and methodology to the two previous studies of Nutrition North subsidy pass-through by Galloway and Li (2023) and Naylor et al. (2020). Galloway and Li (2023) are more comparable as they use the published RNFB data and a similar source of subsidy variation (the October 2016 and January 2019 reforms). Appendix A shows that when we use our product-level RNFB data and restrict it to a more comparable sample (in terms of time

periods, retailers, and weighting of RNFB products) we get pass-through estimates that are qualitatively similar but somewhat smaller in magnitude (for both average pass-through and the monopoly effect) than what they found in the aggregated RNFB data. Naylor et al. (2020) use a different data source (the Nunavut Price Survey) and a very different methodology based on cross-sectional variation in subsidies across products. We discuss the assumptions of this methodology in Appendix B and show that when applied to our data this methodology typically implies similar or even lower pass-through estimates.

4. Pass-through heterogeneity

Our findings so far show that pass-through of subsidy increases is incomplete and that the magnitude of subsidy pass-through varies across subsidy reform episodes and for more restricted or expansive sets of products. In this section we seek to understand this heterogeneity in more depth, focusing on the cleaned RNFB data. Our goal here is to shed light on whether subsidy pass-through in this context should be understood as a result of price-setting by profit-maximizing forces subject to competition (or lack thereof) – i.e. economic fundamentals – or partly constrained by the full pass-through mandate and regulatory/accountability measures of the Nutrition North Canada program.

We begin by looking at broad patterns, replicating our short-run (pooled) and long-run (product-time and community-time fixed effect) specifications but this time interacting the subsidy variable with dummy variables for regions, retailers, and product groups. We group communities into five broad regions (Northwest Territories and Yukon, Nunavut, Ontario, the Prairies, Quebec and Labrador). We consider retailers in four groups (the three largest and the rest) but cannot report retailer identities. We use five broad product groupings defined by NNC in the RNFB price data (dairy products, fruits and vegetables, grain products, meat and alternatives, oils/fats/sugars). The results of these interacted specifications are reported in Table 3. Positive interactions imply lower pass-through, i.e. an increase in subsidies lowers prices by less. Pass-through appears to be somewhat higher in Nunavut and significantly lower in Ontario and the Prairies (though not in the long-run specifications). One retailer features consistently lower pass-through in both the short-run and the long-run, even when accounting for regional heterogeneity. Pass-through differences

are also large across product groups but the pattern (relative to dairy) is not consistent across short-run and long-run specifications. In the long-run though we observe lower pass-through for the most perishable goods even within product groups.

We can further break down the pass-through heterogeneity in our sample by considering the smallest possible unit – an individual subsidy change for a product in a particular store. We compute this type of short-run pass-through coefficient by taking the change in price divided by the change in subsidy for the month before and after each subsidy change ($\Delta P/\Delta S$). This is naturally a noisy measure compared to our results pooling across thousands of changes because prices change for a variety of reasons unrelated to subsidies and the denominator is often very small (we observe subsidy changes as small as \$0.05 in our data). However the distribution of these product-store pass-through episodes is intriguing. Figure 4 plots the density of these short-run pass-through estimates that fall between -3 and 3 in the left panel (which includes about 85% of the estimates). We see a clear bimodal distribution with pass-through concentrated near -1 for many episodes and near 0 for many episodes, with a moderate density in between and lower density in the tails.

As an alternative to the pass-through of each product-store-subsidy change episode, we can consider a more aggregated unit – the product-store – and pool across multiple subsidy reforms and time periods. This approach also allows us to compare subsidy pass-through to pass-through of national prices for the set of 36 RNFB products for which we can observe a national average Canadian price in the same month. We consider regressions like:

$$P_t^k = \alpha^k + \beta^k S_t^k + \gamma^k NatPrice_t^k + \epsilon_t^k \tag{4}$$

where we estimate a separate regression coefficient for each product-store combination (k) that includes only the subsidy in that store and the national price for that product as controls. We plot the density of these subsidy pass-through coefficients in the right panel of Figure 4 and it displays a similar bimodal distribution as the individual episodes.

Note that the coefficient γ on national price pass-through provides an informative benchmark, although we caution that the national retail price of a product may be a noisy measure of the wholesale cost and other retailing costs in our context. It turns out that the γ coefficients for national price pass-through and the β coefficients for subsidy pass-through estimated at the product-store level are correlated (-0.07,

significant at the 1% level). This correlation persists when conditioning on item-community, product-retailer, and community-retailer fixed effects, implying that pass-through identified using these two distinct cost shifters is correlated across retailers, across communities, and across products. However, the correlation is not that strong, which may reflect both the imperfect ability of a national price measure to capture retailer costs as well as the fact that retailers are mandated to immediately and fully pass-through subsidy changes but are free to pass-through other cost changes at their convenience.

To better assess the level of pass-through from these two different factors affecting retailer costs, Table 4 reports results from estimating the equation above (regressing prices on subsidies and national prices) but this time pooling across all of the 36 RNFB products matched to national price data and all stores, in order to estimate a single coefficient for each variable. Column 1 includes only product-community-retailer fixed effects and implies quite similar and symmetric pass-through of around 0.5 for either type of cost shock. Columns 2 and 3 include time and community-time fixed effects, corresponding to columns 1 and 3 from Table 2 (note that we cannot include product-time fixed effects and still identify the effect of national product prices). Table 4 columns 2 and 3 imply significantly higher pass-through of subsidy changes (0.72-0.76) than national price changes (0.43). This suggests that the regulatory and accountability mechanisms of the Nutrition North Canada program could have some bite, leading to higher pass-through than for other cost shifters, though again we caution that our national price measures may be a noisy measure of changes in a retailer's costs. Classical measurement error in this variable (as a proxy for changes in retailer cost) would bias pass-through towards zero relative to subsidy rates which are measured perfectly.

The next factor we consider is the size of subsidy changes, which could affect pass-through for at least three reasons. First, larger subsidy changes are more salient to consumers, program officials and auditors, which may increase the willingness of retailers to pass them through fully; smaller subsidy changes may be less noticeable. Second, the size of subsidy changes may also affect pass-through due to the curvature of demand, which could lead to a positive or negative correlation between the size of subsidy changes and pass-through. Finally, menu costs (the cost to retailers of changing prices) could also play a role, as classic models of state-dependent pricing imply that firms are less willing to change prices in response to small marginal cost shocks.

