CREAP Data V2.0
Documentation and Methods[1]

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Chapter 1

Overview

The CREAP 1998 Version 2 data is microconsistent input-output data for Canada's provinces based on the S-level Input-Output data made available by Statistics Canada's Input-Output Division. The Version 2 data has significant detail on direct and indirect taxes.

Two aggregations of the data are available:

- the S-level balanced data
- the C-level aggregation of the data which has further detail in the energy goods

The data is available to Canadian academics and graduate students (in other words those who would qualify for free access to the Statistics Canada data under the Data Liberation Initiative).

Chapter 2

Input-Output Data

The input-output data is based on the S-level provincial tables published by Statistics Canada. Each province is identified separately, but the territories have been added to British Columbia. All values are in millions of 1998 $C.

The goods and sectors are listed in Tables A.1 and A.2 in the appendix. The sectors in the data correspond exactly to the S-level sectors, but energy commodities have been disaggregated from the S-level data.

CRU Crude Oil; S-level `M_F` Mineral Fuels is split into `CRU` `COL` and `GAS`

COL Coal products (see `CRU`)

GAS Natural Gas; (see `CRU`) note that distribution of natural gas is in `UTL`

PET Refined petroleum fuels is not all of the S-level `P_C` because of presence of coke, tar, pitch, oil etc.)

ELY Electricity; removed from `UTL`

Further information about the energy disaggregation is provided in Chapter 3.

2.1 Structure

The input-output data is rectangular, in that the producing sectors do not correspond to the produced goods. The data satisfy the following microconsistency conditions:

zero profit each productive sector earns zero profit

supply equals demand Total production of each produced good equals total intermediate and final demand by own province, other provinces and foreign users. Total demand for each imported good equals total imports.

factor market equilibrium total demand for each factor of production equals total supply

external balance Each province's final demand is funded from total factor income plus total government receipts plus net foreign borrowing.

A given province's purchases of their own produced goods are not treated as trade.

2.2 Data Balancing and Disaggregation

The Statistics Canada S-level data has a large number of cells suppressed due to confidentiality, with the result that the raw IO tables are not balanced. Many sectors do not earn zero profits or in some cases, have no data. Similarly, total availability does not equal total absorption for several goods. This problem is particularly acute for the Atlantic Provinces.

The first step in obtaining the CREAP data is to balance the S-level data. In many cases we have made best guesses of crucial values based on our intuition and extraneous sources. Given this combination of the original data and our guesses, we then balance the tables using a minimum squares approach.

We realize that this approach is inappropriate because of our understanding of the way the data is published. Our understanding is that any non-zero number published in the I-O table is correct (up to the rounding error). There is no distinction between zeros that really are zero and missing values. One can only verify if a given zero entry is zero if both its row and column control totals correspond to the non-zero data.[1] To the best of our knowledge, solving the 'correct' balancing program given this structure is infeasible.

We are certain that a large number of errors remain in our balanced S-level data. Usually the problems arise because of missing data from the published tables. We would appreciate any help identifying and fixing apparently inaccurate values in our data. Those who have questions, find errors or have suggestions are invited to send email to Randy Wigle or Tracy Snoddon.

[1] One can't always confirm the absence of small numbers because of the possibility of rounding error.

Chapter 3

Provincial Energy and Emissions Accounts

The data described here are provincial energy and emissions accounts corresponding to the input-output (IO) based data used.

The following challenges arose in assembling this data:

1. The organizing concept of the input-output data is the national and provincial IO data for 1998. While much of the energy/emissions data is available in an easily reconcilable format, some issues remained about mapping energy use to the IO concepts.

2. For tractability, the data has a limited number of energy goods, listed in Table 3.1. Within the model and data, each is treated as homogeneous, even though this is not literally true for a number of reasons. For example coal mined in BC is mostly metallurgical coal, whereas that mined in Atlantic Canada is mostly thermal coal. The mix of refined petroleum products produced and/or consumed in one part of Canada differs from that in another.

