Preface

If need be...

In [1]:
```
import pandas as pd
import numpy as np
```

In [2]:
```
!pip install -r requirements.txt
```

```
Collecting CFEDemands>=0.4.1
  Using cached CFEDemands-0.5.3-py2.py3-none-any.whl (47 kB)
Collecting ConsumerDemands
  Using cached ConsumerDemands-0.4.1.dev0-py2.py3-none-any.whl (12 kB)
Requirement already satisfied: matplotlib>=3.3.4 in /opt/conda/lib/python3.
9/site-packages (from -r requirements.txt (line 10)) (3.5.3)
Requirement already satisfied: numpy>=1.21.5 in /opt/conda/lib/python3.9/si
te-packages (from -r requirements.txt (line 14)) (1.21.6)
Requirement already satisfied: pandas>=1.3.5 in /opt/conda/lib/python3.9/si
te-packages (from -r requirements.txt (line 20)) (1.3.5)
Requirement already satisfied: plotly>=5.1.0 in /opt/conda/lib/python3.9/si
te-packages (from -r requirements.txt (line 23)) (5.2.1)
Collecting eep153_tools>=0.11
  Using cached eep153_tools-0.11-py2.py3-none-any.whl (4.4 kB)
Collecting python-gnupg
  Using cached python_gnupg-0.5.0-py2.py3-none-any.whl (18 kB)
Requirement already satisfied: statsmodels>=0.13.2 in /opt/conda/lib/python
3.9/site-packages (from CFEDemands>=0.4.1->-r requirements.txt (line 5))
(0.13.5)
Requirement already satisfied: pytest>=7.1.1 in /opt/conda/lib/python3.9/si
te-packages (from CFEDemands>=0.4.1->-r requirements.txt (line 5)) (7.2.2)
Collecting ray>=2.0.0
  Using cached ray-2.3.1-cp39-cp39-manylinux2014_x86_64.whl (58.6 MB)
Collecting xarray>=0.20.1
  Using cached xarray-2023.3.0-py3-none-any.whl (981 kB)
Collecting pandas>=1.3.5
  Using cached pandas-2.0.0-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_x
86_64.whl (12.4 MB)
Requirement already satisfied: scipy>=1.7.3 in /opt/conda/lib/python3.9/sit
e-packages (from CFEDemands>=0.4.1->-r requirements.txt (line 5)) (1.10.1)
Collecting joblib>=1.1.0
  Using cached joblib-1.2.0-py3-none-any.whl (297 kB)
Collecting dvc>=2.18.1
  Using cached dvc-2.52.0-py3-none-any.whl (415 kB)
Requirement already satisfied: pyparsing>=2.2.1 in /opt/conda/lib/python3.
9/site-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10)) (3.
0.9)
Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.9/sit
e-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10)) (0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in /opt/conda/lib/python3.
9/site-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10)) (4.
39.3)
Requirement already satisfied: pillow>=6.2.0 in /opt/conda/lib/python3.9/si
te-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10)) (9.4.0)
Requirement already satisfied: packaging>=20.0 in /opt/conda/lib/python3.9/
site-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10)) (21.
3)
Requirement already satisfied: kiwisolver>=1.0.1 in /opt/conda/lib/python3.
9/site-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10)) (1.
4.4)
Requirement already satisfied: python-dateutil>=2.7 in /opt/conda/lib/pytho
n3.9/site-packages (from matplotlib>=3.3.4->-r requirements.txt (line 10))
(2.8.0)
Collecting tzdata>=2022.1
  Using cached tzdata-2023.3-py2.py3-none-any.whl (341 kB)
Collecting python-dateutil>=2.7
```