In the case of Nutrition North, however, note that the requirement to display both actual prices and the subsidy amount means that both changing and not changing the retail price may require incurring a "menu cost" in terms of point of sale systems and internal accounting. While prices and subsidy amounts are always listed on receipts, shelf-pricing is something of an exception, as some stores display the full subsidy amount applied to each product while others display only the subsidy level (e.g. level 1 or 2) whose dollar value changes when subsidy rates change.

We begin by looking at the role of price changes, given that Figure 4 shows that subsidy changes often result in pass-through close to zero (implying that before-subsidy prices fully rise to offset an increase in subsidy) or close to -1 (implying before-subsidy prices do not change when subsidies increase). Figure 5 plots share of products with a before-subsidy price increase in a given month (pooling across all products and stores) along with the share of products experiencing a subsidy increase. In a typical month, about 20% of products experience a price increase and there are no subsidy changes. During the two reforms that resulted in subsidy increases for a large share of products (January 2019 and May 2020), we see that the share of products that experience an increase in before-subsidy prices shoots up. This suggests that retailers actively manipulate before-subsidy prices to offset at least some part of subsidy increases, but also that many products experienced full or possibly even greater pass-through, particularly in May 2020 when the share of products with subsidy changes exceeds the share of products with price increases.

Table 5 investigates this more formally in a regression context and considers the effect of the size of a subsidy change on whether before or after subsidy prices change. For each product-store-month observation in our data, we regress an indicator for a price change scenario on an indicator for a subsidy change and the size of the subsidy change. The first two columns correspond to Figure 5 as the dependent variable is an indicator for whether the before subsidy price increased (thereby off-setting part of the subsidy increase and resulting in incomplete pass-through). We find that a product's before subsidy price is much more likely to increase when its subsidy rises, but that this effect is smaller for larger subsidy changes. For example, a product is 50% more likely to experience a price increase for a 10 cent increase in subsidy but only 10% more likely to do so for a $1 increase in subsidy. This effect is broadly similar when including product-store fixed effects and time fixed effects in column 2. Columns 3 and 4 show similarly that a product is more likely to experience a price

decrease when subsidies increase, implying some pass-through of the subsidy, and this effect is stronger when the subsidy change is larger. Columns 5 and 6 consider the extreme case of zero price change and thus zero pass-through, when before-subsidy prices rise to exactly offset subsidy increases. Conditional on a subsidy increase, this is less likely to occur when the subsidy increase is larger. Finally, columns 7 and 8 consider the extreme case of full pass-through (implying no change in before-subsidy prices in that month) and shows that this is more likely for large subsidy changes. Altogether, these findings suggest that the size of subsidy changes is an important determinant of pass-through and that this operates in part through the extensive margin decision by firms about whether to increase before-subsidy prices or not.

As mentioned earlier, the size of subsidy changes may affect pass-through through multiple channels, some of which are grounded in economic theory (e.g. menu costs, demand curvature) and some of which may be related to the special circumstances of the Nutrition North subsidies (e.g. government regulation and public relations). Competitive forces, however, have some clear implications for pass-through according to economic theory. We first note that a standard firm pricing equation implies that retailers set price equal to a markup over marginal cost ($P = \mu C$), and that pass-through of a marginal cost shock like a subsidy change can be expressed as follows:

$$\frac{\partial P}{\partial S} = -\mu + \frac{\partial \mu}{\partial S} C \tag{5}$$

This equation highlights an important point about markups, which is that in the absence of changes in the proportional markup over marginal cost (i.e. $\partial \mu = 0$), pass-through (in levels) should be higher for products with higher markups and should generally be below -1 (given that retailers typically charge a markup over marginal cost, with the exception of "loss-leaders"). On the other hand, observing pass-through that is incomplete implies both that (a) retailers have oligopolistic/monopolistic market power (perfect competition and monopolistic competition imply zero and constant markups respectively) and (b) retailers raise their proportional markups over marginal cost in response to subsidy increases (and may adjust markups in response to demand conditions more generally, e.g. they may raise markups when there is a positive demand shock).

Our results so far already clearly indicate that firms in our setting have oligopolis-

tic/monopolistic market power, but we now consider whether the size of markups is informative about this market power. Specifically, we test the conjecture that products with higher markups experience lower pass-through, which will only be the case if markup variation is related to the ability and incentive of retailers to increase markups in response to a subsidy change. We consider regressions of the individual pass-through coefficients calculated earlier for each product-store-subsidy change episode on the size of subsidy changes and a measure of the product's markup. Although we cannot directly observe product markups (due to lack of data on the marginal cost for each product/store), for the 36 RNFB products matched to national price data we can consider two measures that are likely correlated – the ratio and the difference of a product's before subsidy price relative to the national average price. We calculate an average for each product-store in the period before any subsidy reforms, so this measure varies across retailers, communities and products and is not related to the subsidy reforms.

Table 6 presents the results of these regressions including markups in ratio (Panel A) and in differences (Panel B). Column 1 includes no controls, while columns 2 through 5 include different combinations of fixed effects to isolate particular dimensions of pass-through heterogeneity. Note that the adjusted R^2 here are also informative about the importance of different dimensions for pass-through heterogeneity. Column 2 includes retailer-product fixed effects such that only pass-through variation over time and across communities contributes to identification. Column 3 includes community-product fixed effects such that only pass-through variation across retailers and time contributes. Column 4 includes retailer-community fixed effects such that only variation across products and time contributes. Note that the adjusted R^2 reported at the bottom of the table is itself informative about the dimensions of pass-through heterogeneity, highlighting that about 20% of the sample variation in pass-through coefficients can be "explained" by product-retailer specific factors, while product-community and retailer-community specific factors account for much less of the variation.

The coefficient estimates in Table 6 provide further evidence that pass-through is higher for larger subsidy changes, and that this is true across all dimensions of the data. This suggests that if weight our short-run pass-through estimates in Table1 by the size of each subsidy change we might find higher pass-through, which is indeed the case – the pooled short-run estimates in this case are substantially higher

at -0.74 and -0.37 for all RNFB and perishable RNFB products respectively. We also see that markups during the pre-reform period have some predictive power for pass-through of subsidy reforms but that the relationship depends on the dimension of pass-through heterogeneity considered. Across all pass-through episodes, and when comparing across pass-through episodes for the same retailer and community (thus comparing only across products sold in the same store) we find that the coefficient is positive, which implies that products with higher initial markups have lower subsidy pass-through. When comparing the same product, either across communities for the same retailer or across retailers in the same community, largerr markups are associated with higher subsidy pass-through. These findings are consistent with the notion that market power is an important determinant of low average pass-through and pass-through heterogeneity, with the most marked up products generally having lower pass-through, but also highlight the idiosyncracies of product pricing across retailers and communities.