3. In some cases dollar transactions available from the IO data seem at variance with the energy data available (either in dollars or physical units).

The intent was to generate a set of accounts in real and nominal terms that mimic the Canadian economy as reasonably as possible given the constraints imposed by consistency with the model.

3.1 Data Sources

Table 3.2 details the sources of data used to generate energy targets and greenhouse gas emissions by province.

The greenhouse gas emissions and energy data available from CEOU were relied on very heavily, with some other sources used to help extract additional

Table 3.1: CREAP Energy Goods

Code	Description	Real Units
COL	Coal	1,000 tonnes
CRU	Crude Mineral Oil	1,000 m^3
GAS	Natural Gas	1,000,000 m^3
PET	Refined petroleum products	PJ (Petajoules)
ELY	Electricity (total)	Gwh
ELY_F	Fossil Electricity	Gwh
ELY_N	Non-Fossil Electricity	Gwh

detail. The CEOU data gives detailed energy and emissions data for transportation, which is not directly allocated between final demand and intermediate use.[1]

Table 3.2: Major Sources of Energy and Emissions Data

NRCAN CEO	1996–2020	provincial GHG emissions with alternative sectoral breakdowns
	1996–2020	provincial prices of crude oil, natural gas, "energy"
	1996–2020	oil and gas supply
	1996–2020	energy demand by fuel by province
Mineral Production of Canada (MPOC)	1998	Production of fossil fuels in real and dollar values.
National L-level IO Table	1998	Supplies national totals in millions of $1998 for many of the transactions we have provincially.

3.2 Description

The energy data includes:

production production in physical units and dollars of each of the energy goods by province

[1] Another source which we expect to use in the near future is Statistics Canada's Econnections data. They are available for 1996 and 1998, and correspond to the National L-level industries. In these tables, emissions from transportation are included in the sector which purchases the fuels, but they are not broken down by fuel.

intermediate use intermediate use in physical units and dollars of each of the energy commodities by all intermediate users in the province

final use final use in physical units and dollars of each of the energy commodities by province

emissions emissions in Mt CO2 equivalent for each province associated with burning of the appropriate fuel[2]

These values will be used both to supply starting points for the unbalanced input-output data and to supply targets for balancing the data set.

Numerous summary tables of our provincial energy accounts data are available for 1998 (our reference year) on the CREAP web site.[3]. They are presented in real units, in constant dollar terms (millions of $C1998) and finally (for comparison only) in PJ. Emissions are CO2 equivalents of energy-related CO2, N2O and methane emissions, including fugitive emissions from fossil fuel production. We hope to add emissions related to forestry and agriculture at a later stage.

3.3 Methods

1. Most real data on final demand, intermediate demand and emissions were determined from the CEOU data.
2. Most $C1998 transactions were calculated to reproduce the national total from the 1998 L-level IO table. The main exceptions are:
   (a) The dollar value of production of mineral fuels, which is available provincially from MPOC.
   (b) Total intermediate use in nominal terms for refined petroleum products was constrained so as not to exceed the value in the S-level provincial input-output data for 'petroleum and coal products' (P_C). This commodity is dominated by refined petroleum products.
   (c) Intermediate use of crude oil was inferred from the dollar values of provincial production of P_C and the ratio of crude oil input to total output in the national L-level table.
3. An ad-hoc constant share ($\beta = \frac{1}{3}$) of provincial use of transportation demand for refined petroleum products was allocated to final demand, with the remainder allocated to intermediate use.
4. The provincial production of mineral fuels in real and nominal terms for 1998 was taken from RPROD98.
5. Provincial production of refined petroleum products is assumed to grow at the same rate as overall provincial demand for refined petroleum products.

[2] We include emissions of all greenhouse gases associated with energy use, including fugitive emissions. Only fugitive emissions are listed in the CRU column. Emissions associated with petroleum refining are listed under intermediate use of the appropriate fuel.