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  Using cached python_dateutil-2.8.2-py2.py3-none-any.whl (247 kB)
Requirement already satisfied: pytz>=2020.1 in /opt/conda/lib/python3.9/sit
e-packages (from pandas>=1.3.5->-r requirements.txt (line 20)) (2021.1)
Requirement already satisfied: six in /opt/conda/lib/python3.9/site-package
s (from plotly>=5.1.0->-r requirements.txt (line 23)) (1.16.0)
Requirement already satisfied: tenacity>=6.2.0 in /opt/conda/lib/python3.9/
site-packages (from plotly>=5.1.0->-r requirements.txt (line 23)) (8.2.2)
Collecting scmrepo<1,>=0.1.17
  Using cached scmrepo-0.2.1-py3-none-any.whl (54 kB)
Collecting funcy>=1.14
  Using cached funcy-2.0-py2.py3-none-any.whl (30 kB)
Requirement already satisfied: tabulate>=0.8.7 in /opt/conda/lib/python3.9/
site-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (li
ne 5)) (0.9.0)
Collecting pydot>=1.2.4
  Using cached pydot-1.4.2-py2.py3-none-any.whl (21 kB)
Collecting tqdm<5,>=4.63.1
  Using cached tqdm-4.65.0-py3-none-any.whl (77 kB)
Collecting iterative-telemetry>=0.0.7
  Using cached iterative_telemetry-0.0.8-py3-none-any.whl (10 kB)
Collecting dvc-studio-client<1,>=0.6.1
  Using cached dvc_studio_client-0.6.1-py3-none-any.whl (9.8 kB)
Collecting grandalf<1,>=0.7
  Using cached grandalf-0.8-py3-none-any.whl (41 kB)
Collecting flatten-dict<1,>=0.4.1
  Using cached flatten_dict-0.4.2-py2.py3-none-any.whl (9.7 kB)
Collecting shtab<2,>=1.3.4
  Using cached shtab-1.6.1-py3-none-any.whl (13 kB)
Requirement already satisfied: requests>=2.22 in /opt/conda/lib/python3.9/s
ite-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (lin
e 5)) (2.26.0)
Collecting rich>=12
  Using cached rich-13.3.3-py3-none-any.whl (238 kB)
Requirement already satisfied: colorama>=0.3.9 in /opt/conda/lib/python3.9/
site-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (li
ne 5)) (0.4.4)
Collecting zc.lockfile>=1.2.1
  Using cached zc.lockfile-3.0.post1-py3-none-any.whl (9.8 kB)
Collecting pygtrie>=2.3.2
  Using cached pygtrie-2.5.0-py3-none-any.whl (25 kB)
Collecting voluptuous>=0.11.7
  Using cached voluptuous-0.13.1-py3-none-any.whl (29 kB)
Collecting dvc-data<0.47,>=0.46.0
  Using cached dvc_data-0.46.0-py3-none-any.whl (59 kB)
Collecting dvc-task<1,>=0.2.0
  Using cached dvc_task-0.2.0-py3-none-any.whl (23 kB)
Requirement already satisfied: ruamel.yaml>=0.17.11 in /opt/conda/lib/pytho
n3.9/site-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.tx
t (line 5)) (0.17.21)
Requirement already satisfied: platformdirs<4,>=3.1.1 in /opt/conda/lib/pyt
hon3.9/site-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.
txt (line 5)) (3.2.0)
Requirement already satisfied: networkx>=2.5 in /opt/conda/lib/python3.9/si
te-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (line
5)) (2.6.3)
Requirement already satisfied: psutil>=5.8 in /opt/conda/lib/python3.9/site
```

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-packages (from dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (line
5)) (5.9.4)
Collecting shortuuid>=0.5
  Using cached shortuuid-1.0.11-py3-none-any.whl (10 kB)
Collecting tomlkit>=0.11.1
  Using cached tomlkit-0.11.7-py3-none-any.whl (35 kB)
Collecting dvc-render<0.4.0,>=0.3.1
  Using cached dvc_render-0.3.1-py3-none-any.whl (18 kB)
Collecting distro>=1.3
  Using cached distro-1.8.0-py3-none-any.whl (20 kB)
Collecting dvc-http
  Using cached dvc_http-2.30.2-py3-none-any.whl (12 kB)
Collecting pathspec>=0.10.3
  Using cached pathspec-0.11.1-py3-none-any.whl (29 kB)
Collecting dpath<3,>=2.1.0
  Using cached dpath-2.1.5-py3-none-any.whl (17 kB)
Collecting configobj>=5.0.6
  Using cached configobj-5.0.8-py2.py3-none-any.whl (36 kB)
Collecting flufl.lock>=5
  Using cached flufl.lock-7.1.1-py3-none-any.whl (11 kB)
Collecting hydra-core>=1.1
  Using cached hydra_core-1.3.2-py3-none-any.whl (154 kB)
Requirement already satisfied: exceptiongroup>=1.0.0rc8 in /opt/conda/lib/p
ython3.9/site-packages (from pytest>=7.1.1->CFEDemands>=0.4.1->-r requireme
nts.txt (line 5)) (1.1.1)
Requirement already satisfied: iniconfig in /opt/conda/lib/python3.9/site-p
ackages (from pytest>=7.1.1->CFEDemands>=0.4.1->-r requirements.txt (line
5)) (2.0.0)
Requirement already satisfied: pluggy<2.0,>=0.12 in /opt/conda/lib/python3.
9/site-packages (from pytest>=7.1.1->CFEDemands>=0.4.1->-r requirements.txt
(line 5)) (1.0.0)
Requirement already satisfied: attrs>=19.2.0 in /opt/conda/lib/python3.9/si
te-packages (from pytest>=7.1.1->CFEDemands>=0.4.1->-r requirements.txt (li
ne 5)) (19.3.0)
Requirement already satisfied: tomli>=1.0.0 in /opt/conda/lib/python3.9/sit
e-packages (from pytest>=7.1.1->CFEDemands>=0.4.1->-r requirements.txt (lin
e 5)) (2.0.1)
Requirement already satisfied: filelock in /opt/conda/lib/python3.9/site-pa
ckages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line 5))
(3.10.7)
Requirement already satisfied: jsonschema in /opt/conda/lib/python3.9/site-
packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line 5))
(4.17.3)
Requirement already satisfied: msgpack<2.0.0,>=1.0.0 in /opt/conda/lib/pyth
on3.9/site-packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.tx
t (line 5)) (1.0.5)
Requirement already satisfied: click>=7.0 in /opt/conda/lib/python3.9/site-
packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line 5))
(8.0.4)
Requirement already satisfied: pyyaml in /opt/conda/lib/python3.9/site-pack
ages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line 5)) (6.
0)
Requirement already satisfied: virtualenv>=20.0.24 in /opt/conda/lib/python
3.9/site-packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt
(line 5)) (20.21.0)
Requirement already satisfied: aiosignal in /opt/conda/lib/python3.9/site-p
```