Our analysis above is based on the notion that higher prices and markups can provide a good measure of market power and hence a firm's incentives to pass-through subsidy changes. Economic theory also suggests that market structure could be a good measure of this market power. Weyl and Fabinger (2012) provide a formulation of pass-through in levels that effectively relates the size of the markup adjustment governing pass-through ($\partial\mu$) to a demand parameter (ϵ_{ms}) and a conduct parameter(θ), through the formula:

$$\frac{dP}{dC} = \frac{1}{1 + \frac{\theta}{\epsilon_{ms}}} \tag{6}$$

Importantly, $\theta = 0$ under competitive conduct (resulting in full pass-through) and $\theta = 1$ under monopoly conduct. The conduct parameter for symmetric Cournot oligopoly is $1/N$ (with N the number of firms) and for asymmetric Cournot oligopoly it is the quantity market share of each firm. Market structure may not perfectly predict conduct, because oligopoly firms can collude (in which case their conduct resembles that of a monopolist) and monopolistic firms may choose lower prices to evade regulators or deter entry (in which case their pricing may correspond to a more competitive conduct). Three of the four largest retailers operating in Nutrition North eligible communities are Co-ops, which may have objectives beyond profit-

maximization, and these also operate as monopolies in some communities.[1] Nevertheless, the substantial variation in market structure in our sample may be informative to the extent that it predicts pass-through consistent with its associated conduct parameter. Given our findings of incomplete pass-through (implying that ϵ_{ms} above is greater than zero), more competitive conduct should be associated with greater pass-through.

Galloway and Li (2023) compare pass-through between communities with a local retail monopoly and those with two or more local retailers. We can consider a similar analysis with the product level data here, but also take advantage of direct measure of quantity market share for each retailer. Specifically, we observe the share of subsidized food shipped, by weight, for each firm receiving Nutrition North subsidies, including "Southern registered suppliers." These are retail or wholesale firms that do not operate in a community but ship directly to individuals and institutions and are eligible to receive the subsidy. There are many such suppliers, and collectively they receive approximately 15% of all subsidy dollars, making them a potentially important competitor. We find that in communities in our data with a local retail monopoly, the average quantity market share of the local retailer is 89.5%, compared to 49.7% in non-monopoly communities. This implies that there is substantially more competition from Southern suppliers in communities with a local retail monopoly. We explore the effects of monopoly and retailer-community market share by regressing the individual pass-through coefficients calculated earlier on an indicator for local retail monopoly and the annual quantity market share of a retailer in a community. We include the size of the subsidy changer as a control, similar to Table 6, and also consider controls for community population and median household income (from the 2015 census) and the total quantity of subsidized food shipped to the community.

Table 7 presents the results of this analysis. Panel A shows that, conditional on the controls and product or product-retailer fixed effects, local retail monopoly in a community is not significantly correlated with pass-through. This is somewhat surprising in light of the findings in Galloway and Li (2023), but note that the sample we use is different in many respects. In Appendix A we show that using a similar sam-

[1] For example, it is known by program officials, and observed in our data, that during some periods the Quebec co-op chain deliberately equalize prices across all of the communities served. This is unlikely to be profit-maximizing except under very specific circumstances and potentially contradicts a full pass-through mandate. Instead, it reflects fairness and equity considerations that are deemed acceptable to the government.

ple and methodology, the RNFB product data imply qualitatively similar findings as the RNFB basket findings albeit with somewhat smaller magnitudes for average pass-through and for the difference between monopoly and non-monopoly communities. Panel B shows that when we use the quantity market share measure, we find that the coefficient is positive, supporting the theoretical prediction that firms with a higher quantity market share have less competitive conduct and therefore lower pass-through. The effect is stronger when we include product-community fixed effects, suggesting that this result is mainly driven by differences across retailers in the same community rather than differences across communities (i.e. comparing duopoly versus monopoly communities).

Altogether, our findings on pass-through heterogeneity suggest that both regulatory evasion and economic incentives shape the pass-through of Nutrition North subsidies. Pass-through is higher for larger subsidy changes and is higher for subsidy changes than national price changes. This suggests that price-setting by profit-maximizing firms is at least partly constrained by the program's mandated full pass-through and regulatory measures. At the same time, incomplete pass-through is consistent with standard economic forces, i.e. price setting by profit-maximizing firms that have substantial market power and increase their before-subsidy prices in response to subsidy increases. We see this in the positive correlation between subsidy pass-through and (unregulated) national price pass-through across stores and products, the negative correlation between subsidy pass-through and markups across products, and the negative correlation between pass-through and local market share.

5. Conclusion

Our findings suggest that increases in Nutrition North Canada subsidies are not fully passed-through to retail prices, and that this incomplete pass-through results from the pricing decisions of profit-maximizing firms that have a high degree of market power. However, we also find suggestive evidence that the program's mandate that retailers fully pass-through subsidies partly moderates this effect. In our view, government actions that further strengthen the oversight and accountability of retailers in this context have a good chance of being effective in terms of increasing pass-through of future subsidy increases and perhaps also current subsidies. Two actions that should considered are increasing data access and increasing the transparency

and methodological rigour in terms of how pass-through is measured. In light of our findings, we also think there is value in considering alternative mechanisms to address the core objectives of Nutrition North – increasing the availability and affordability of nutritious foods in Canada's remote northern communities.

Galloway and Li (2023)'s analysis was only possible because Nutrition North Canada improved on Food Mail in one important aspect, by providing at least some public data on prices and subsidy rates for each community. Our analysis here was possible because some program officials recently deemed it useful for policy development to provide some more disaggregated price and quantity data to academic researchers. Analyses like ours could be improved further if scanner data – containing quantities and prices at the barcode level – were available for all subsidized goods. While this would put an undue burden on smaller retailers (which already face challenges in meeting current reporting requirements), the costs do not appear substantial for larger retailers that already have systems to upload product price data to the government every month.