[3] See http://creap.wlu.ca/doc/pea-tables-98-1.pdf

3.4 Remaining Issues

There are some general issues about our Provincial Energy Accounts:

Energy The provincial energy accounts currently treat inventory changes in final demand as consumption.

Electricity Intermediate use of electricity for some provinces (e.g. NF) exceeds the total from the provincial IO data for UTL (UTL+ELY). The national total adds up. At first Randy thought this was caused by relative prices, but it does not seem explainable in that way.

There is even a worse problem for output of electricity in NF, where our estimate of the dollar value of the production of ELY is 3 times as large as the S-level data for UTL ($M620).

PEI production of electricity is zero, but there is at least some electricity generation in PEI. (It may be safer to assume that there is no trade?)

Coal Intermediate use of COL in AB and ON differ from the balanced IO data by about 50%.

PET We are still working on further refinements to this data. Tony Clark at NRCan provided some very helpful suggestions which we have not yet had time to implement.

Chapter 4

Tax Data

The model has a detailed allocation of direct and indirect taxes to all transactions in the economy.

4.1 Indirect Taxes

Statistics Canada's Input-Output Division provided us with a detailed breakdown of the indirect taxes assessed on all transactions in the S-level IO table for 1998. The classes of indirect tax identified are listed in Table 4.1. The taxes are identified by the level of government (local, provincial or federal) that imposes them.

The indirect tax entry in a given sector's column of the balanced IO tables is allocated across all transactions in the table according to the indirect tax data provided to us by the IO Division. Similarly, indirect taxes in a given demand class are allocated according to the breakdown provided.

4.2 Direct Taxes

CANSIM data on collections of personal income tax, capital (stock) taxes and corporate income tax were allocated to each province's factors using the following methodology:

1. Personal income tax collections were allocated over earnings of all primary factors.

2. Corporate income taxes were allocated over all of 'Other Operating Surplus' and 40% of 'Mixed Income.'[1]

3. Corporate taxes assessed on capital stock were allocated over 'Other Operating Surplus' alone, since our judgement was that most of these taxes

[1] Mixed Income was assumed to be 60% self-employment (labour) income and the remainder returns to capital. Any suggestions on improving this breakdown would be appreciated.

Table 4.1: Indirect Taxes Identified

Code	Indirect Tax	Level
GA_F	Gasoline Taxes	(F)
ET_F	Excise Taxes	(F)
ED_F	Excise Duties	(F)
AL_P	Gallonage (alcohol) tax	(P)
AT_F	Air Transportation Tax	(F)
TP_P	Trading Profits (Liquor/Gaming)	(P)
GA_P	Gasoline Tax	(P)
EG_F	GST	(F)
RS_P	Provincial Sales Taxes	(P)
EG_P	HST	(P)
RS_L	Municipal Sales Taxes	(L)
TP_F	Trading Profits (Gaming/Tobacco)	(F)
AM_P	Provincial Amusement Taxes	(P)
AM_L	Local Amusement Taxes	(L)
UI_U	Unidentified	(U)

would exempt smaller firms whose income tends to show up as part of Mixed Income.

The rates derived are listed in Appendix B.

The direct tax rates are average rates (versus marginal) and thus may seem low. The average total income tax rate (federal plus provincial income taxes) varies between 13.8% (Saskatchewan) and 17.9% (Québec).

Our estimates of all taxes on capital came from assuming that there are no sectoral preferences in taxation.[2]

4.3 Limitations

1. We have no detail about the incidence of natural resource rents.
2. "Gasoline" taxes are allocated over all refined petroleum products.

[2]In future releases we intend to incoporate sectoral preferences into the federal and provincial corporate tax rates.

Chapter 5

Usage and Availability

This section describes the installation and usage of the CREAP V2 distribution. Two separate files are made available. The first (`CREAP-2a.zip`) includes all documentation and model files, and can be freely distributed.