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ackages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line 5))
(1.3.1)
Requirement already satisfied: protobuf!=3.19.5,>=3.15.3 in /opt/conda/lib/
python3.9/site-packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirement
s.txt (line 5)) (3.19.6)
Requirement already satisfied: frozenlist in /opt/conda/lib/python3.9/site-
packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line 5))
(1.3.3)
Requirement already satisfied: grpcio>=1.32.0 in /opt/conda/lib/python3.9/s
ite-packages (from ray>=2.0.0->CFEDemands>=0.4.1->-r requirements.txt (line
5)) (1.43.0)
Requirement already satisfied: patsy>=0.5.2 in /opt/conda/lib/python3.9/sit
e-packages (from statsmodels>=0.13.2->CFEDemands>=0.4.1->-r requirements.tx
t (line 5)) (0.5.3)
Collecting pandas>=1.3.5
  Using cached pandas-1.5.3-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_x
86_64.whl (12.2 MB)
Collecting nanotime>=0.5.2
  Using cached nanotime-0.5.2-py3-none-any.whl
Collecting diskcache>=5.2.1
  Using cached diskcache-5.4.0-py3-none-any.whl (44 kB)
Collecting sqltrie<1,>=0.3.0
  Using cached sqltrie-0.3.0-py3-none-any.whl (16 kB)
Collecting attrs>=19.2.0
  Using cached attrs-22.2.0-py3-none-any.whl (60 kB)
Collecting dictdiffer>=0.8.1
  Using cached dictdiffer-0.9.0-py2.py3-none-any.whl (16 kB)
Collecting dvc-objects<1,>=0.21.1
  Using cached dvc_objects-0.21.1-py3-none-any.whl (37 kB)
Collecting dulwich
  Using cached dulwich-0.21.3-cp39-cp39-manylinux_2_17_x86_64.manylinux2014
_x86_64.whl (505 kB)
Collecting kombu<6,>=5.2.0
  Using cached kombu-5.2.4-py3-none-any.whl (189 kB)
Collecting celery<6,>=5.2.0
  Using cached celery-5.2.7-py3-none-any.whl (405 kB)
Collecting atpublic>=2.3
  Using cached atpublic-3.1.1-py3-none-any.whl (4.8 kB)
Collecting antlr4-python3-runtime==4.9.*
  Using cached antlr4_python3_runtime-4.9.3-py3-none-any.whl
Collecting omegaconf<2.4,>=2.2
  Using cached omegaconf-2.3.0-py3-none-any.whl (79 kB)
Requirement already satisfied: appdirs in /opt/conda/lib/python3.9/site-pac
kages (from iterative-telemetry>=0.0.7->dvc>=2.18.1->CFEDemands>=0.4.1->-r
requirements.txt (line 5)) (1.4.4)
Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/lib/python
3.9/site-packages (from requests>=2.22->dvc>=2.18.1->CFEDemands>=0.4.1->-r
requirements.txt (line 5)) (2021.10.8)
Requirement already satisfied: idna<4,>=2.5 in /opt/conda/lib/python3.9/sit
e-packages (from requests>=2.22->dvc>=2.18.1->CFEDemands>=0.4.1->-r require
ments.txt (line 5)) (3.1)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/lib/pyth
on3.9/site-packages (from requests>=2.22->dvc>=2.18.1->CFEDemands>=0.4.1->-
r requirements.txt (line 5)) (1.26.7)
Requirement already satisfied: charset-normalizer~=2.0.0 in /opt/conda/lib/
python3.9/site-packages (from requests>=2.22->dvc>=2.18.1->CFEDemands>=0.4.
```