In terms of methodology, the lack of transparency around how auditors assess subsidy pass-through is an important oversight of the program. Auditors may have access to better data than academic researchers, including data on retailer costs that would be difficult to make public, but the publicly available findings of the auditors provide no information on the methodology and data used to reach conclusions about the extent of subsidy pass-through. Many of these audit reports were conducted prior to 2019, meaning there was no possibility of employing quasi-experimental methodologies like the one we use here that exploit changes in subsidies for most communities; instead, their methodology likely involved cross-sectional comparisons of prices, costs, subsidies, and gross margins across different markets, which may or may not be more reliable depending on the data available and assumptions made. Given that third-party auditors, rather than academic researchers, should be the first line of defense when it comes to subsidy pass-through, strengthening the role and reliability of these audit reports is important. Clearly specifying a penalty for non-compliance that does not unduly penalize local communities through withdrawal of subsidies could give these audit reports more bite.

Future work should provide a more comprehensive assessment of how well the Nutrition North Canada program achieves its main objectives and whether alternative uses of public funds could achieve better results. Although there is evidence that

the current subsidies increase shipments of subsidy eligible food to communities, the extent to which this has actually improved nutrition, and for who, is unclear. The subsidy benefits all households in a community by reducing prices, but households that spend more on subsidized goods benefit more; many of the poorest and most vulnerable households have little money to spend at stores, and may also consume less of the subsidized goods due to preferences or other factors. The elasticity of consumption for different types of food with respect to prices is not understood in this context, and a full accounting of the program incidence and distributional benefits requires leveraging data on quantities and household heterogeneity within communities. Alternative uses of public funds, like enhanced child benefits, may achieve better targeting to vulnerable populations, but may also be subject to partial capture by retailers (Daley et al., 2024). In-kind food transfers, like recent expansions of school feeding programs or programs that exist in other countries (Li, 2023), may help achieve targeting and nutritional objectives better but the method of purchase and distribution could lead to similar capture (e.g. schools purchase food from local retailers who raise their prices in response to this demand shock). Infrastructure can help lower food costs in some communities but comes at a very high cost in these remote communities and there is no guarantee that reductions in retailer marginal costs will be passed-through to consumers given our findings here (Kenny and Li, 2024). Initiatives to promote local food harvesting, such as the Harvester Support Grant that was introduced as part of the January 2019 Nutrition North reform, have strong support from some community members but the interactions between policy and local food harvesting have only started to receive quantitative evaluations (Georgiev and Li, 2024).

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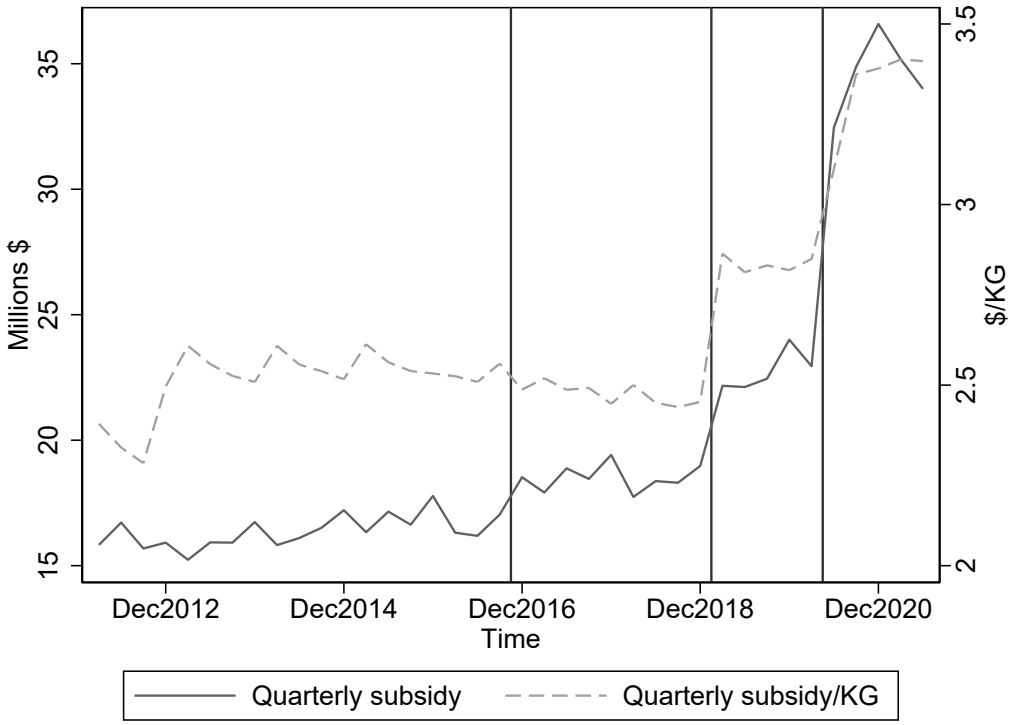

Figure 1: Nutrition North quarterly subsidy expenditure (in millions, and per$/ KG shipped). The vertical lines denote the three reforms in October 2016, January 2019, and May 2020.

	Oct. 2016 reform	Jan. 2019 reform	May. 2020 reform
Communities affected	37	All (117)	All (122)
One quarter change in subsidy ($millions)	1.50	3.20	9.50
Subsidy rates ($/KG)			
One quarter change in mean subsidy	-0.08	0.41	0.25
High subsidy level range		2.25-20.2	2.7-20.7
High subsidy mean		3.86	4.39
High subsidy range of increases		0.55-4.2	0-0.65
Medium subsidy level range	0.05-16	1.8-16.15	2.5-17.15
Medium subsidy mean	2.79	3.08	4.06
Medium subsidy range of increases	0-2.85	0.1-1.3	1-1.2
Low subsidy level range	0.05-14.2	1-14.2	1-14.2
Low subsidy mean	1.16	1.73	1.71
Low subsidy range of increases	0-1.05	0-0.95	0-0.1
Price data			
Number of subsidy eligible RNFB products (out of 67)	42	46	65
Number of store-product subsidy increases (RNFB)	1282	6322	7482
Mean store-product subsidy increase (RNFB) $/KG	1.51	0.62	1.29
Number of store-product subsidy increases (All)	4933	29028	22855
Mean store-product subsidy increase (All) $	1.47	0.36	0.97

Figure 2: Summary of Nutrition North Canada subsidy reforms and subsidy changes in the price data

