

## Variable Dictionaries

- Households: Number of households in a given quintile, province and time cell.
- gas\_exp: Gasoline expenditure (“Gas and other fuels (all vehicles and tools)” from 11100223)
- ng\_exp: Natural gas expenditure (“Natural gas for principal accommodation” from 11100223)
- oil\_exp: Other fuel expenditure (“Other fuel for principal accommodation” from 11100223)
- total\_exp: Total expenditure (“Total expenditure” from 11100223)
- gasoline\_price: Yearly average price of gasoline (“Regular unleaded gasoline at self service filling stations” from 18100001, Monthly values are averaged across cities within each province)
- heating\_oil\_price: Yearly average price of household heating oil (“Household heating fuel” from 18100001, Monthly values are averaged across cities within each province)
- Gasoline: Tax rate of gasoline (CAD/liter, from [S.C. 2018, c. 12, s. 186](#))
- Light fuel oil: Tax rate of light fuel oil (CAD/liter, from [S.C. 2018, c. 12, s. 186](#))
- Marketable natural gas: Tax rate of marketable natural gas (CAD/m<sup>3</sup>, from [S.C. 2018, c. 12, s. 186](#))
- ng\_rate\_per\_GJ: Tax rate for natural gas in CAD/GJ  

$$(ng\_rate\_per\_GJ) = (\text{Marketable natural gas}) \times 26.853$$
- direct\_tax: Direct gross carbon tax paid on all consumption of energy (not including general equilibrium effect of carbon tax on the price of all other goods).

$$\text{gasoline_litres}_{rqt} = \frac{\text{gas}_\text{exp}_{rqt}}{\text{gasoline}_\text{price}_{pt}}$$

$$(\text{Oil Litres})_{rqt} = \frac{(\text{oil}_\text{exp})_{pqt}}{(\text{heating}_\text{oil}_\text{price})_{rt}}$$

$$\text{ng}_\text{GJ}_{rqt} = \text{ng}_\text{exp}_{rqt} \times \text{GJ\_PER\_DOLLAR}_r$$

$$\text{tax}_\text{gasoline}_{rqt} = \text{gasoline}_\text{litres}_{rqt} \times \text{GasolineRate}_{rt}$$

$$\text{tax}_\text{oil}_{rqt} = \text{oil}_\text{litres}_{rqt} \times \text{LightFuelOilRate}_{rt}$$

$$\text{tax}_\text{ng}_{rqt} = \text{ng}_\text{GJ}_{rqt} \times \text{ng}_\text{rate\_per\_GJ}_{rt}$$

$$\text{direct}_\text{tax}_{rqt} = \text{tax}_\text{gasoline}_{rqt} + \text{tax}_\text{oil}_{rqt} + \text{tax}_\text{ng}_{rqt}$$

- gross\_cost: Direct cost + Indirect cost (calibrated by Canada Dept of Finance estimates)
- CCR\_single\_base: Annual CCR/CAI amount for single adult non-rural household.
- CCR\_couple\_base: Annual CCR/CAI amount for couple non-rural household.
- CCR\_family4\_base: Annual CCR/CAI amount for a family of four in a non-rural household.
- CCR\_[single/couple/family4]\_rural: Annual CCR/CAI amount for single/couple/family of four household living in rural area in a given base year (which subject to 10% increment compared to non-rural households between 2019-2024; the compensation raised to 20% since Apr 2024([URL](#)))
- net\_[single/couple/family4]\_[base/rural]: Net tax expenditure = gross\_cost – CCR\_[single/couple/family4]\_[base/rural]
- etr\_direct\_tax: Effective direct tax rate = direct\_tax/total\_exp
- etr\_gross\_cost: Effective gross tax rate = gross\_cost/total\_exp

### **Canada Carbon Rebate (CCR)/ Climate Action Incentive (CAI) Payment Schedule)**

Note: CAI (2018-20), CAIP (2021-23) and CCR (2024-) are the same thing...

- [2019](#): (All states; Base Year) April 2019 to April 2020
- [2020](#): Base Year
  - o For Ontario, Manitoba and Saskatchewan: Jan-Mar 2020 (with fuel price \$20) + Apr 2020 to Apr 2021 (with fuel price \$30)
  - o For Alberta: April 2020 to March 2021
- [2021](#): Base Year
- [2022](#): Base Year
- [2023](#): Base Year

### **Calculation of GJ\_PER\_DOLLAR constant**

$$\phi_r = \frac{(\bar{GJ})_r}{NGExp_r}$$

- $\bar{GJ}_r$  = Unconditional provincial annual natural-gas energy use per household ([Data](#))
 
$$(\bar{GJ})_r \approx s_r \cdot \bar{GJ}_r^{\text{NGHome}}$$
  - Alberta:  $(\bar{GJ})_{AB} = 0.805 \cdot 109.8 = 88.389 \text{ GJ} \cdot \text{Household}^{-1}$

- Ontario:  $\overline{(GJ)}_{ON} = 0.673 \cdot 86.7 = 58.35 \text{ GJ} \cdot \text{Household}^{-1}$
- Manitoba:  $\overline{(GJ)}_{MB} = 0.588 \cdot 106 = 62.328 \text{ GJ} \cdot \text{Household}^{-1}$
- Saskatchewan:  $\overline{(GJ)}_{SK} = 0.752 \cdot 96.8 = 72.79 \text{ GJ} \cdot \text{Household}^{-1}$
- $NGExp_r$  = Average annual household natural-gas expenditure in region  $r$  (averaged across all households)
- Estimation of GJ\_PER\_DOLLAR constant
  - Alberta:  $\phi_{AB} = \frac{88.389}{1029.6} = 0.0858479021 \text{ GJ} \cdot \text{CAD}^{-1}$
  - Ontario:  $\phi_{ON} = \frac{58.35}{810.2} = 0.07201925451 \text{ GJ} \cdot \text{CAD}^{-1}$
  - Manitoba  $\phi_{MB} = \frac{62.328}{449.6} = 0.1386298932 \text{ GJ} \cdot \text{CAD}^{-1}$
  - Saskatchewan:  $\phi_{SK} = \frac{72.79}{828.8} = 0.0878257722 \text{ GJ} \cdot \text{CAD}^{-1}$

### Indirect Effects: Calibrating Kappa

Since we don't have the gross cost data for all years (in fact we only have [2021](#), [2022](#) and [2024](#)), we must use somehow extrapolate the value to guess how much indirect tax were in 2019, 2020 and 2023.

- Household-weighted provincial average direct fuel-charge burden

$$\bar{T}_{r,t}^{\text{direct}} = \frac{\sum_q w_{rqt} T_{rqt}^{\text{direct}}}{\sum_q w_{rqt}}$$

Where  $w_{pqt}$  = Number of households in quintile  $q$  in province  $r$  at year  $t$ .

In an anchor year (2021, 2022, 2024), the model takes an external estimate of the **average cost impact per household** (direct + indirect) denoted  $A_{rt}$ , and backs out  $\kappa_{rt}$  by rearranging the gross-cost identity:

$$\kappa_{rt} = \frac{A_{rt}}{\bar{T}_{rt}^{\text{direct}}} - 1$$

Remaining  $\kappa$  are fitted using OLS.