```
1->-r requirements.txt (line 5)) (2.0.0)
Requirement already satisfied: markdown-it-py<3.0.0,>=2.2.0 in /opt/conda/l
ib/python3.9/site-packages (from rich>=12->dvc>=2.18.1->CFEDemands>=0.4.1->
-r requirements.txt (line 5)) (2.2.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in /opt/conda/lib/py
thon3.9/site-packages (from rich>=12->dvc>=2.18.1->CFEDemands>=0.4.1->-r re
quirements.txt (line 5)) (2.14.0)
Requirement already satisfied: ruamel.yaml.clib>=0.2.6 in /opt/conda/lib/py
thon3.9/site-packages (from ruamel.yaml>=0.17.11->dvc>=2.18.1->CFEDemands>=
0.4.1->-r requirements.txt (line 5)) (0.2.7)
Collecting asyncssh<3,>=2.13.1
  Using cached asyncssh-2.13.1-py3-none-any.whl (348 kB)
Collecting pygit2>=1.10.0
  Using cached pygit2-1.12.0-cp39-cp39-manylinux_2_17_x86_64.manylinux2014_
x86_64.whl (4.9 MB)
Collecting gitpython>3
  Using cached GitPython-3.1.31-py3-none-any.whl (184 kB)
Requirement already satisfied: fsspec>=2021.7.0 in /opt/conda/lib/python3.
9/site-packages (from scmrepo<1,>=0.1.17->dvc>=2.18.1->CFEDemands>=0.4.1->-
r requirements.txt (line 5)) (2023.3.0)
Requirement already satisfied: distlib<1,>=0.3.6 in /opt/conda/lib/python3.
9/site-packages (from virtualenv>=20.0.24->ray>=2.0.0->CFEDemands>=0.4.1->-
r requirements.txt (line 5)) (0.3.6)
Requirement already satisfied: setuptools in /opt/conda/lib/python3.9/site-
packages (from zc.lockfile>=1.2.1->dvc>=2.18.1->CFEDemands>=0.4.1->-r requi
rements.txt (line 5)) (67.6.1)
Collecting aiohttp-retry>=2.5.0
  Using cached aiohttp_retry-2.8.3-py3-none-any.whl (9.8 kB)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.
0 in /opt/conda/lib/python3.9/site-packages (from jsonschema->ray>=2.0.0->C
FEDemands>=0.4.1->-r requirements.txt (line 5)) (0.19.3)
Requirement already satisfied: aiohttp in /opt/conda/lib/python3.9/site-pac
kages (from aiohttp-retry>=2.5.0->dvc-http->dvc>=2.18.1->CFEDemands>=0.4.1-
>-r requirements.txt (line 5)) (3.8.4)
Requirement already satisfied: cryptography>=3.1 in /opt/conda/lib/python3.
9/site-packages (from asyncssh<3,>=2.13.1->scmrepo<1,>=0.1.17->dvc>=2.18.1-
>CFEDemands>=0.4.1->-r requirements.txt (line 5)) (3.4.8)
Requirement already satisfied: typing-extensions>=3.6 in /opt/conda/lib/pyt
hon3.9/site-packages (from asyncssh<3,>=2.13.1->scmrepo<1,>=0.1.17->dvc>=2.
18.1->CFEDemands>=0.4.1->-r requirements.txt (line 5)) (4.5.0)
Collecting click-didyoumean>=0.0.3
  Using cached click_didyoumean-0.3.0-py3-none-any.whl (2.7 kB)
Collecting click-repl>=0.2.0
  Using cached click_repl-0.2.0-py3-none-any.whl (5.2 kB)
Requirement already satisfied: click-plugins>=1.1.1 in /opt/conda/lib/pytho
n3.9/site-packages (from celery<6,>=5.2.0->dvc-task<1,>=0.2.0->dvc>=2.18.1-
>CFEDemands>=0.4.1->-r requirements.txt (line 5)) (1.1.1)
Collecting vine<6.0,>=5.0.0
  Using cached vine-5.0.0-py2.py3-none-any.whl (9.4 kB)
Collecting pytz>=2020.1
  Using cached pytz-2023.3-py2.py3-none-any.whl (502 kB)
Collecting billiard<4.0,>=3.6.4.0
  Using cached billiard-3.6.4.0-py3-none-any.whl (89 kB)
Collecting gitdb<5,>=4.0.1
  Using cached gitdb-4.0.10-py3-none-any.whl (62 kB)
Collecting amqp<6.0.0,>=5.0.9
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  Using cached amqp-5.1.1-py3-none-any.whl (50 kB)
Requirement already satisfied: mdurl~=0.1 in /opt/conda/lib/python3.9/site-
packages (from markdown-it-py<3.0.0,>=2.2.0->rich>=12->dvc>=2.18.1->CFEDema
nds>=0.4.1->-r requirements.txt (line 5)) (0.1.2)
Requirement already satisfied: cffi>=1.9.1 in /opt/conda/lib/python3.9/site
-packages (from pygit2>=1.10.0->scmrepo<1,>=0.1.17->dvc>=2.18.1->CFEDemands
>=0.4.1->-r requirements.txt (line 5)) (1.14.6)
Collecting orjson
  Using cached orjson-3.8.9-cp39-cp39-manylinux_2_28_x86_64.whl (144 kB)
Requirement already satisfied: multidict<7.0,>=4.5 in /opt/conda/lib/python
3.9/site-packages (from aiohttp->aiohttp-retry>=2.5.0->dvc-http->dvc>=2.18.
1->CFEDemands>=0.4.1->-r requirements.txt (line 5)) (6.0.4)
Requirement already satisfied: yarl<2.0,>=1.0 in /opt/conda/lib/python3.9/s
ite-packages (from aiohttp->aiohttp-retry>=2.5.0->dvc-http->dvc>=2.18.1->CF
EDemands>=0.4.1->-r requirements.txt (line 5)) (1.8.2)
Requirement already satisfied: async-timeout<5.0,>=4.0.0a3 in /opt/conda/li
b/python3.9/site-packages (from aiohttp->aiohttp-retry>=2.5.0->dvc-http->dv
c>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (line 5)) (4.0.2)
Requirement already satisfied: pycparser in /opt/conda/lib/python3.9/site-p
ackages (from cffi>=1.9.1->pygit2>=1.10.0->scmrepo<1,>=0.1.17->dvc>=2.18.1-
>CFEDemands>=0.4.1->-r requirements.txt (line 5)) (2.20)
Requirement already satisfied: prompt-toolkit in /opt/conda/lib/python3.9/s
ite-packages (from click-repl>=0.2.0->celery<6,>=5.2.0->dvc-task<1,>=0.2.0-
>dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (line 5)) (3.0.38)
Collecting smmap<6,>=3.0.1
  Using cached smmap-5.0.0-py3-none-any.whl (24 kB)
Requirement already satisfied: wcwidth in /opt/conda/lib/python3.9/site-pac
kages (from prompt-toolkit->click-repl>=0.2.0->celery<6,>=5.2.0->dvc-task<
1,>=0.2.0->dvc>=2.18.1->CFEDemands>=0.4.1->-r requirements.txt (line 5))
(0.2.6)
Installing collected packages: voluptuous, pytz, python-gnupg, pygtrie, nan
otime, funcy, eep153_tools, dictdiffer, ConsumerDemands, billiard, antlr4-p
ython3-runtime, zc.lockfile, vine, tqdm, tomlkit, smmap, shtab, shortuuid,
python-dateutil, pydot, pathspec, orjson, omegaconf, joblib, grandalf, flat
ten-dict, dvc-render, dulwich, dpath, distro, diskcache, configobj, click-d
idyoumean, attrs, atpublic, sqltrie, rich, pygit2, pandas, iterative-teleme
try, hydra-core, gitdb, flufl.lock, dvc-studio-client, dvc-objects, click-r
epl, amqp, xarray, ray, kombu, gitpython, dvc-data, asyncssh, aiohttp-retr
y, scmrepo, dvc-http, celery, dvc-task, dvc, CFEDemands
  Attempting uninstall: pytz
    Found existing installation: pytz 2021.1
    Uninstalling pytz-2021.1:
      Successfully uninstalled pytz-2021.1
  Attempting uninstall: tqdm
    Found existing installation: tqdm 4.62.1
    Uninstalling tqdm-4.62.1:
      Successfully uninstalled tqdm-4.62.1
  Attempting uninstall: python-dateutil
    Found existing installation: python-dateutil 2.8.0
    Uninstalling python-dateutil-2.8.0:
      Successfully uninstalled python-dateutil-2.8.0
  Attempting uninstall: pathspec
    Found existing installation: pathspec 0.9.0
    Uninstalling pathspec-0.9.0:
      Successfully uninstalled pathspec-0.9.0
  Attempting uninstall: joblib
```