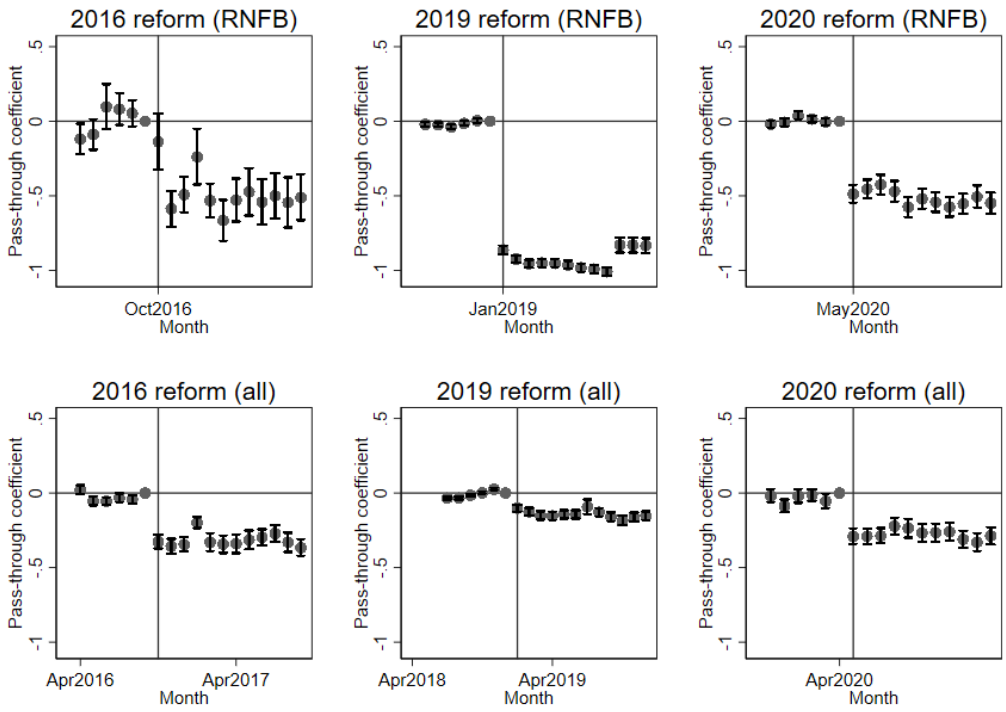

Figure 3: Dynamic pass-through estimates for each reform with 95% CI. Omitted category is the period before the reform. See text for description of regression; all estimates include time fixed-effects and product-community-retailer fixed effects.

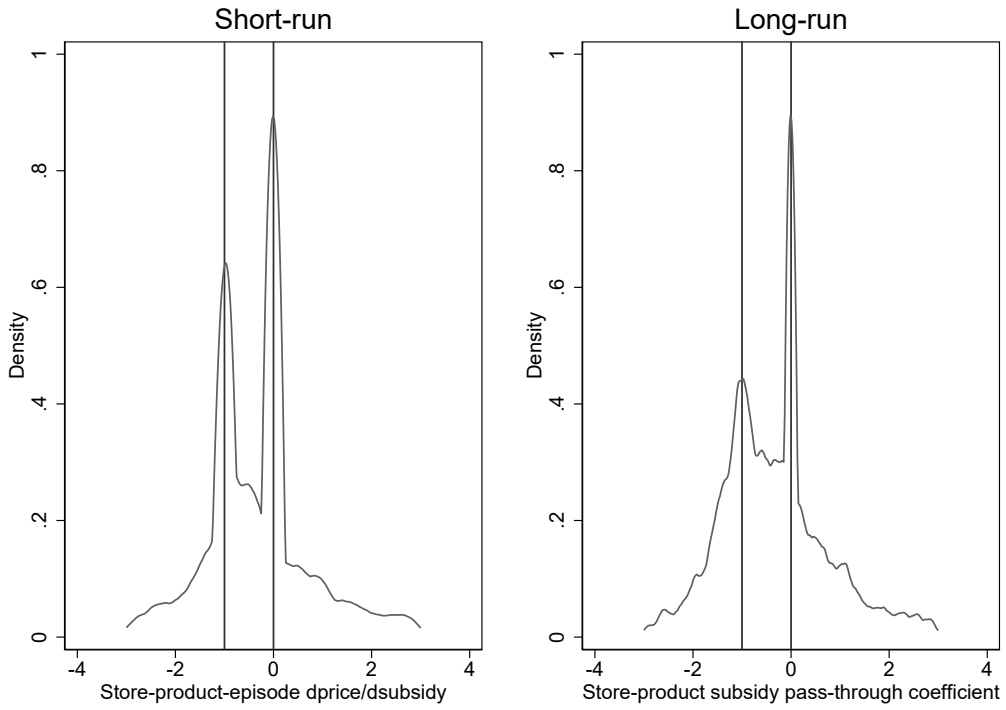

Figure 4: Distribution of product-store level pass-through estimates. Left panel is for one-period change (dP/dS) and right panel is from equation 4 (a time-series regression of the price in a product store on the national price and subsidy).

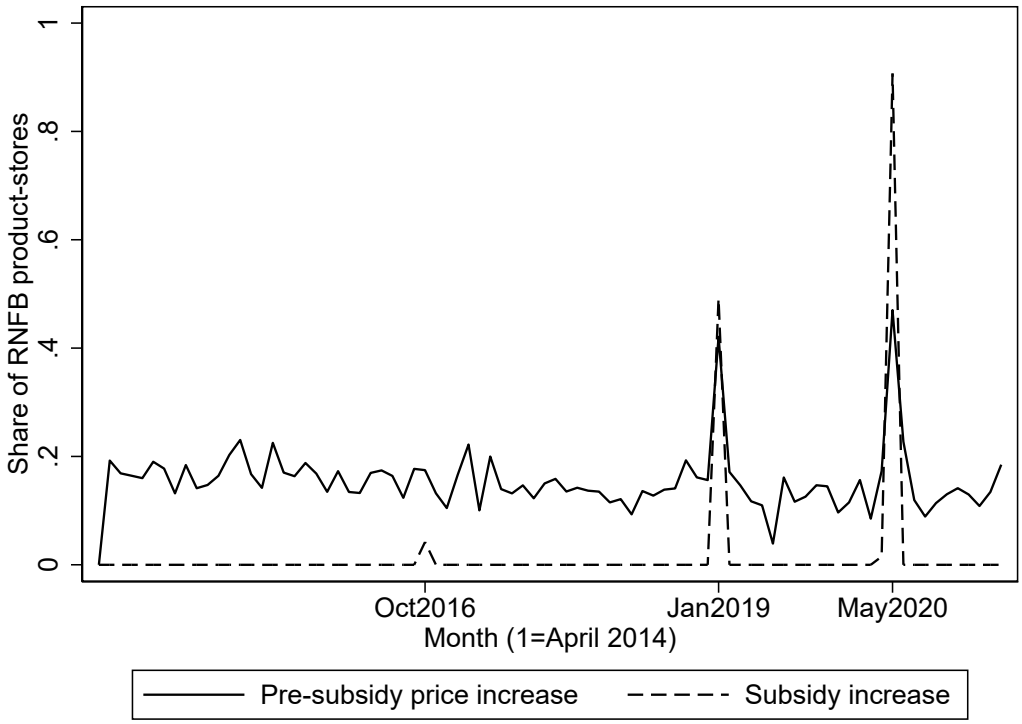

Figure 5: Share of product-store observations with a before-subsidy price increase or subsidy increase relative to the preceeding month (RNFB products only).