The second (`CREAP-data-98-v2.zip`) includes the data files and should not be distributed to others. The data will be made available on request to Canadian academics and graduate covered by Statistics Canada's Data Liberation Initiative. The files are made available for academic research or teaching purposes only. All requests for access should be made to CREAP.

The files included in the public and data distributions, respectively are listed in Tables 5.1 and 5.2. Many of the documentation files included with the distribution are also available at http://creap.wlu.ca.

5.1 Usage

To create the directory structure noted, one should follow these steps:

1. Create a base folder (we will call it CREAP in the example).
2. Download (or copy) the archives `CREAP-2a.zip` and creap-data-98-v2.zip into CREAP.
3. Unzip the archives using Info-ZIP's compressor-archiver, being sure to preserve the directory structure outlined in Table 5.3. This structure is assumed in all the GAMS programs in the zip file.
4. Open a command prompt window and enter:

```
gams bmrt
```

5. The results can be viewed by inspecting the file bmrt.lst

5.1.1 System Requirements

To read the spreadsheet-format data the only requirement is a spreadsheet program capable of reading Excel-format spreadsheet files.

The documentation files are all distributed in Adobe Acrobat format. The free reader can be downloaded from Adobe's Acrobat download page.

GAMS users will need a licenced GAMS system (21.1 or later) to read the GDX files and use the gams programs which read and transform the data (all those in the `build` folder).

The BMRT model is currently only available in MPSGE format. To solve `bmrt.gms` one needs the MPSGE solver for GAMS, and an MCP solver on top of the GAMS system already mentioned.

More information about GAMS and MPSGE is available from GAMS corporation.

Table 5.1: Files in CREAP Public Distribution 2

`build/read-creap.gms` file for reading either of the gdx data files in the data folder: This file declares the GAMS `SETS` needed to read the data and can print some summary information about the data. See discussion of directory tree structure below. (Includes read-tax.gms)

`build/read-tax.gms` file for reading the tax data present in the tax files

`model/bmrt.gms` basic MPSGE model that does a benchmark test and then a simple experiment (includes `read-creap.gms` and `mod-data.gms`)

`model/dtax.gms` file to implement direct tax change experiments

`model/mod-data.gms` data manipulations to make the balanced data consistent with BMRT

`model/no-change.gms` file to implement no-change experiment

`model/scale.gms` file to implement rescaling test experiment (all endowments in all regions are change by the same porportion)

`doc/BMRT-doc.pdf` documentation for the BMRT model

`doc/CREAP-data-98-v2.pdf` documentation for the CREAP 1998 Version 2 data

`doc/pea-tables-98-1.pdf` extensive listing of the provincial energy accounts (unchanged from V1)

Table 5.2: Files in CREAP Data Distribution 2

`data/creap-data-98S-V2.gdx` Version 2 data at the S-level of aggregation (gdx file for use with GAMS and MPSGE) no GHG emissions coefficients

`data/creap-data-98C-V2.gdx` Version 2 data at the C-level of aggregation (gdx file for use with GAMS and MPSGE) includes GHG emissions coefficients

`data/creap-data-98S-V2.xls` spreadsheet of the S-level 1998 Version 2 data (no emissions coefficients)

`data/creap-data-98C-V2.xls` spreadsheet of the C-level 1998 V2 data (with GHG emissions coefficients)

Table 5.3: CREAP Directory Structure

`CREAP`	the base/ root directory for the CREAP model/data.[1]
`CREAP/build`	gms files related to data reading and aggregation
`CREAP/data`	data files (gdx and spreadsheets)
`CREAP/defines`	define files for aggregation of data (not used at this time)
`CREAP/doc`	data and model documentation in PDF format
`CREAP/model`	gms model files