```
    Found existing installation: joblib 1.0.1
    Uninstalling joblib-1.0.1:
      Successfully uninstalled joblib-1.0.1
  Attempting uninstall: attrs
    Found existing installation: attrs 19.3.0
    Uninstalling attrs-19.3.0:
      Successfully uninstalled attrs-19.3.0
  Attempting uninstall: pandas
    Found existing installation: pandas 1.3.5
    Uninstalling pandas-1.3.5:
      Successfully uninstalled pandas-1.3.5
  Attempting uninstall: xarray
    Found existing installation: xarray 0.19.0
    Uninstalling xarray-0.19.0:
      Successfully uninstalled xarray-0.19.0
  Attempting uninstall: ray
    Found existing installation: ray 1.13.0
    Uninstalling ray-1.13.0:
      Successfully uninstalled ray-1.13.0
ERROR: pip's dependency resolver does not currently take into account all t
he packages that are installed. This behaviour is the source of the followi
ng dependency conflicts.
pysal 2.5.0 requires python-dateutil<=2.8.0, but you have python-dateutil
2.8.2 which is incompatible.
dbt-core 1.3.0 requires pathspec~=0.9.0, but you have pathspec 0.11.1 which
is incompatible.
datasets 2.2.1 requires pyarrow>=6.0.0, but you have pyarrow 5.0.0 which is
incompatible.
ast-scope 0.3.1 requires attrs==19.3.0, but you have attrs 22.2.0 which is
incompatible.
Successfully installed CFEDemands-0.5.3 ConsumerDemands-0.4.1.dev0 aiohttp-
retry-2.8.3 amqp-5.1.1 antlr4-python3-runtime-4.9.3 asyncssh-2.13.1 atpubli
c-3.1.1 attrs-22.2.0 billiard-3.6.4.0 celery-5.2.7 click-didyoumean-0.3.0 c
lick-repl-0.2.0 configobj-5.0.8 dictdiffer-0.9.0 diskcache-5.4.0 distro-1.
8.0 dpath-2.1.5 dulwich-0.21.3 dvc-2.52.0 dvc-data-0.46.0 dvc-http-2.30.2 d
vc-objects-0.21.1 dvc-render-0.3.1 dvc-studio-client-0.6.1 dvc-task-0.2.0 e
ep153_tools-0.11 flatten-dict-0.4.2 flufl.lock-7.1.1 funcy-2.0 gitdb-4.0.10
gitpython-3.1.31 grandalf-0.8 hydra-core-1.3.2 iterative-telemetry-0.0.8 jo
blib-1.2.0 kombu-5.2.4 nanotime-0.5.2 omegaconf-2.3.0 orjson-3.8.9 pandas-
1.5.3 pathspec-0.11.1 pydot-1.4.2 pygit2-1.12.0 pygtrie-2.5.0 python-dateut
il-2.8.2 python-gnupg-0.5.0 pytz-2023.3 ray-2.3.1 rich-13.3.3 scmrepo-0.2.1
shortuuid-1.0.11 shtab-1.6.1 smmap-5.0.0 sqltrie-0.3.0 tomlkit-0.11.7 tqdm-
4.65.0 vine-5.0.0 voluptuous-0.13.1 xarray-2023.3.0 zc.lockfile-3.0.post1
```

Introduction

Here we give a set of generic instructions for analyzing demand for food and nutrition. Inputs include a datasets of consumption quantities, consumption expenditures, household characteristics, and a food conversion table.

The different datasets should be indexed as follows:

Dataset	Indexed by	Columns
Expenditures	i,t,m	j
Consumption	i,t,m,u	j
Prices	t,m	j
HH Characteristics	i,t,m	k
FCT	j,u	n
RDI	n	k

where `i` indexes households, `t` indexes periods, `m` indexes markets, `j` indexes goods, `k` indexes different kinds of household characteristics, `u` indexes different unit names, and `n` indexes different nutrients. Finally, any RDI ("recommended daily intake") tables should be indexed by nutrients, with columns corresponding to characteristics of persons within the household (e.g., age & sex categories).

Note that some countries have more than one dataframe of consumption, distinguished by source; for example Malawi has consumption items purchased as well as consumption items produced. Here we focus on consumption purchases, since one of our immediate aims is to infer prices paid.

Step 1: Acquire DataFrames

Here are addresses of google sheets for different dataframes for the case of Uganda:

In [3]:
```
InputFiles = {'Expenditures':('https://docs.google.com/spreadsheets/d/1-RiJT
              'Prices':('https://docs.google.com/spreadsheets/d/1wx7rBgDpjpE
              'HH Characteristics':('https://docs.google.com/spreadsheets/d/
              'FCT':('https://docs.google.com/spreadsheets/d/1V2AyYaFURAbW7-
              'RDI':('1yVLriVpo7KGUXvR3hq_n53XpXlD5NmLaH1oOMZyV0gQ','RDI'),}
```

Note that in some cases not the food items for the FCT (e.g., for Niger) are **not** yet all matched up ("harmonized") with food labels indexed by `j` in the expenditure, consumption and price datasets.

In [4]:
```
from eep153_tools.sheets import read_sheets


def get_clean_sheet(key,sheet=None):

    df = read_sheets(key,sheet=sheet)
    df.columns = [c.strip() for c in df.columns.tolist()]

    df = df.loc[:,~df.columns.duplicated(keep='first')]

    df = df.drop([col for col in df.columns if col.startswith('Unnamed')], a

    df = df.loc[~df.index.duplicated(), :]
```

```
    return df

# Get expenditures...
x = get_clean_sheet(InputFiles['Expenditures'][0],
                    sheet=InputFiles['Expenditures'][1])

if 'm' not in x.columns:
    x['m'] = 1

x = x.set_index(['i','t','m'])
x.columns.name = 'j'

x = x.apply(lambda x: pd.to_numeric(x,errors='coerce'))
x = x.replace(0,np.nan)