Table 1: Short-run pass-through methodology. Dependent variable is price.

	(1)	(2)	(3)	(4)	(5)	(6)
Reform	Oct.2016	Jan.2019	May.2020	Pooled	Pooled (pop.weight)	Pooled (quant.weight)
				Panel A: All RNFB products (67)		
Subsidy	-0.214	-0.876***	-0.501***	-0.568***	-0.502***	-0.480***
	(0.159)	(0.019)	(0.048)	(0.037)	(0.044)	(0.049)
Observations	14,979	14,029	13,843	42,851	42,730	42,359
				Panel B: Perishable RNFB products (33)		
Subsidy	-0.209	-0.625***	-0.492***	-0.481***	-0.451***	-0.440***
	(0.197)	(0.039)	(0.096)	(0.069)	(0.092)	(0.110)
Observations	7,353	6,923	6,711	20,987	20,926	20,741
				Panel C: All products (unprocessed data)		
Subsidy	-0.282***	-0.138***	-0.321***	-0.198***	-0.200***	-0.208***
	(0.033)	(0.021)	(0.082)	(0.021)	(0.025)	(0.025)
Observations	94,130	96,740	83,009	273,879	271,919	266,276

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All regressions include product-community-retailer fixed effects. Panels A and B use Price and Subsidy per kilogram, Panel C uses Price and Subsidy for the product.

Table 2: Long-run pass-through methodology. Dependent variable is price.

	(1)	(2)	(3)	(4)	(5)	(6)
Fixed effects	Time	Product-time	Community-time	Product-time and community-time		
Weights	None	None	None	None	Population	Quant.
			Panel A: All RNFB products			
Subsidy	-0.787***	-0.742***	-0.768***	-0.790***	-0.815***	-0.852***
	(0.026)	(0.035)	(0.037)	(0.028)	(0.045)	(0.046)
Observations	578,442	572,416	572,415	578,441	571,118	567,774
			Panel B: Perishable RNFB products			
Subsidy	-0.167***	-0.423***	-0.006	-0.694***	-0.747***	-0.727***
	(0.045)	(0.033)	(0.068)	(0.077)	(0.084)	(0.097)
Observations	284,626	281,689	284,622	281,685	281,050	279,378
			Panel C: All products			
Subsidy	-0.102***	-0.244***	-0.089***	-0.230***	-0.261***	-0.291***
	(0.011)	(0.019)	(0.002)	(0.020)	(0.028)	(0.028)
Observations	3,929,114	3,902,370	3,929,108	3,902,367	3,870,632	3,791,105

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All regressions include product-community-retailer fixed effects. Panels A and B use Price and Subsidy per kilogram, Panel C uses Price and Subsidy for the product.

Table 3: Heterogeneous pass-through for short-run and long-run specifications (All RNFB products). Dependent variable is price.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specification	Short-run				Long-run			
Subsidy	-0.579***	-0.861***	-0.926***	-1.088***	-0.706***	-0.887***	-0.866***	-0.867***
	(0.096)	(0.057)	(0.134)	(0.179)	(0.051)	(0.064)	(0.067)	(0.093)
Nunavut	-0.081			-0.273**	-0.088*			-0.056
	(0.110)			(0.118)	(0.052)			(0.055)
Ontario	0.271**			-0.081	-0.074			-0.100
	(0.135)			(0.158)	(0.066)			(0.069)
Prairies	0.339**			-0.011	0.080			0.068
	(0.142)			(0.164)	(0.072)			(0.075)
Quebec/Labrador	0.017			0.137	-0.023			0.016
	(0.119)			(0.186)	(0.064)			(0.077)
Retailer B		-0.079		-0.296*		-0.099		-0.211*
		(0.071)		(0.178)		(0.089)		(0.112)
Retailer C		0.577***		0.621***		0.187**		0.072
		(0.078)		(0.104)		(0.084)		(0.098)
Retailer D		-0.282		-0.264		0.191**		-0.002
		(0.215)		(0.235)		(0.086)		(0.101)
Fruit and vegetables			0.415***	0.494***			-0.015	0.001
			(0.137)	(0.137)			(0.064)	(0.064)
Grain products			0.172	0.025			0.235***	0.234***
			(0.138)	(0.137)			(0.072)	(0.075)
Meat and alternatives			0.390**	0.502***			-0.048	-0.030
			(0.154)	(0.152)			(0.079)	(0.081)
Oils, fats, sugar			0.132	0.014			-0.182	-0.177
			(0.131)	(0.131)			(0.112)	(0.112)
Perishable			0.136	-0.085			0.340***	0.304***
			(0.087)	(0.087)			(0.060)	(0.073)
Observations	42,851	42,851	42,851	42,851	572,415	572,415	572,415	572,415
Adj R-squared	0.958	0.959	0.958	0.959	0.968	0.968	0.968	0.968

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All regressions include product-community-retailer fixed effects. Columns 5 through 8 include community-time and product-time fixed effects. The omitted interaction categories are Yukon/Northwest Territories for region, retailer A, and dairy products.

Table 4: Comparing subsidy and national price pass-through for 36 matched RNFB products

	(1)	(2)	(3)
Fixed Effects	None	Time	Community-time
Subsidy	-0.486***	-0.718***	-0.757***
	(0.019)	(0.024)	(0.024)
National Price	0.511***	0.428***	0.429***
	(0.035)	(0.035)	(0.035)
Observations	280,179	280,179	280,177
Adj R-squared	0.910	0.912	0.913

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All regressions include product-community-retailer fixed effects. National prices from Statscan table 18-10-0002-01.