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Appendix A

Reference Tables

Tables

Table A.1: CREAP Aggregation Commodities

GRA	Grains
OAG	Other agricultural products
FRS	Forestry products
F_T	Fish seafood and trapping products
ORE	Metal ores & concentrates
CRU	Crude Oil ‡
COL	Coal Products ‡
GAS	Natural Gas ‡
NMM	Non-metallic minerals
S_M	Services incidental to mining
MFD	Meat fish and dairy products
FVF	Fruit veg and other food products feeds
BEV	Soft drinks and alcoholic beverages
TOB	Tobacco and tobacco products
LRP	Leather rubber and plastic products
TEX	Textile products
CLO	Hosiery clothing and accessories
LUM	Lumber and wood products
F_F	Furniture and fixtures
P_P	Wood pulp paper and paper products
PRP	Printing and publishing
MET	Primary metal products
OMP	Other metal products
MEQ	Machinery and equipment
MVP	Motor veh oth transport equip and parts
ELE	Electrical electronic and communic prod
NMP	Non-metallic mineral products
P_C	Non-fuel Petroleum and coal products
PET	Refined petroleum fuels ‡
CPP	Chemicals pharmaceuticals & chemical prod
MPO	Other manufactured products
RES	Residential construction
NRC	Non-residential construction
REP	Repair construction

‡ indicates commodity has been disaggregated from one or more existing S-level goods.

CREAP Commodities

TRS	Transportation and storage
COM	Communications services
UTL	Other utilities
ELY	Electricity (Fossil) ‡
W_M	Wholesaling margins
R_M	Retailing margins
REN	Gross imputed rent
FIR	Other finance insurance and real estate services
BSV	Business and computer services
PED	Private education services
HSS	Health and social services
A_M	Accommodation services and meals
O_S	Other services
TRM	Transportation margins
OPS	Operating office cafeteria and lab supplies
TEA	Travel & entertainment advertising & promotion
NPI	Non-profit institutions serving households
GOV	Government sector services
OGS	Sales of other government services
W_S	Wages and Salaries
SLI	Supplementary labour income
MIX	Mixed income
PRF	Other operating surplus

‡ indicates commodity has been disaggregated from one or more existing S-level goods.

Table A.2: CREAP Aggregation Sectors

S1	Crop and Animal Production
S2	Forestry and Logging
S3	Fishing, Hunting and Trapping
S4	Support Activities for Agriculture and Forestry
S5	Mining and Oil and Gas Extraction
S6	Utilities
S7	Construction
S8	Manufacturing
S9	Wholesale Trade
S10	Retail Trade
S11	Transportation and Warehousing
S12	Information and Cultural Industries
S13	Finance, Insurance, Real Estate and Renting and Leasing
S14	Professional, Scientific and Technical Services
S15	Administrative and Support, Waste Management and Remediation Services
S16	Education Services
S17	Health Care and Social Assistance
S18	Arts, Entertainment and Recreation
S19	Accommodation and Food Services
S20	Other Services (Except Public Administration)
S21	Operating, Office, Cafeteria and Laboratory Supplies
S22	Travel, Entertainment, Advertising and Promotion
S23	Transportation Margins
S24	Non-Profit Institutions Serving Households
S25	Government Sector

Table A.3: Final Demand Classes

`PE`	Personal Expenditure
`PI`	Private Investment
`GI`	Government (public) Investment
`AI`	Additions to Inventories
`GE`	Government Expenditure
`EN`	Endowment/Income category

Table A.4: Mapping of Energy Goods

Good	S	M	L
Fuel wood and other crude wood	3	4	21
Coal	6	9	30
Crude Mineral Oils	6	10	31
Natural Gas	6	11	32
Motor Gasoline	26	62	303
Diesel, Fuel Oil, Air Fuel	26	62	304
Liquefied Propane and Natural Gas	26	63	307
Petroleum Feed Stocks	26	63	310
Methyl alcohol	27	64	341
Pipeline transmission	32	73	403
Electric Power	34	78	409
Gas distribution	34	79	410
Coke	26	63	411

Table A.5: Regional Abbreviations

NF	Newfoundland
PE	Prince Edward Island
NS	Nova Scotia
NB	New Brunswick
QC	Québec
ON	Ontario
MB	Manitoba
SK	Saskatchewan
AB	Alberta
BC	British Columbia
W	Rest of World

Appendix B

Direct Taxes

Legend for Direct Tax Tables	
Mixed	Mixed Income
Wages	Wages and Salaries
S Lab	Supplementary Labour Income
Oth O	Other Operating Surplus

Tax Rates (%) NF		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	8.73	8.73	8.73	8.73
Personal Income Tax	Provincial	6.15	6.15	6.15	6.15
Corporate (K-stock) Tax	Provincial	0.05	0.00	0.00	0.20
Corporate (Income) Tax	Federal	0.00	0.00	0.00	4.71
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	1.74

Tax Rates (%) PE		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	11.02	11.02	11.02	11.02
Personal Income Tax	Provincial	5.65	5.65	5.65	5.65
Corporate (K-stock) Tax	Provincial	0.05	0.00	0.00	0.23
Corporate (Income) Tax	Federal	0.00	0.00	0.00	4.94
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	2.96

Tax Rates (%) NS		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	10.56	10.56	10.56	10.56
Personal Income Tax	Provincial	5.99	5.99	5.99	5.99
Corporate (K-stock) Tax	Provincial	0.18	0.00	0.00	0.96
Corporate (Income) Tax	Federal	0.00	0.00	0.00	5.51
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	2.77

Tax Rates (%) NB		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	9.28	9.28	9.28	9.28
Personal Income Tax	Provincial	5.69	5.69	5.69	5.69
Corporate (K-stock) Tax	Provincial	0.13	0.00	0.00	0.63
Corporate (Income) Tax	Federal	0.00	0.00	0.00	5.07
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	2.90

Tax Rates (%) QC		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	8.75	8.75	8.75	8.75
Personal Income Tax	Provincial	9.15	9.15	9.15	9.15
Corporate (K-stock) Tax	Provincial	0.56	0.00	0.00	2.63
Corporate (Income) Tax	Federal	0.00	0.00	0.00	8.44
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	4.01

Tax Rates (%) ON		Mixed	Wages	S Lab	Oth O
(Income) Tax	Federal	11.72	11.72	11.72	11.72
(Income) Tax	Provincial	5.27	5.27	5.27	5.27
Corporate (K-stock) Tax	Provincial	0.25	0.00	0.00	1.19
Corporate (Income) Tax	Federal	0.00	0.00	0.00	8.48
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	5.58

Tax Rates (%) MB		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	9.82	9.82	9.82	9.82
Personal Income Tax	Provincial	5.94	5.94	5.94	5.94
Corporate (K-stock) Tax	Provincial	0.29	0.00	0.00	1.31
Corporate (Income) Tax	Federal	0.00	0.00	0.00	4.79
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	3.26

Tax Rates (%) SK		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	8.24	8.24	8.24	8.24
Personal Income Tax	Provincial	5.59	5.59	5.59	5.59
Corporate (K-stock) Tax	Provincial	0.74	0.00	0.00	2.12
Corporate (Income) Tax	Federal	0.00	0.00	0.00	4.07
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	2.07

Tax Rates (%) AB		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	9.85	9.85	9.85	9.85
Personal Income Tax	Provincial	4.67	4.67	4.67	4.67
Corporate (K-stock) Tax	Provincial	0.03	0.00	0.00	0.09
Corporate (Income) Tax	Federal	0.00	0.00	0.00	6.83
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	3.36

Tax Rates (%) BC		Mixed	Wages	S Lab	Oth O
Personal Income Tax	Federal	10.33	10.33	10.33	10.33
Personal Income Tax	Provincial	5.66	5.66	5.66	5.66
Corporate (K-stock) Tax	Provincial	0.27	0.00	0.00	1.36
Corporate (Income) Tax	Federal	0.00	0.00	0.00	5.51
Corporate (Income) Tax	Provincial	0.00	0.00	0.00	3.23