# Get HH characteristics...
z = get_clean_sheet(InputFiles['HH Characteristics'][0],
                    sheet=InputFiles['HH Characteristics'][1])

if 'm' not in z.columns:
    z['m'] = 1

z = z.set_index(['i','t','m'])
z.columns.name = 'k'

z = z.apply(lambda x: pd.to_numeric(x,errors='coerce'))

# Get prices
p = get_clean_sheet(InputFiles['Prices'][0],
                    sheet=InputFiles['Prices'][1])

if 'm' not in p.columns:  # Supply "market" indicator if missing
    p['m'] = 1

p = p.set_index(['t','m'])
p.columns.name = 'j'

p = p.apply(lambda x: pd.to_numeric(x,errors='coerce'))
p = p.replace(0,np.nan)

fct = get_clean_sheet(InputFiles['FCT'][0],
                    sheet=InputFiles['FCT'][1])

#### This bit peculiar to Niger FCT #####
#fct = fct.loc[fct.Code.str.len()==6]
#fct = fct.set_index('Code')
#fct.columns = [v.replace('\n',' ') for v in fct.columns]
#########################################
fct = fct.set_index('Food Item Name')
fct.columns.name = 'n'

fct = fct.apply(lambda x: pd.to_numeric(x,errors='coerce'))

################## RDI, if available (consider using US) ###################
rdi = get_clean_sheet(InputFiles['RDI'][0],
```

```
                    sheet=InputFiles['RDI'][1])
rdi = rdi.set_index('n')
rdi.columns.name = 'k'
```

```
Key available for students@eep153.iam.gserviceaccount.com.
Key available for students@eep153.iam.gserviceaccount.com.
Key available for students@eep153.iam.gserviceaccount.com.
Key available for students@eep153.iam.gserviceaccount.com.
Key available for students@eep153.iam.gserviceaccount.com.
```

In [5]:
```
x=x.xs(2004,level='t',drop_level=False).sample(n=2500,replace=False)
z=z.xs(2004,level='t',drop_level=False).sample(n=2500,replace=False)
p=p.xs(2004,level='t',drop_level=False).sample(n=2500,replace=False)
#fct=fct.xs(2004,level='t',drop_level=False).sample(n=5000,replace=False)
```

Step 2: Estimate Demand System

Here, use data on log *expenditures* and household characteristics to create a CFEDemand `result`.

In [6]:
```
import cfe

result = cfe.Regression(y=np.log(x.stack()),d=z)

result.get_beta().sort_values(ascending=False) # Check sanity...
```

```
Missing dependencies for OracleDemands.
```

Out[6]:
```
j
Cooking oil                   0.912755
Buns, scones                  0.779404
Onion                         0.699120
Tomato                        0.677638
Dried fish                    0.597587
Rice                          0.563397
Mandazi, doughnut (vendor)    0.527505
Tea                           0.461661
Cabbage                       0.423969
Sugar                         0.411843
Tanaposi rape                 0.373835
Banana                        0.368875
Salt                          0.278063
Cassava tubers                0.059373
Name: beta, dtype: float64
```

Make this persistent...

In [7]:
```
result.to_pickle('./foo.pickle')
```

Step 3: Infer quantities

Next, we divide predicted expenditures by prices to get quantities (in kilograms) we can map into the FCT.

In [8]:
```
result = cfe.read_pickle('foo.pickle')  # Get persistent result saved above.

xhat = result.predicted_expenditures()