Table 5: Extensive margin price changes and subsidy changes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	Before-sub. price increase		Price decrease		Zero price change		Zero before-sub. price change	
Any subsidy change	0.514***	0.411***	0.295***	0.234***	-0.490***	-0.237***	0.011***	-0.005
	(0.006)	(0.011)	(0.007)	(0.010)	(0.005)	(0.010)	(0.003)	(0.003)
Δ Subsidy	-0.083***	-0.051***	0.053***	0.073***	-0.034***	-0.037***	0.038***	0.035***
	(0.004)	(0.004)	(0.005)	(0.006)	(0.003)	(0.004)	(0.003)	(0.003)
Product-store fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Time fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Observations	611,952	611,952	611,952	611,952	611,952	611,952	611,952	611,952
Adj R-squared	0.0277	0.146	0.0217	0.144	0.0231	0.338	0.0858	0.0930

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

Table 6: Pass-through heterogeneity for markups and size of subsidy changes. Dependent variable is $\partial P/\partial S$ for each store-product subsidy change.

	(1)	(2)	(3)	(4)
Fixed Effects	None	Prod-ret	Prod-comm.	Ret-comm.
Panel A: Markup ratio (price/national price) for 36 products				
Δ Subsidy	-0.184***	-0.167*	-0.278**	-0.220***
	(0.063)	(0.099)	(0.115)	(0.063)
Markup ratio	0.031***	-0.052*	-0.362***	0.034***
	(0.006)	(0.027)	(0.082)	(0.006)
Observations	3,718	3,707	3,400	3,718
Adj R-squared	0.00414	0.148	-0.0977	0.00449
Panel B: Markup difference (price - national price) for 36 products				
Δ Subsidy	-0.168**	-0.171*	-0.279**	-0.203***
	(0.068)	(0.098)	(0.117)	(0.065)
Markup difference	0.024*	-0.057	-0.206*	0.027**
	(0.013)	(0.038)	(0.115)	(0.013)
Observations	3,718	3,707	3,400	3,718
Adj R-squared	0.00236	0.149	-0.0999	0.00254

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. Fixed effects for product (prod), retailer (ret) and community (comm) listed in first row. National prices from Statscan table 18-10-0002-01.

Table 7: Pass-through heterogeneity for prices, markups and size of subsidy changes. Dependent variable is $\partial P/\partial S$ for each store-product subsidy change.

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Monopoly			
Monopoly	-0.005	-0.007	-0.063	0.006	0.004	-0.047
	(0.066)	(0.059)	(0.052)	(0.077)	(0.066)	(0.061)
Log(pop.)				0.017	0.149	0.318***
				(0.137)	(0.123)	(0.120)
Log(income)				-0.242**	-0.198**	0.092
				(0.099)	(0.086)	(0.083)
Log(annual shipments)				0.099	-0.039	-0.296***
				(0.129)	(0.116)	(0.111)
Δ Subsidy	-0.164***	-0.177***	-0.112***	-0.186***	-0.215***	-0.158***
	(0.025)	(0.029)	(0.032)	(0.032)	(0.037)	(0.041)
Fixed Effects	No	Product	Prod.-ret.	No	Product	Prod.-ret.
Observations	10,128	10,126	10,089	9,285	9,285	9,249
Adj R-squared	0.00184	0.0827	0.175	0.00267	0.0865	0.169
			Panel B: Retailer market share			
Market share	0.435***	0.402***	0.789***	0.421**	0.378**	0.858***
	(0.135)	(0.127)	(0.261)	(0.168)	(0.159)	(0.276)
Log(pop.)				0.035	0.169	
				(0.136)	(0.121)	
Log(income				-0.121	-0.090	
				(0.103)	(0.090)	
Log(annual shipments)				0.102	-0.039	0.043
				(0.129)	(0.115)	(0.287)
Δ Subsidy	-0.159***	-0.180***	-0.274***	-0.178***	-0.210***	-0.294***
	(0.026)	(0.030)	(0.085)	(0.032)	(0.037)	(0.082)
Fixed Effects	No	Product	Prod.-comm.	No	Product	Prod.-comm.
Observations	10,064	10,064	8,504	9,285	9,285	7,954
Adj R-squared	0.00299	0.0843	-0.112	0.00346	0.0871	-0.116

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

A Appendix A: Analysis using the Galloway and Li (2023) sample

Galloway and Li (2023) estimate a mean pass-through coefficient of 0.67 using the public RNFB basket cost data and subsidy changes from the October 2016 and January 2019 reform. They also estimate a heterogeneity specification interacting subsidies with an indicator for retail monopoly, failing to reject complete pass-through for non-monopoly communities and finding significantly lower (0.46) pass-through for monopoly communities.

Our main estimates in the paper use product-level data, but using a comparable methodology (product-community and product-time fixed effects) we find somewhat higher pass-through for the RNFB sample and do not find significant effects of the local retail monopoly interaction. However our sample is quite different for several reasons. Galloway and Li (2023) exclude the May 2020 reform because of the limited variation it generated across communities and their identification-strategy based on across-community variation in the change in RNFB subsidy content. The public RNFB basket cost data also exclude data from the second largest retailer in NNC communities, Arctic Co-op Ltd. The public RNFB basket data is also only available quarterly in December, March, June and September. Table 8 presents results that restrict to the same time-periods and set of retailers used in Galloway and Li (2023), with and without applying the RNFB weights for each product, to attempt to replicate their findings using the product-level data.

The results in Table 8 point to lower pass-through overall although within the 95% confidence interval of the average pass-through estimates reported in Galloway and Li (2023). We can also reject full pass-through for non-monopoly communities using the product-level data. With this sample, there is still a significant effect of local retail monopoly on pass-through, but it is much smaller – compared to non-monopoly communities, monopoly communities have pass-through that is lower by 0.09-0.14 percentage points.

B Appendix B: Naylor et al. (2020) methodology

The Naylor et al. (2020) methodology (hereafter NDK) regresses a community's average retail price of a product (P_{ic} measured in \$/KG) on its community-specific sub-

Table 8: Replicating the Galloway and Li (2023) sample and main results

	(1)	(2)	(3)	(4)
Weight	None	RNFB quant.	None	RNFB quant.
Subsidy	-0.524***	-0.546***	-0.612***	-0.612***
	(0.033)	(0.039)	(0.040)	(0.049)
Subsidy*Monopoly			0.137***	0.085**
			(0.033)	(0.043)
Observations	129,809	129,809	129,809	129,809

Standard errors clustered by product-community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All regressions include product-community fixed effects and product-time fixed effects.

sidy level in \$/KG (S_{ic}), a community fixed effect (α_i) and a measure of the product's retail price in another (non-subsidy eligible) community (P_i^{NS}). They use cross-sectional data on product prices and subsidy rates across multiple communities to estimate a regression equation of the form:

$$P_{ic} = \alpha_c + \beta S_{ic} + \eta P_i^{NS} + \epsilon_{ic} \tag{7}$$

NDK interpret the coefficient β as a causal measure of subsidy pass-through by NDK, with -1 reprsenting full pass-through of the subsidy. Note that while NDK use all 25 Nunavut communities for their main analysis, this methodology does not require more than one community and NDK present separate pass-through estimates for each community. It only requires multiple products with different subsidy levels. When pooling across communities, they recognize the importance of include community fixed effects, given that subsidy rates are higher for communities with higher historical freight costs. Using variation in subsidy levels across communities would likely bias the pass-through estimate towards zero, which is what they find when comparing columns 1 and 2 of their Table 4.

The reason for including a measure of prices in a non-subsidy eligible market (Ottawa in their application) is unclear. While it is possible that the subsidy rate variation across products may be correlated with relative prices in Ottawa, this need not be the case, and it is not clear that Ottawa prices plus an additive community \$/KG shift (the community fixed effect) provide a valid counter-factual against which to assess subsidy pass-through. The Nutrition North program is premised on the assumption

that people in eligible communities consume too little nutritious perishable food, due to some combination of relatively expensive costs (e.g. this food must be shipped by air rather than seasonal surface transit) and low demand (e.g. due to poverty, preferences, and unfamiliarity with some of the subsidized foods). This suggests that relative costs and markups for products are likely to be quite different in Northern communities than in Ottawa/rest of Canada, and that Ottawa/rest of Canada may provide a poor counter-factual (beyond data limitations concerning comparability of retailers and brands). Even subsidy differences between Northern communities may be correlated with these factors – the relative cost of perishable and non-perishable freight in different NNC communities is likely to be correlated with relative subsidies by virtue of how subsidies rates were initially determined.

Despite these concerns with the identification assumptions in NDK, we believe it is potentially informative to apply their methodology to our data. Although our data have fewer products (67 RNFB products versus 232 products and a much higher proportion of unsubsidized products) we have many more communities and time periods. We stick as closely to their specification as possible, so we use a single cross-section for estimation, use community average retail prices for each product, include community fixed effects, and weight by population.

Table 9 presents the results. Panel A includes only Nunavut communities and we focus first on the July 2017 cross-section (NDK use data from 2017 but the precise date of collection in Ottawa and Nunavut is not specified). Columns 1 to 3 restrict to the products for which we have an unsubsidized comparison price – for our analysis we use the same national average price data collected by Statistics Canada described in the paper, which can be matched to 36 RNFB products. Column 1 includes only the subsidy variable, column 2 includes the national price control, and column 3 also adds a dummy variable for highly perishable products. The implied pass-through coefficiet is significantly different than -1 in all cases and similar in magnitude to our findings on subsidy reform, but the different magnitudes highlight the sensitivity of estimates to controls for product price and characteristics. Columns 4 through 6 consider the full sample of RNFB products, which means we cannot include a national price control, but we can potentially include a product fixed effect, which would capture any common factor affecting the relative price of products ranging from relative transport costs to relative markups and wholesale costs. Column 4 includes no controls, column 5 adds the perishability control and column 6 adds the product fixed

effects. We see that including product fixed effects dramatically lowers the estimated pass-through, which is no longer significant different than zero. Columns 7 and 8 consider the most "saturated" specifications in columns 3 (for products matched to national price data) and column 6 (product fixed effects) but uses a different time period, finding dramtically different results. In column 7 we cannot reject full pass-through and in column 8 pass-through appears negative but not significantly different than zero.

Table 9 Panel B uses the full sample of communities but similar specifications. Once again we see that pass-through estimated using the NDK methodology is very sensitive to the set of products, controls and communities chosen, and substantially lower when including community fixed effects. Thus while the NDK method applied to our data generally supports our findings of incomplete pass-through of subsidies, our view is that this methodology is unlikely to be as reliable as the one we use in the paper. The source of subsidy variation used in the NDK methodology – variation in subsidy levels across products in a cross-section, rather than variation in subsidy levels over time for a particular product/store – is less likely to be exogenous, which makes the estimates particularly sensitive to the choice of controls such as non-subsidy prices, product characteristics, or product fixed effects.

Table 9: Applying Naylor et al. (2020) methodology to NNC RNFB product data. Dependent variable is community average price.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Products	Matched	Matched	Matched	All RNFB	All RNFB	All RNFB	Matched	All RNFB
Period				July 2017			March 2021	
				Panel A: Nunavut communities only (25)				
Subsidy	-0.556***	-0.746***	-0.462***	-0.485***	-0.506***	-0.179*	-0.904***	0.059
	(0.081)	(0.110)	(0.091)	(0.063)	(0.058)	(0.090)	(0.115)	(0.133)
National price		0.197***	0.226***				0.249***	
		(0.026)	(0.024)				(0.022)	
Highly perishable			-1.656***		0.120		-1.417***	
			(0.149)		(0.251)		(0.172)	
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No No	Yes	No	Yes	
Observations	921	921	921	1,544	1,544	1,544	901	1,525
Adj R-squared	0.0223	0.0515	0.0660	0.00909	0.00848	0.913	0.0590	0.914
				Panel B: All sample communities (88)				
Subsidy	-0.477***	-0.757***	-0.591***	-0.293***	-0.502***	-0.439***	-0.780***	0.133
	(0.053)	(0.076)	(0.073)	(0.052)	(0.043)	(0.077)	(0.075)	(0.144)
National price		0.225***	0.239***				0.233***	
		(0.013)	(0.012)				(0.010)	
Highly perishable			-0.788***		0.996***		-1.017***	
			(0.129)		(0.189)		(0.105)	
Community FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product FE	No	No	No	No	Yes	No	Yes	
Observations	3,284	3,284	3,284	5,475	5,475	5,475	3,254	5,501
Adj R-squared	0.00807	0.0490	0.0525	0.00186	0.00446	0.901	0.0386	0.892

Standard errors clustered by community in parentheses. *** p<0.01, ** p<0.05, * p<0.10. All regressions use population weights as in Naylor et al. (2020). Matched products are the 36 RNFB products that can be exactly matched to national averge prices from Statscan table 18-10-0002-01.