# Expenditures divided by prices/kg gives quantities in kgs...
qhat = (xhat.unstack('j')/p).dropna(how='all')

# Drop missing columns
qhat = qhat.loc[:,qhat.count()>0]
```

Note that `qhat` may give prices for different *units*. If prices differ **only** because of units (e.g., one deciliter costs one tenth as much as a liter), then we can use these differences in prices to convert between different units, even if the units (e.g., "basket") is otherwise unclear.

If we have enough data on purchases in kilograms, just keep those prices (otherwise choose some other useful unit). We also assume prices are the same for everyone, so just take median.

Step 4: Map predicted quantities into nutrients

Before this will work, need columns of qhat to match columns of fct.

In [9]:
```
#fct.set_index('Food Item Name').index
qhat.columns
fct.index
```

Out[9]:
```
Index(['', 'African cake, (Chikondamoyo/Chigumu cha nthochi ndi dzira)',
       'Banana fritters, (Zitumbuwa)',
       'Bread, wheat, brown, homemade (Buledi wa bulawuni)',
       'Bread, wheat, white, commercial,(Buledi woyera)',
       'Bread, wheat, white, homemade,(Buledi woyera)',
       'Bean and groundnut stew, (Ndawva)', 'Bean soup, (Supu wa nyemba)',
       'Bean stew, (Nyemba zouma zokazingira)',
       'Beef mince, fried, (Nyama ya ng'ombe yogaya yokazinga)',
       'Beef stew, (Nyama ya ng'ombe yokazingira)',
       'Bean, lima, green, fresh, Phaseolus lunatus, (Kabaifa/Kamumpanda)',
       'Avocado, raw, peeled', 'Banana, white fleshed, raw, peeled',
       'Bean, brown', 'Bean, white', 'Beef ', 'Biscuits ',
       'Bread, wheat, brown, homemade', 'Milk scones', 'Cabbage, raw',
       'Cassava, tuber, raw', 'Chibuku/ Napolo',
       'Chicken, meat with skin, free range, local, raw',
       'Chinese cabbage, boiled', 'Chips (vendor)', 'Cooking oil',
       'Cowpea (khobwe)', 'Cucumber', 'Dried fish', 'Eggs', 'Fish (vendo
r)',
       'Freezes (flavoured ice)', 'Fresh milk ', 'Goat ', 'Green maize ',
       'Fresh fish ', 'Groundnut', 'Groundnut flour ', 'Guava ',
       'Irish potato ', 'Maize - boiled or roasted ',
       'Maize ufa mgaiwa (normal flour)', 'Maize ufa refined (fine flour)',
       'Mandazi, doughnut (vendor)', 'Meat (vendor)',
       'Meat eaten at restaurant', 'Nkwani', 'Okra / Therere', 'Onion',
       'Orange sweet potato', 'Pork', 'Powdered milk', 'Rice', 'Salt',
       'Samosa (vendor)', 'Soft drinks (coca cola, fanta)', 'Sugar',
       'Sugar cane', 'Sweets, candy, chocolates', 'Tanaposi rape', 'Tea',
       'Tomato', 'White sweet potato',
       'Yeast, baking powder, bicarbonate of soda'],
      dtype='object', name='Food Item Name')
```

In [12]:
```
qhat_new=qhat.fillna(0)
fct_new=fct.fillna(0)
```

In [14]:
```
qhat_new
```

Out[14]:

t	m	j / i	Banana	Buns, scones	Cabbage	Cassava tubers	Cooking oil	Dried fish	Manc dougl (ven
2004	**Malawi**	**10204801041**	0.000000	0.0	0.0	3.521996	0.0	0.0	
		10204801041	1.157349	0.0	0.0	0.000000	0.0	0.0	
		10204801041	0.000000	0.0	0.0	0.000000	0.0	0.0	
		10204801041	0.000000	0.0	0.0	0.000000	0.0	0.0	
		10204801041	0.000000	0.0	0.0	0.000000	0.0	0.0	
		...	...	...	...	...	...	...	
		31202044020	0.000000	0.0	0.0	0.000000	0.0	0.0	
		31202044020	0.000000	0.0	0.0	0.457070	0.0	0.0	
		31202044020	0.000000	0.0	0.0	2.742418	0.0	0.0	
		31202044020	0.000000	0.0	0.0	4.113627	0.0	0.0	
		31202044020	0.000000	0.0	0.0	0.000000	0.0	0.0	

87660 rows × 12 columns

In [15]:
```
fct_new
```

Out[15]:

Food Item Name	n	Code	Food Group	Reference	Mois	Energy	N	Prot	Fat	SAFA	MI
	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0
African cake, (Chikondamoyo/Chigumu cha nthochi ndi dzira)	0.0	0.0	0.0	49.0	215.0	0.91	5.7	3.0	0.00	0
Banana fritters, (Zitumbuwa)	0.0	0.0	0.0	54.8	189.0	0.51	3.2	2.5	0.12	0
Bread, wheat, brown, homemade (Buledi wa bulawuni)	0.0	0.0	0.0	11.2	362.0	1.72	0.0	6.2	1.71	0
Bread, wheat, white, commercial,(Buledi woyera)	0.0	0.0	2.0	35.6	256.0	1.36	8.5	1.5	0.00	0
...	...	...	...	...	...	...	...	...	...	
Tanaposi rape	0.0	0.0	10.0	89.7	37.0	0.24	1.5	0.3	0.00	0
Tea	0.0	0.0	0.0	100.0	33.0	0.00	0.0	0.0	0.00	0
Tomato	0.0	0.0	0.0	94.5	26.0	0.14	0.9	0.2	0.00	0
White sweet potato	0.0	0.0	0.0	76.0	97.0	0.21	1.3	0.1	0.00	0
Yeast, baking powder, bicarbonate of soda	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.00	0

65 rows × 44 columns

In [16]:
```
use = fct_new.index.intersection(qhat_new.columns)


nutrients = qhat_new[use]@fct_new.loc[use,:]
nutrients.mean()    # NB: Nutrients are for past /week/ for entire household
```

Out[16]:

	n
Code	0.000000
Food Group	0.000000
Reference	10.552447
Mois	247.206671
Energy	1970.042784
N	4.940732
Prot	34.134828
Fat	30.968030
SAFA	7.914427
MUFA	2.239845
PUFA	5.677289
Chol	0.000000
CHO	399.852968
CHO,	391.376650
Total	2.234706
Added	0.045688
Fiber	9.020798
Starch	0.000000
Ash	5.553262
Ca	1880.506421
Fe	395.501729
Mg	1155.878783
P	1626.386086
K	1788.926872
Na	665.130776
Zn	123.374043
Cu	8.411425
Mn	3486.366564
I	1078.466345
Se	15.954224
VitA-RAE	458.354210
VitA-RE	0.294975
Thia	0.954175
Ribo	0.235417
Niac	2.051771
Vit B6	2.595133
Folate	184.734044
Vit B12	8.883141
Panto	2.588773
Biot	0.000000
Vit C	55.579498
Vit D	0.000000
Vit E	13.425250
Phytate	0.650252

dtype: float64

Household Nutritional Adequacy

Our data on demand and nutrients is at the *household* level; we can't directly compare household level nutrition with individual level requirements. What we **can** do is add up minimum individual requirements, and see whether household total exceed these. This isn't a guarantee that all individuals have adequate nutrition (since the way food is

allocated in the household might be quite unequal, or unrelated to individual requirements), but it is *necessary* if all individuals are to have adequate nutrition.

For each household, we know the numbers of people in different age-sex categories. We can match these up with data from an RDI (Recommended Dietary Intakes), then sum over different types.

In [17]:
```
rdi
z
```

Out[17]:

			k	M 0-3	M 4-8	M 9-13	M 14-18	M 19-30	M 31-50	M 51+	F 0-3	F 4-8	F 9-13	F 14-18	F 19-30	F 31-50	5
i	t	m															
20603082292	2004	Malawi		0	0	0	0	0	0	0	0	1	0	0	0	0	
10305002355	2004	Malawi		0	0	1	0	0	0	0	0	0	0	0	0	1	
20605005127	2004	Malawi		0	1	0	1	0	0	0	0	0	1	0	0	0	
30203022161	2004	Malawi		0	0	0	0	0	0	1	0	0	0	0	2	0	
10505013106	2004	Malawi		0	1	0	0	3	0	1	0	0	1	2	0	1	
...	...	...		...	...	...	...	...	...	...	...	...	...	...	...	...	
30603016046	2004	Malawi		0	0	0	0	0	0	0	1	0	0	0	1	0	
20421804160	2004	Malawi		0	0	0	0	1	1	0	1	0	0	0	1	0	
30540007060	2004	Malawi		0	0	0	0	1	0	0	1	1	0	0	1	0	
30105009078	2004	Malawi		0	0	0	0	0	0	0	0	0	1	1	0	0	
30602004063	2004	Malawi		0	1	0	1	1	0	1	0	0	0	0	1	0	

2500 rows × 14 columns

In [18]:
```
rdi = rdi.rename(columns={'F 00-03':'F 0-3', 'M 00-03':'M 0-3',
                          'F 04-08':'F 4-8', 'M 04-08':'M 4-8',
                          'F 09-13':'F 9-13', 'M 09-13':'M 9-13'})
```

In [25]:
```
z = z[rdi.columns.tolist()]

hh_rdi = z@rdi.T


hh_rwi = hh_rdi*7
```

Now, what proportion of `hh_rwi` do households consume?

In [20]:
```
# Match up nutrient names
use = nutrients.columns.intersection(hh_rwi.columns)

nutrient_ratio = (nutrients[use]/hh_rwi[use]).dropna()
```

```
nutrient_ratio
```

Out[20]:

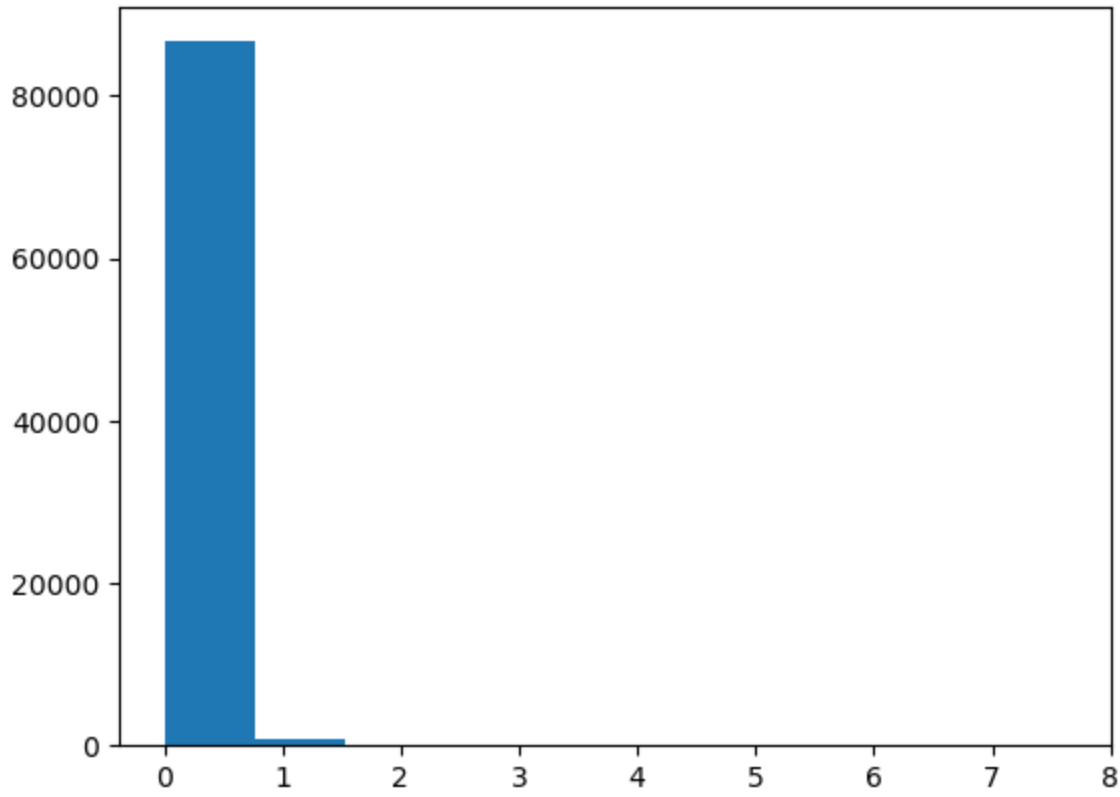
t	m	n i	Energy	Fiber	Folate
2004	Malawi	10204801041	0.000000	0.000000	0.000000
		10204801041	0.000000	0.000000	0.000000
		10204801041	0.254929	0.057558	0.030474
		10204801041	0.001120	0.003693	0.003361
		10204801041	0.000840	0.002770	0.002521
		...	...	...	...
		31202044020	0.005932	0.019558	0.016257
		31202044020	0.000847	0.002794	0.002322
		31202044020	0.000000	0.000000	0.000000
		31202044020	0.000000	0.000000	0.000000
		31202044020	0.007515	0.046422	0.187152

87660 rows × 3 columns

Graph ratios of adequacy for particular nutrients

In [24]:
```
import matplotlib.pyplot as plt
#%matplotlib notebook
plt.hist(nutrient_ratio['Energy'])
```

Out[24]:
```
(array([8.6696e+04, 7.7600e+02, 1.4300e+02, 1.9000e+01, 8.0000e+00,
        1.6000e+01, 1.0000e+00, 0.0000e+00, 0.0000e+00, 1.0000e+00]),
 array([0.        , 0.76248305, 1.5249661 , 2.28744915, 3.0499322 ,
        3.81241526, 4.57489831, 5.33738136, 6.09986441, 6.86234746,
        7.62483051]),
 <BarContainer object of 10 artists>)
```



In [ ]: