

```
In [1]: !pip install --proxy=http://internet.ford.com:83 pyreadstat
```

```
Requirement already satisfied: pyreadstat in /opt/conda/lib/python3.7/site-packages (1.2.0)
Requirement already satisfied: pandas>=1.2.0 in /opt/conda/lib/python3.7/site-packages (from pyreadstat) (1.3.5)
Requirement already satisfied: python-dateutil>=2.7.3 in /opt/conda/lib/python3.7/site-packages (from pandas>=1.2.0->pyreadstat) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in /opt/conda/lib/python3.7/site-packages (from pandas>=1.2.0->pyreadstat) (2022.5)
Requirement already satisfied: numpy>=1.17.3 in /opt/conda/lib/python3.7/site-packages (from pandas>=1.2.0->pyreadstat) (1.21.6)
Requirement already satisfied: six>=1.5 in /opt/conda/lib/python3.7/site-packages (from python-dateutil>=2.7.3->pandas>=1.2.0->pyreadstat) (1.16.0)
```

```
In [2]: !pip install --proxy=http://internet.ford.com:83 gaminet
```

Requirement already satisfied: gaminet in /opt/conda/lib/python3.7/site-packages (0.5.8)

Requirement already satisfied: scikit-learn>=0.23.0 in /opt/conda/lib/python3.7/site-packages (from gaminet) (1.0.2)

Requirement already satisfied: matplotlib>=3.1.3 in /opt/conda/lib/python3.7/site-packages (from gaminet) (3.5.3)

Requirement already satisfied: tensorflow-lattice>=2.0.8 in /opt/conda/lib/python3.7/site-packages (from gaminet) (2.0.11)

Requirement already satisfied: numpy>=1.15.2 in /opt/conda/lib/python3.7/site-packages (from gaminet) (1.21.6)

Requirement already satisfied: tensorflow>=2.0.0 in /opt/conda/lib/python3.7/site-packages (from gaminet) (2.10.0)

Requirement already satisfied: pandas>=0.19.2 in /opt/conda/lib/python3.7/site-packages (from gaminet) (1.3.5)

Requirement already satisfied: fonttools>=4.22.0 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (4.38.0)

Requirement already satisfied: kiwisolver>=1.0.1 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (1.4.4)

Requirement already satisfied: pillow>=6.2.0 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (9.2.0)

Requirement already satisfied: pyparsing>=2.2.1 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (3.0.9)

Requirement already satisfied: cyclor>=0.10 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (0.11.0)

Requirement already satisfied: python-dateutil>=2.7 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (2.8.2)

Requirement already satisfied: packaging>=20.0 in /opt/conda/lib/python3.7/site-packages (from matplotlib>=3.1.3->gaminet) (21.3)

Requirement already satisfied: pytz>=2017.3 in /opt/conda/lib/python3.7/site-packages (from pandas>=0.19.2->gaminet) (2022.5)

Requirement already satisfied: joblib>=0.11 in /opt/conda/lib/python3.7/site-packages (from scikit-learn>=0.23.0->gaminet) (1.2.0)

Requirement already satisfied: threadpoolctl>=2.0.0 in /opt/conda/lib/python3.7/site-packages (from scikit-learn>=0.23.0->gaminet) (3.1.0)

Requirement already satisfied: scipy>=1.1.0 in /opt/conda/lib/python3.7/site-packages (from scikit-learn>=0.23.0->gaminet) (1.7.3)

Requirement already satisfied: grpcio<2.0,>=1.24.3 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (1.50.0)

Requirement already satisfied: tensorflow-estimator<2.11,>=2.10.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (2.10.0)

Requirement already satisfied: libclang>=13.0.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (14.0.6)

Requirement already satisfied: wrapt>=1.11.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (1.14.1)

Requirement already satisfied: protobuf<3.20,>=3.9.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (3.19.6)

Requirement already satisfied: typing-extensions>=3.6.6 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (4.4.0)

Requirement already satisfied: flatbuffers>=2.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (22.10.26)

Requirement already satisfied: h5py>=2.9.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (3.7.0)

Requirement already satisfied: keras<2.11,>=2.10.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (2.10.0)

Requirement already satisfied: google-pasta>=0.1.1 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (0.2.0)

Requirement already satisfied: keras-preprocessing>=1.1.1 in /opt/conda/lib/python3.

```

7/site-packages (from tensorflow>=2.0.0->gaminet) (1.1.2)
Requirement already satisfied: astunparse>=1.6.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (1.6.3)
Requirement already satisfied: six>=1.12.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (1.16.0)
Requirement already satisfied: gast<=0.4.0,>=0.2.1 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (0.4.0)
Requirement already satisfied: tensorboard<2.11,>=2.10 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (2.10.1)
Requirement already satisfied: termcolor>=1.1.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (2.1.0)
Requirement already satisfied: absl-py>=1.0.0 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (1.3.0)
Requirement already satisfied: setuptools in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (59.8.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (0.27.0)
Requirement already satisfied: opt-einsum>=2.3.2 in /opt/conda/lib/python3.7/site-packages (from tensorflow>=2.0.0->gaminet) (3.3.0)
Requirement already satisfied: graphviz in /opt/conda/lib/python3.7/site-packages (from tensorflow-lattice>=2.0.8->gaminet) (0.20.1)
Requirement already satisfied: dm-sonnet in /opt/conda/lib/python3.7/site-packages (from tensorflow-lattice>=2.0.8->gaminet) (2.0.0)
Requirement already satisfied: wheel<1.0,>=0.23.0 in /opt/conda/lib/python3.7/site-packages (from astunparse>=1.6.0->tensorflow>=2.0.0->gaminet) (0.37.1)
Requirement already satisfied: requests<3,>=2.21.0 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (2.28.1)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (0.6.1)
Requirement already satisfied: markdown>=2.6.8 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (3.4.1)
Requirement already satisfied: werkzeug>=1.0.1 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (2.2.2)
Requirement already satisfied: google-auth<3,>=1.6.3 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (2.13.0)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (0.4.6)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /opt/conda/lib/python3.7/site-packages (from tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (1.8.1)
Requirement already satisfied: dm-tree>=0.1.1 in /opt/conda/lib/python3.7/site-packages (from dm-sonnet->tensorflow-lattice>=2.0.8->gaminet) (0.1.7)
Requirement already satisfied: tabulate>=0.7.5 in /opt/conda/lib/python3.7/site-packages (from dm-sonnet->tensorflow-lattice>=2.0.8->gaminet) (0.9.0)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /opt/conda/lib/python3.7/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (0.2.7)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in /opt/conda/lib/python3.7/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (5.2.0)
Requirement already satisfied: rsa<5,>=3.1.4 in /opt/conda/lib/python3.7/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (4.9)
Requirement already satisfied: requests-oauthlib>=0.7.0 in /opt/conda/lib/python3.7/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (1.3.1)

```

Requirement already satisfied: importlib-metadata>=4.4 in /opt/conda/lib/python3.7/site-packages (from markdown>=2.6.8->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (4.11.4)

Requirement already satisfied: certifi>=2017.4.17 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (2022.9.24)

Requirement already satisfied: urllib3<1.27,>=1.21.1 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (1.26.11)

Requirement already satisfied: charset-normalizer<3,>=2 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (2.1.1)

Requirement already satisfied: idna<4,>=2.5 in /opt/conda/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (3.4)

Requirement already satisfied: MarkupSafe>=2.1.1 in /opt/conda/lib/python3.7/site-packages (from werkzeug>=1.0.1->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (2.1.1)

Requirement already satisfied: zipp>=0.5 in /opt/conda/lib/python3.7/site-packages (from importlib-metadata>=4.4->markdown>=2.6.8->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (3.10.0)

Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /opt/conda/lib/python3.7/site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (0.4.8)

Requirement already satisfied: oauthlib>=3.0.0 in /opt/conda/lib/python3.7/site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.11,>=2.10->tensorflow>=2.0.0->gaminet) (3.2.2)

In [3]: !pip install --proxy=http://internet.ford.com:83 xlwt

Requirement already satisfied: xlwt in /opt/conda/lib/python3.7/site-packages (1.3.0)

```
In [4]: import pandas as pd
import numpy as np
import pyreadstat
import re
import os

import tensorflow as tf
import json
from sklearn.preprocessing import MinMaxScaler, OrdinalEncoder
from sklearn.model_selection import train_test_split
from sklearn.metrics import r2_score, roc_auc_score

from gaminet import GAMINet
from gaminet.utils import local_visualize
from gaminet.utils import global_visualize_density
from gaminet.utils import feature_importance_visualize
from gaminet.utils import plot_trajectory
from gaminet.utils import plot_regularization
```

```

2022-11-03 22:01:17.448970: I tensorflow/core/platform/cpu_feature_guard.cc:193] This
TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to us
e the following CPU instructions in performance-critical operations:  AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler
flags.
2022-11-03 22:01:21.566046: E tensorflow/stream_executor/cuda/cuda_blas.cc:2981] Unab
le to register cuBLAS factory: Attempting to register factory for plugin cuBLAS when
one has already been registered
2022-11-03 22:01:27.432583: W tensorflow/stream_executor/platform/default/dso_loader.
cc:64] Could not load dynamic library 'libnvinfer.so.7'; dlerror: libnvinfer.so.7: ca
nnot open shared object file: No such file or directory; LD_LIBRARY_PATH: /usr/local/
cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64
2022-11-03 22:01:27.432737: W tensorflow/stream_executor/platform/default/dso_loader.
cc:64] Could not load dynamic library 'libnvinfer_plugin.so.7'; dlerror: libnvinfer_p
lugin.so.7: cannot open shared object file: No such file or directory; LD_LIBRARY_PAT
H: /usr/local/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64
2022-11-03 22:01:27.432749: W tensorflow/compiler/tf2tensorrt/utils/py_utils.cc:38] T
F-TRT Warning: Cannot dlopen some TensorRT libraries. If you would like to use Nvidia
GPU with TensorRT, please make sure the missing libraries mentioned above are install
ed properly.

```

```

In [5]: df, meta = pyreadstat.read_sas7bdat('uk_comm_pttrans_data.sas7bdat')
print(df.values.shape)

(20980, 83)

```

```

In [6]: cols = meta.column_names
# temp_df = (df.mean() >= 1)
# print(temp_df.values.shape)
date_cols = [i for i in cols if "date" in i]
print(date_cols)
# print(df[date_cols].value_counts())
# print(*cols, sep="\n")

['applic_date', 'purchase_date', 'date_into_lru']

```

```

In [7]: def cat_or_num(col):
    if(df["odefind_new"].value_counts().shape[0] == 2):
        return {"type":"categorical"}
    else:
        return {"type":"continuous"}

meta_info = {}
col_odefind1 = None
for col in sorted(cols):
    if(col != "odefind1" and col not in date_cols):
        meta_info[col] = cat_or_num(col)
    else:
        try:
            req = df.pop(col)
            if(col == "odefind1"):
                df["odefind1"] = req
        except Exception:
            print("Already popped")
meta_info["odefind1"] = {"type":"target"}
print(meta_info)
print(len(meta_info))

```

```
{'acidtest_1': {'type': 'categorical'}, 'advance_pct': {'type': 'categorical'}, 'avgt
erm': {'type': 'categorical'}, 'balloon_amt': {'type': 'categorical'}, 'balloon_ind':
{'type': 'categorical'}, 'business': {'type': 'categorical'}, 'capitalemployed_1':
{'type': 'categorical'}, 'ccjtoshtotl24m_1': {'type': 'categorical'}, 'compage_1':
{'type': 'categorical'}, 'compavgdbt_12mth_1': {'type': 'categorical'}, 'compavgdbt_3
mth_1': {'type': 'categorical'}, 'compavgdbt_6mth_1': {'type': 'categorical'}, 'compd
bt_1': {'type': 'categorical'}, 'compnumdbt_100000_1': {'type': 'categorical'}, 'comp
numdbt_10000_1': {'type': 'categorical'}, 'compunpaccs_1': {'type': 'categorical'},
'country': {'type': 'categorical'}, 'creditlimit_1': {'type': 'categorical'}, 'curren
tliabilitiestotal_1': {'type': 'categorical'}, 'curtoprevdir1st12mth_1': {'type': 'ca
tegorical'}, 'dl12_regnumber_1': {'type': 'categorical'}, 'dl41_supppaypattn_1': {'ty
pe': 'categorical'}, 'dl77_creditrating_1': {'type': 'categorical'}, 'dl80_region_1':
{'type': 'categorical'}, 'dl80_siccode1992_1': {'type': 'categorical'}, 'equitygear_
1': {'type': 'categorical'}, 'exposure': {'type': 'categorical'}, 'final_term': {'typ
e': 'categorical'}, 'grossassets_1': {'type': 'categorical'}, 'indavgdbt_12mth_1':
{'type': 'categorical'}, 'indavgdbt_3mth_1': {'type': 'categorical'}, 'indavgdbt_6mth
_1': {'type': 'categorical'}, 'inddb1': {'type': 'categorical'}, 'indexpmth_1': {'t
ype': 'categorical'}, 'lru_mth': {'type': 'categorical'}, 'lru_qtr': {'type': 'catego
rical'}, 'numccjlast12_1': {'type': 'categorical'}, 'numcc1s_1': {'type': 'categorica
l'}, 'numcurdirs_1': {'type': 'categorical'}, 'numdirwshares_1': {'type': 'categorica
l'}, 'numprevsrchs_12mths_1': {'type': 'categorical'}, 'numprevsrchs_3mths_1': {'typ
e': 'categorical'}, 'numprevsrchs_6mths_1': {'type': 'categorical'}, 'numsatmortchrg
s_1': {'type': 'categorical'}, 'numunpaidacctslstmth_1': {'type': 'categorical'}, 'nu
mysacctsavail_1': {'type': 'categorical'}, 'numyspretaxproflst4yrs_1': {'type': 'ca
tegorical'}, 'odefind_new': {'type': 'categorical'}, 'percappts1st12mth_1': {'type':
'categorical'}, 'perccapemploftotassts_1': {'type': 'categorical'}, 'percchngecapempl
d_1': {'type': 'categorical'}, 'percchngecurratio_1': {'type': 'categorical'}, 'perc
hngeshfunds_1': {'type': 'categorical'}, 'percchngetotassts_1': {'type': 'categorica
l'}, 'perccurliaboftotassts_1': {'type': 'categorical'}, 'percfasstsoftotassts_1':
{'type': 'categorical'}, 'percstockofcurassts_1': {'type': 'categorical'}, 'phwt':
{'type': 'categorical'}, 'phwtaa': {'type': 'categorical'}, 'phwtdf': {'type': 'categ
orical'}, 'ppavcurrdbt_1': {'type': 'categorical'}, 'product': {'type': 'categorica
l'}, 'product2': {'type': 'categorical'}, 'purch_mth': {'type': 'categorical'}, 'purc
h_qtr': {'type': 'categorical'}, 'riskscore_1': {'type': 'categorical'}, 'scol_pop_fi
nal': {'type': 'categorical'}, 'scope_refno': {'type': 'categorical'}, 'shorttermloan
s_1': {'type': 'categorical'}, 'sic92_2': {'type': 'categorical'}, 'sincelastacctssub
mtd_1': {'type': 'categorical'}, 'sincelastretnssubmtd_1': {'type': 'categorical'},
'slife_km': {'type': 'categorical'}, 'term': {'type': 'categorical'}, 'term_ds': {'ty
pe': 'categorical'}, 'time_in_business': {'type': 'categorical'}, 'totallongtermliabi
lities_1': {'type': 'categorical'}, 'totassets_1': {'type': 'categorical'}, 'vehicle_
age': {'type': 'categorical'}, 'odefind1': {'type': 'target'}}
```

80

```
In [8]: nan_cols = pd.DataFrame(df.isna().sum())
nan100_cols = pd.DataFrame(df.isna().sum()*100/df.values.shape[0])
print(nan100_cols)
nan_df = pd.concat([nan_cols, nan100_cols], axis=1, join='inner')
print(nan_df)
nan_df.to_excel("information.xls", sheet_name="Nan_Columns")
```

```

0
scope_refno      0.000000
advance_pct      0.000000
balloon_amt      0.000000
final_term       0.000000
time_in_business 0.000000
...
percapptslst12mth_1 0.934223
numcccls_1        0.934223
compunpaccs_1     28.517636
numunpaidaccts1stmth_1 3.112488
odefind1          0.000000

[80 rows x 1 columns]

0      0
scope_refno      0  0.000000
advance_pct      0  0.000000
balloon_amt      0  0.000000
final_term       0  0.000000
time_in_business 0  0.000000
...
percapptslst12mth_1 196  0.934223
numcccls_1        196  0.934223
compunpaccs_1     5983 28.517636
numunpaidaccts1stmth_1 653 3.112488
odefind1          0  0.000000

[80 rows x 2 columns]

```

/opt/conda/lib/python3.7/site-packages/ipykernel_launcher.py:6: FutureWarning: As the xlwt package is no longer maintained, the xlwt engine will be removed in a future version of pandas. This is the only engine in pandas that supports writing in the xls format. Install openpyxl and write to an xlsx file instead. You can set the option io.excel.xls.writer to 'xlwt' to silence this warning. While this option is deprecated and will also raise a warning, it can be globally set and the warning suppressed.

Imputing and Removing specified columns:

1. Remove `compnumdbt_100000_1` and `scope_refno`
2. Imputing remaining

```

In [9]: remove_cols = ["compnumdbt_100000_1", "scope_refno"]
try:
    for i in remove_cols:
        meta_info.pop(i)
        df.pop(i)
except Exception:
    print("Already popped")
print(df.values.shape, len(meta_info))

(20980, 78) 78

```

```

In [10]: # Imputed!!
for i, (key, value) in enumerate(meta_info.items()):
    if(value["type"] == "categorical"):
        df[key].fillna(df[key].mode()[0], inplace=True)

```

```

else:
    df[key].fillna(df[key].mean(), inplace=True)

```

```

In [11]: x, y = df.iloc[:, :-1].values, df.iloc[:, [-1]].values

print(x.shape, y.shape)

xx = np.zeros((x.shape[0], x.shape[1]), dtype=np.float32)
for i, (key, item) in enumerate(meta_info.items()):
    if item['type'] == 'target':
        sy = MinMaxScaler((0,1))
        y = sy.fit_transform(y)
        meta_info[key]['scaler'] = sy
    elif item['type'] == 'categorical':
        enc = OrdinalEncoder()
        xx[:, [i]] = enc.fit_transform(x[:, [i]])
        meta_info[key]['values'] = []
        for item in enc.categories_[0].tolist():
            try:
                if item == int(item):
                    meta_info[key]['values'].append(str(int(item)))
                else:
                    meta_info[key]['values'].append(str(item))
            except ValueError:
                meta_info[key]['values'].append(str(item))
    else:
        sx = MinMaxScaler((0, 1))
        xx[:, [i]] = sx.fit_transform(x[:, [i]])
        meta_info[key]['scaler'] = sx

task_type = 'Regression'
train_x, test_x, train_y, test_y = train_test_split(xx.astype(np.float32), y, test_size=0.2)
print(train_x.shape, train_y.shape)

```

```

(20980, 77) (20980, 1)
(14686, 77) (14686, 1)

```

```

In [12]: def metric_wrapper(metric, scaler):
    def wrapper(label, pred):
        return metric(label, pred, scaler=scaler)
    return wrapper

def ras(label, pred, scaler=None):
    return r2_score(label, pred)

get_metric = metric_wrapper(ras, None)

```

```

=====

```

```

In [13]: model = GAMINet(meta_info=meta_info, interact_num=30,
    interact_arch=[100] * 5, subnet_arch=[100] * 5,
    batch_size=100, task_type=task_type, activation_func=tf.nn.relu,
    main_effect_epochs=50, interaction_epochs=50, tuning_epochs=100,
    lr_bp=[0.0001, 0.0001, 0.0001], early_stop_thres=[50, 50, 50],
    heredity=True, loss_threshold=0.01, reg_clarity=0.1,
    mono_increasing_list=[], mono_decreasing_list=[], ## the indices list
    verbose=True, val_ratio=0.2, random_state=0)

```



```
model.fit(train_x, train_y)
```

```
2022-11-03 22:01:38.287403: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:98
0] successful NUMA node read from SysFS had negative value (-1), but there must be at
least one NUMA node, so returning NUMA node zero
2022-11-03 22:01:38.335063: W tensorflow/stream_executor/platform/default/dso_loader.
cc:64] Could not load dynamic library 'libcusolver.so.11'; dlerror: libcusolver.so.1
1: cannot open shared object file: No such file or directory; LD_LIBRARY_PATH: /usr/l
ocal/cuda/lib64:/usr/local/nccl2/lib:/usr/local/cuda/extras/CUPTI/lib64
2022-11-03 22:01:38.343833: W tensorflow/core/common_runtime/gpu/gpu_device.cc:1934]
Cannot dlopen some GPU libraries. Please make sure the missing libraries mentioned ab
ove are installed properly if you would like to use GPU. Follow the guide at https://
www.tensorflow.org/install/gpu for how to download and setup the required libraries f
or your platform.
Skipping registering GPU devices...
2022-11-03 22:01:38.374650: I tensorflow/core/platform/cpu_feature_guard.cc:193] This
TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to us
e the following CPU instructions in performance-critical operations: AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler
flags.
```

```
#####GAMI-Net training start.#####
#####Stage 1: main effect training start.#####
Main effects training epoch: 1, train loss: 0.83310, val loss: 0.83401
Main effects training epoch: 2, train loss: 0.63944, val loss: 0.64192
Main effects training epoch: 3, train loss: 0.44092, val loss: 0.44475
Main effects training epoch: 4, train loss: 0.26800, val loss: 0.27261
Main effects training epoch: 5, train loss: 0.14116, val loss: 0.14575
Main effects training epoch: 6, train loss: 0.06432, val loss: 0.06823
Main effects training epoch: 7, train loss: 0.02665, val loss: 0.02959
Main effects training epoch: 8, train loss: 0.01196, val loss: 0.01404
Main effects training epoch: 9, train loss: 0.00724, val loss: 0.00871
Main effects training epoch: 10, train loss: 0.00580, val loss: 0.00694
Main effects training epoch: 11, train loss: 0.00525, val loss: 0.00623
Main effects training epoch: 12, train loss: 0.00493, val loss: 0.00584
Main effects training epoch: 13, train loss: 0.00467, val loss: 0.00556
Main effects training epoch: 14, train loss: 0.00446, val loss: 0.00535
Main effects training epoch: 15, train loss: 0.00429, val loss: 0.00517
Main effects training epoch: 16, train loss: 0.00413, val loss: 0.00502
Main effects training epoch: 17, train loss: 0.00399, val loss: 0.00489
Main effects training epoch: 18, train loss: 0.00386, val loss: 0.00477
Main effects training epoch: 19, train loss: 0.00373, val loss: 0.00466
Main effects training epoch: 20, train loss: 0.00362, val loss: 0.00456
Main effects training epoch: 21, train loss: 0.00351, val loss: 0.00447
Main effects training epoch: 22, train loss: 0.00340, val loss: 0.00437
Main effects training epoch: 23, train loss: 0.00330, val loss: 0.00429
Main effects training epoch: 24, train loss: 0.00319, val loss: 0.00421
Main effects training epoch: 25, train loss: 0.00309, val loss: 0.00412
Main effects training epoch: 26, train loss: 0.00299, val loss: 0.00403
Main effects training epoch: 27, train loss: 0.00289, val loss: 0.00396
Main effects training epoch: 28, train loss: 0.00279, val loss: 0.00388
Main effects training epoch: 29, train loss: 0.00270, val loss: 0.00380
Main effects training epoch: 30, train loss: 0.00260, val loss: 0.00373
Main effects training epoch: 31, train loss: 0.00251, val loss: 0.00365
Main effects training epoch: 32, train loss: 0.00241, val loss: 0.00358
Main effects training epoch: 33, train loss: 0.00232, val loss: 0.00351
Main effects training epoch: 34, train loss: 0.00222, val loss: 0.00344
Main effects training epoch: 35, train loss: 0.00214, val loss: 0.00338
Main effects training epoch: 36, train loss: 0.00204, val loss: 0.00330
Main effects training epoch: 37, train loss: 0.00195, val loss: 0.00322
Main effects training epoch: 38, train loss: 0.00185, val loss: 0.00314
Main effects training epoch: 39, train loss: 0.00176, val loss: 0.00311
Main effects training epoch: 40, train loss: 0.00167, val loss: 0.00300
Main effects training epoch: 41, train loss: 0.00158, val loss: 0.00294
Main effects training epoch: 42, train loss: 0.00149, val loss: 0.00289
Main effects training epoch: 43, train loss: 0.00141, val loss: 0.00282
Main effects training epoch: 44, train loss: 0.00133, val loss: 0.00277
Main effects training epoch: 45, train loss: 0.00124, val loss: 0.00271
Main effects training epoch: 46, train loss: 0.00116, val loss: 0.00266
Main effects training epoch: 47, train loss: 0.00109, val loss: 0.00257
Main effects training epoch: 48, train loss: 0.00101, val loss: 0.00255
Main effects training epoch: 49, train loss: 0.00093, val loss: 0.00250
Main effects training epoch: 50, train loss: 0.00086, val loss: 0.00244
#####Stage 1: main effect training stop.#####
#####Stage 2: interaction training start.#####
Interaction training epoch: 1, train loss: 0.00007, val loss: 0.00113
Interaction training epoch: 2, train loss: 0.00005, val loss: 0.00105
Interaction training epoch: 3, train loss: 0.00004, val loss: 0.00106
```

```
Interaction training epoch: 4, train loss: 0.00003, val loss: 0.00102
Interaction training epoch: 5, train loss: 0.00002, val loss: 0.00098
Interaction training epoch: 6, train loss: 0.00002, val loss: 0.00103
Interaction training epoch: 7, train loss: 0.00002, val loss: 0.00105
Interaction training epoch: 8, train loss: 0.00002, val loss: 0.00104
Interaction training epoch: 9, train loss: 0.00001, val loss: 0.00106
Interaction training epoch: 10, train loss: 0.00002, val loss: 0.00100
Interaction training epoch: 11, train loss: 0.00001, val loss: 0.00102
Interaction training epoch: 12, train loss: 0.00001, val loss: 0.00104
Interaction training epoch: 13, train loss: 0.00002, val loss: 0.00111
Interaction training epoch: 14, train loss: 0.00001, val loss: 0.00107
Interaction training epoch: 15, train loss: 0.00001, val loss: 0.00105
Interaction training epoch: 16, train loss: 0.00001, val loss: 0.00108
Interaction training epoch: 17, train loss: 0.00001, val loss: 0.00106
Interaction training epoch: 18, train loss: 0.00001, val loss: 0.00109
Interaction training epoch: 19, train loss: 0.00001, val loss: 0.00099
Interaction training epoch: 20, train loss: 0.00001, val loss: 0.00110
Interaction training epoch: 21, train loss: 0.00001, val loss: 0.00098
Interaction training epoch: 22, train loss: 0.00001, val loss: 0.00113
Interaction training epoch: 23, train loss: 0.00001, val loss: 0.00102
Interaction training epoch: 24, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 25, train loss: 0.00001, val loss: 0.00101
Interaction training epoch: 26, train loss: 0.00001, val loss: 0.00102
Interaction training epoch: 27, train loss: 0.00001, val loss: 0.00102
Interaction training epoch: 28, train loss: 0.00001, val loss: 0.00101
Interaction training epoch: 29, train loss: 0.00001, val loss: 0.00109
Interaction training epoch: 30, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 31, train loss: 0.00001, val loss: 0.00101
Interaction training epoch: 32, train loss: 0.00001, val loss: 0.00104
Interaction training epoch: 33, train loss: 0.00001, val loss: 0.00106
Interaction training epoch: 34, train loss: 0.00001, val loss: 0.00107
Interaction training epoch: 35, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 36, train loss: 0.00001, val loss: 0.00108
Interaction training epoch: 37, train loss: 0.00001, val loss: 0.00104
Interaction training epoch: 38, train loss: 0.00001, val loss: 0.00105
Interaction training epoch: 39, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 40, train loss: 0.00001, val loss: 0.00102
Interaction training epoch: 41, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 42, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 43, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 44, train loss: 0.00001, val loss: 0.00103
Interaction training epoch: 45, train loss: 0.00001, val loss: 0.00109
Interaction training epoch: 46, train loss: 0.00000, val loss: 0.00104
Interaction training epoch: 47, train loss: 0.00001, val loss: 0.00109
Interaction training epoch: 48, train loss: 0.00001, val loss: 0.00106
Interaction training epoch: 49, train loss: 0.00001, val loss: 0.00100
Interaction training epoch: 50, train loss: 0.00001, val loss: 0.00103
#####Stage 2: interaction training stop.#####
Fine tuning epoch: 1, train loss: 0.00001, val loss: 0.00109
Fine tuning epoch: 2, train loss: 0.00001, val loss: 0.00104
Fine tuning epoch: 3, train loss: 0.00001, val loss: 0.00102
Fine tuning epoch: 4, train loss: 0.00001, val loss: 0.00108
Fine tuning epoch: 5, train loss: 0.00000, val loss: 0.00103
Fine tuning epoch: 6, train loss: 0.00001, val loss: 0.00109
Fine tuning epoch: 7, train loss: 0.00000, val loss: 0.00103
Fine tuning epoch: 8, train loss: 0.00001, val loss: 0.00108
Fine tuning epoch: 9, train loss: 0.00000, val loss: 0.00107
```

```

Fine tuning epoch: 10, train loss: 0.00000, val loss: 0.00101
Fine tuning epoch: 11, train loss: 0.00001, val loss: 0.00102
Fine tuning epoch: 12, train loss: 0.00000, val loss: 0.00105
Fine tuning epoch: 13, train loss: 0.00000, val loss: 0.00107
Fine tuning epoch: 14, train loss: 0.00000, val loss: 0.00104
Fine tuning epoch: 15, train loss: 0.00000, val loss: 0.00105
Fine tuning epoch: 16, train loss: 0.00001, val loss: 0.00102
Fine tuning epoch: 17, train loss: 0.00000, val loss: 0.00106
Fine tuning epoch: 18, train loss: 0.00000, val loss: 0.00106
Fine tuning epoch: 19, train loss: 0.00000, val loss: 0.00106
Fine tuning epoch: 20, train loss: 0.00001, val loss: 0.00111
Fine tuning epoch: 21, train loss: 0.00000, val loss: 0.00105
Fine tuning epoch: 22, train loss: 0.00000, val loss: 0.00102
Fine tuning epoch: 23, train loss: 0.00000, val loss: 0.00110
Fine tuning epoch: 24, train loss: 0.00000, val loss: 0.00107
Fine tuning epoch: 25, train loss: 0.00000, val loss: 0.00108
Fine tuning epoch: 26, train loss: 0.00000, val loss: 0.00106
Fine tuning epoch: 27, train loss: 0.00000, val loss: 0.00106
Fine tuning epoch: 28, train loss: 0.00000, val loss: 0.00107
Fine tuning epoch: 29, train loss: 0.00000, val loss: 0.00106
Fine tuning epoch: 30, train loss: 0.00000, val loss: 0.00111
Fine tuning epoch: 31, train loss: 0.00000, val loss: 0.00109
Fine tuning epoch: 32, train loss: 0.00001, val loss: 0.00117
Fine tuning epoch: 33, train loss: 0.00001, val loss: 0.00116
Fine tuning epoch: 34, train loss: 0.00000, val loss: 0.00113
Fine tuning epoch: 35, train loss: 0.00000, val loss: 0.00110
Fine tuning epoch: 36, train loss: 0.00001, val loss: 0.00113
Fine tuning epoch: 37, train loss: 0.00000, val loss: 0.00115
Fine tuning epoch: 38, train loss: 0.00000, val loss: 0.00116
Fine tuning epoch: 39, train loss: 0.00000, val loss: 0.00112
Fine tuning epoch: 40, train loss: 0.00000, val loss: 0.00118
Fine tuning epoch: 41, train loss: 0.00000, val loss: 0.00117
Fine tuning epoch: 42, train loss: 0.00000, val loss: 0.00118
Fine tuning epoch: 43, train loss: 0.00000, val loss: 0.00119
Fine tuning epoch: 44, train loss: 0.00000, val loss: 0.00122
Fine tuning epoch: 45, train loss: 0.00001, val loss: 0.00116
Fine tuning epoch: 46, train loss: 0.00001, val loss: 0.00126
Fine tuning epoch: 47, train loss: 0.00001, val loss: 0.00124
Fine tuning epoch: 48, train loss: 0.00001, val loss: 0.00128
Fine tuning epoch: 49, train loss: 0.00001, val loss: 0.00129
Fine tuning epoch: 50, train loss: 0.00001, val loss: 0.00122
Fine tuning epoch: 51, train loss: 0.00001, val loss: 0.00136
Fine tuning epoch: 52, train loss: 0.00000, val loss: 0.00131
Fine tuning epoch: 53, train loss: 0.00000, val loss: 0.00133
Fine tuning epoch: 54, train loss: 0.00000, val loss: 0.00131
Fine tuning epoch: 55, train loss: 0.00001, val loss: 0.00138
Fine tuning epoch: 56, train loss: 0.00001, val loss: 0.00138
Fine tuning epoch: 57, train loss: 0.00001, val loss: 0.00143
Fine tuning epoch: 58, train loss: 0.00001, val loss: 0.00144
Fine tuning epoch: 59, train loss: 0.00001, val loss: 0.00142
Fine tuning epoch: 60, train loss: 0.00001, val loss: 0.00143
Fine tuning epoch: 61, train loss: 0.00001, val loss: 0.00147
Early stop at epoch 61, with validation loss: 0.00147
#####GAMI-Net training finished.#####

```

```

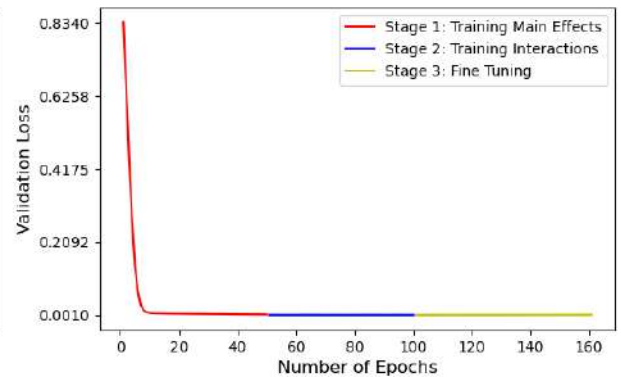
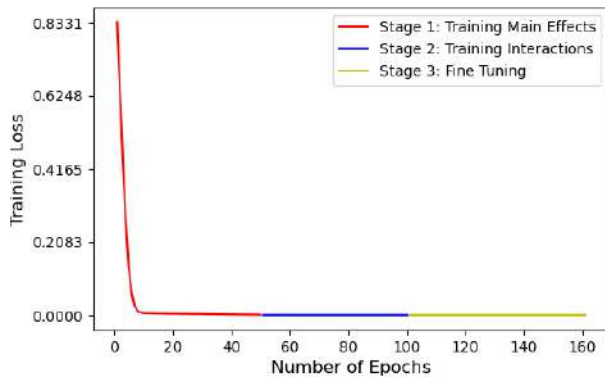
In [14]: folder = "./imgs/"
         if not os.path.exists(folder):

```

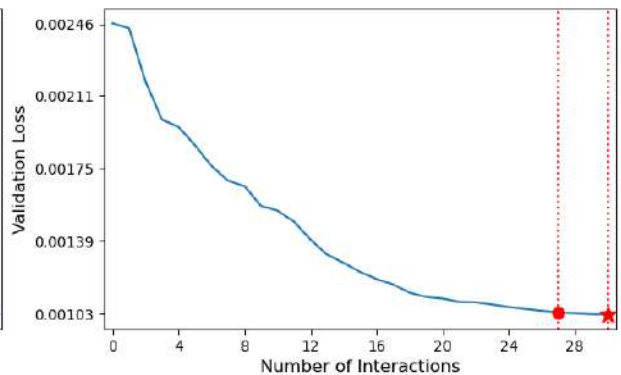
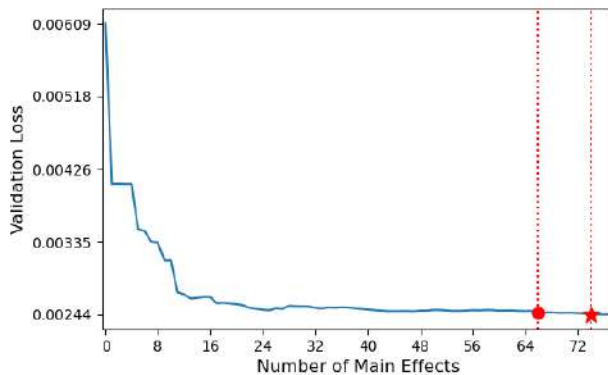
```

os.makedirs(folder)
data_dict_logs = model.summary_logs(save_dict=False)
plot_trajectory(data_dict_logs, folder=folder, name="DATASET_TRAJ", save_png=True, save_fig=True)
plot_regularization(data_dict_logs, folder=folder, name="DATASET_REGU", save_png=True, save_fig=True)

```



The PostScript backend does not support transparency; partially transparent artists will be rendered opaque.



```

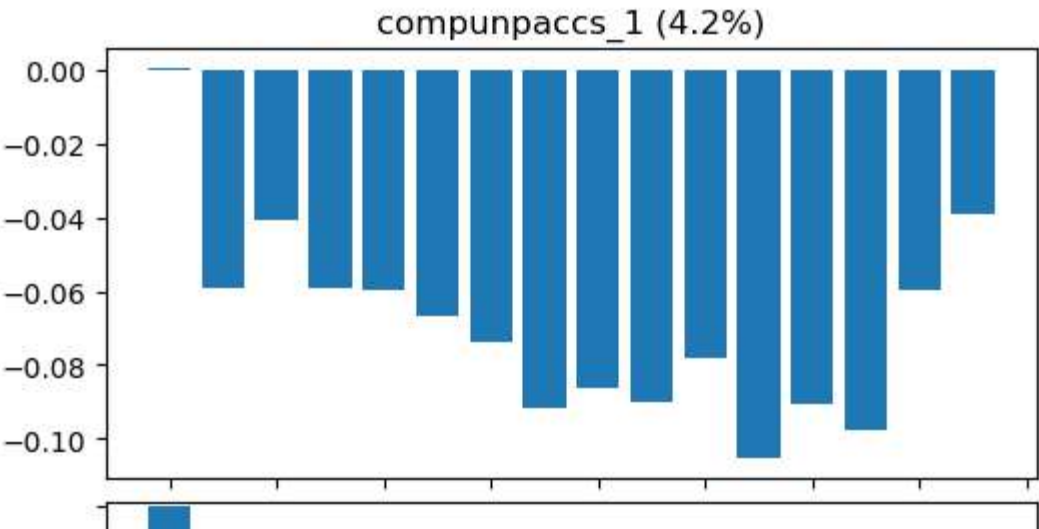
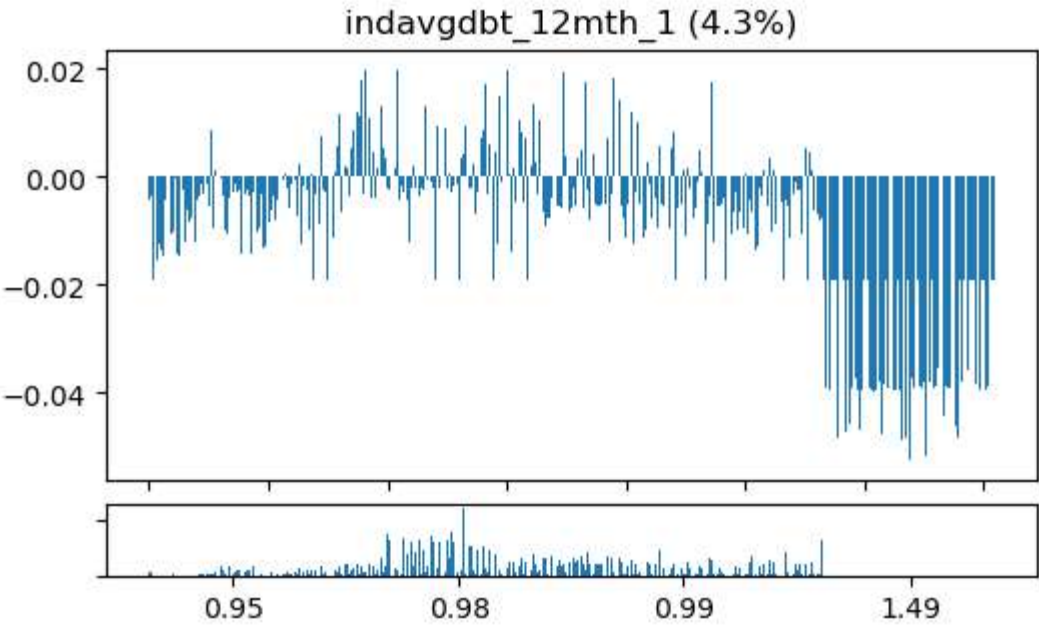
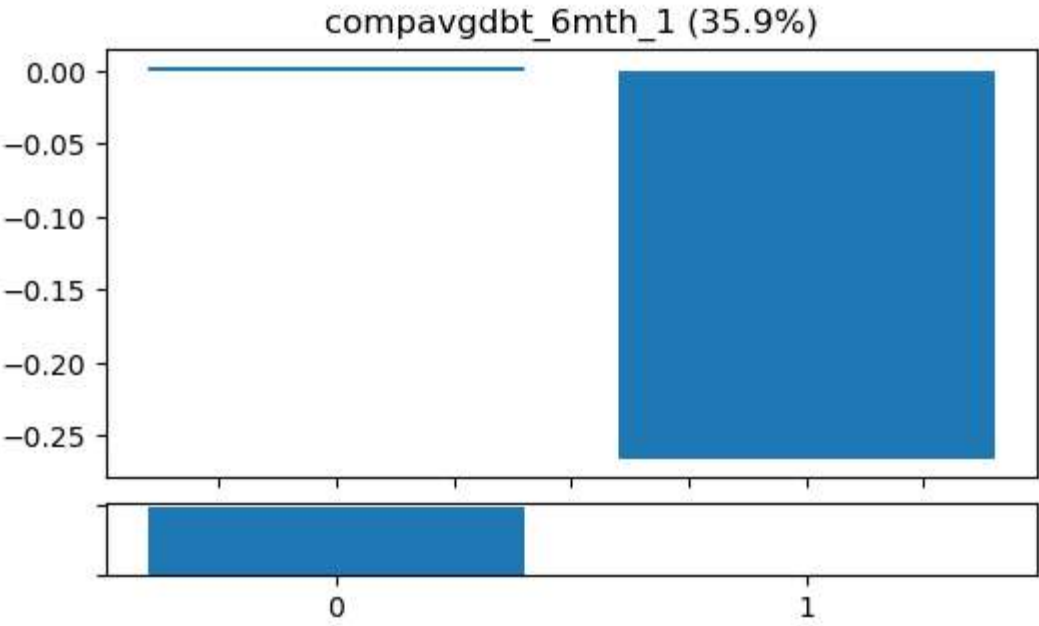
In [15]: data_dict_global = model.global_explain(save_dict=True, folder=folder, name="gaminet_global",
global_visualize_density(data_dict_global, folder=folder, name="gaminet_global", main_

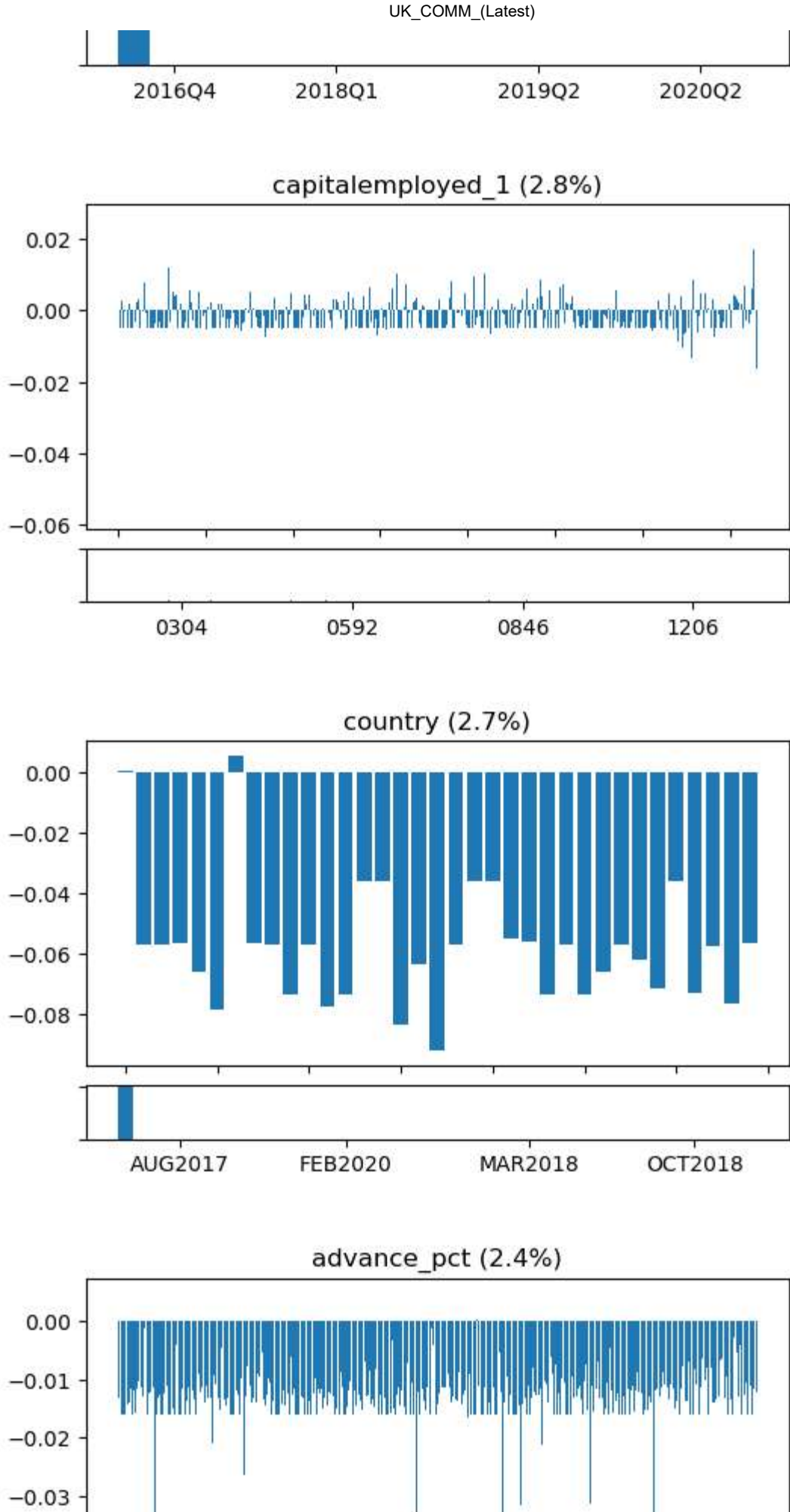
```

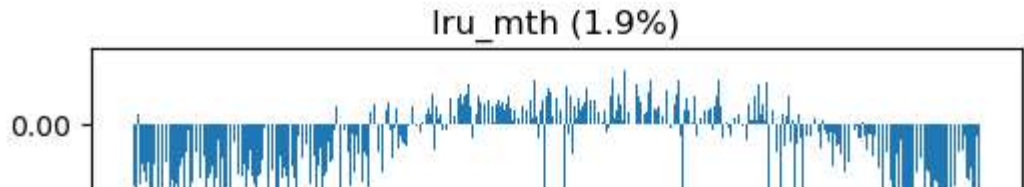
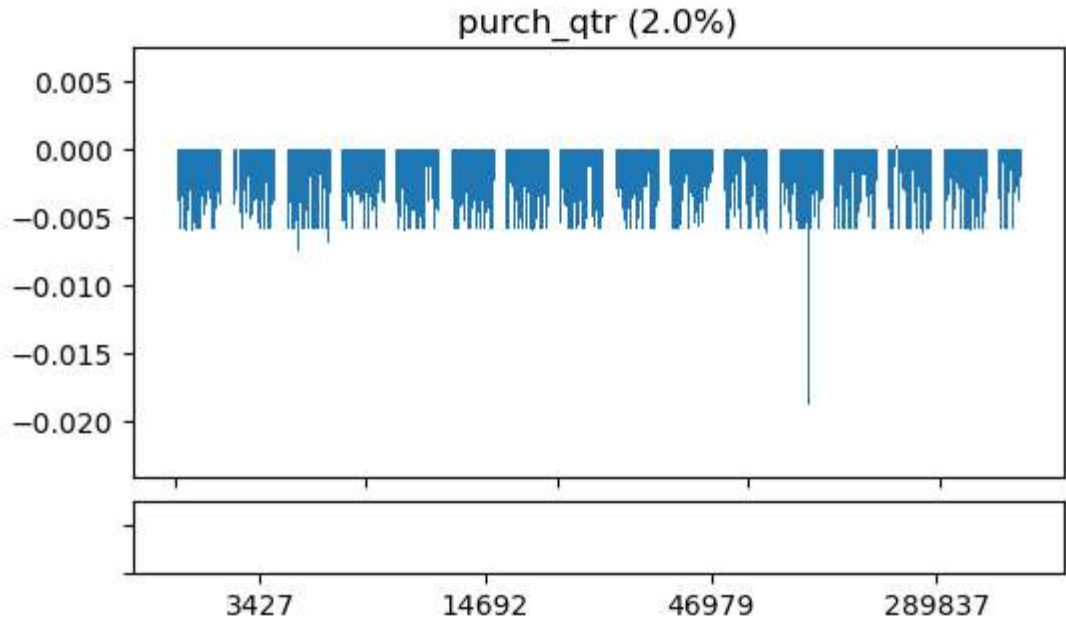
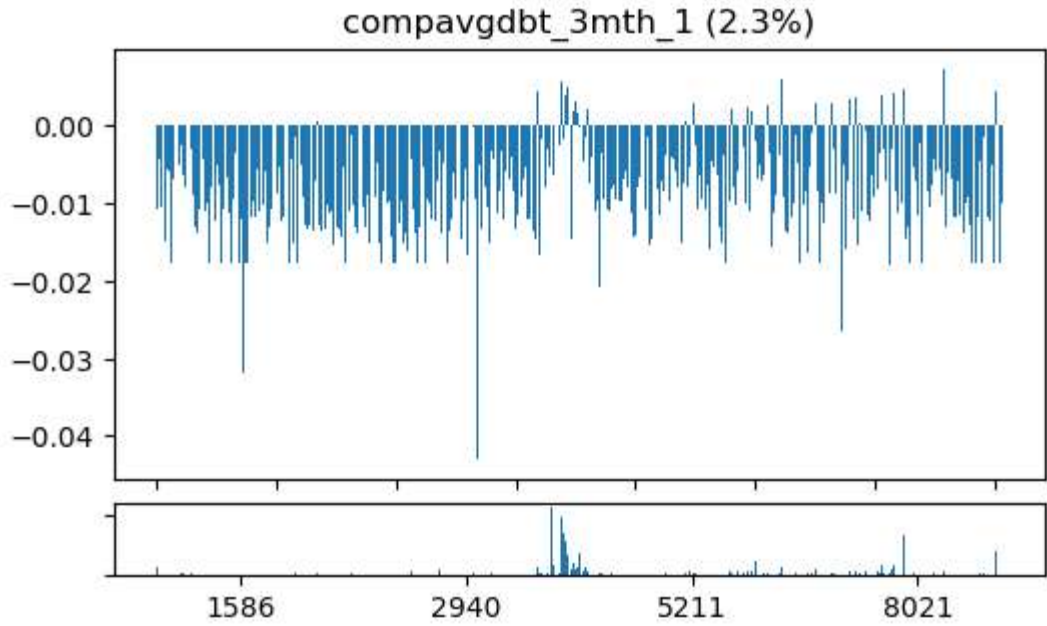
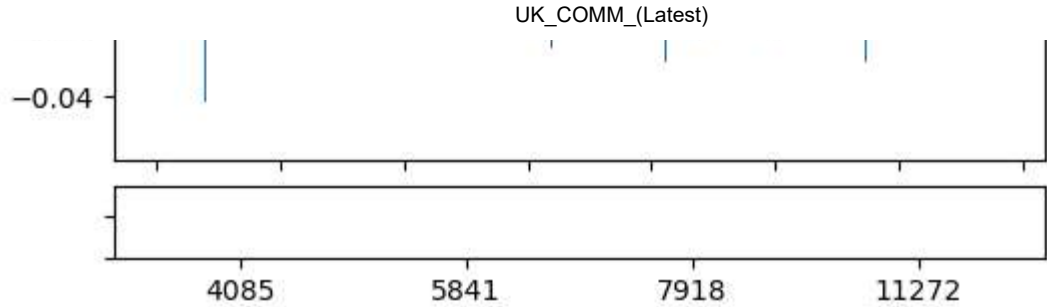
```

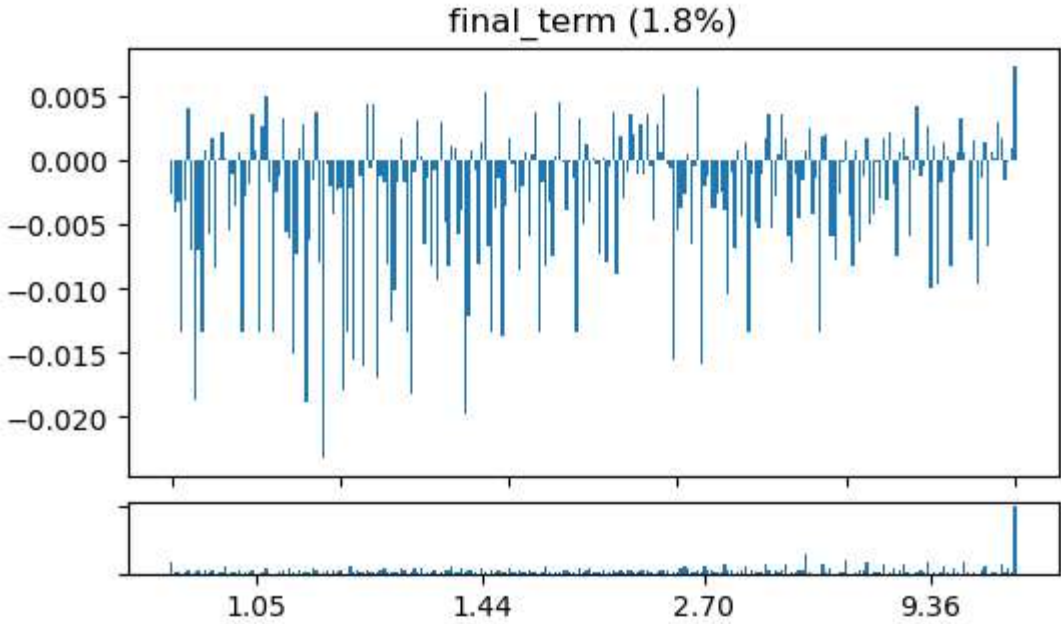
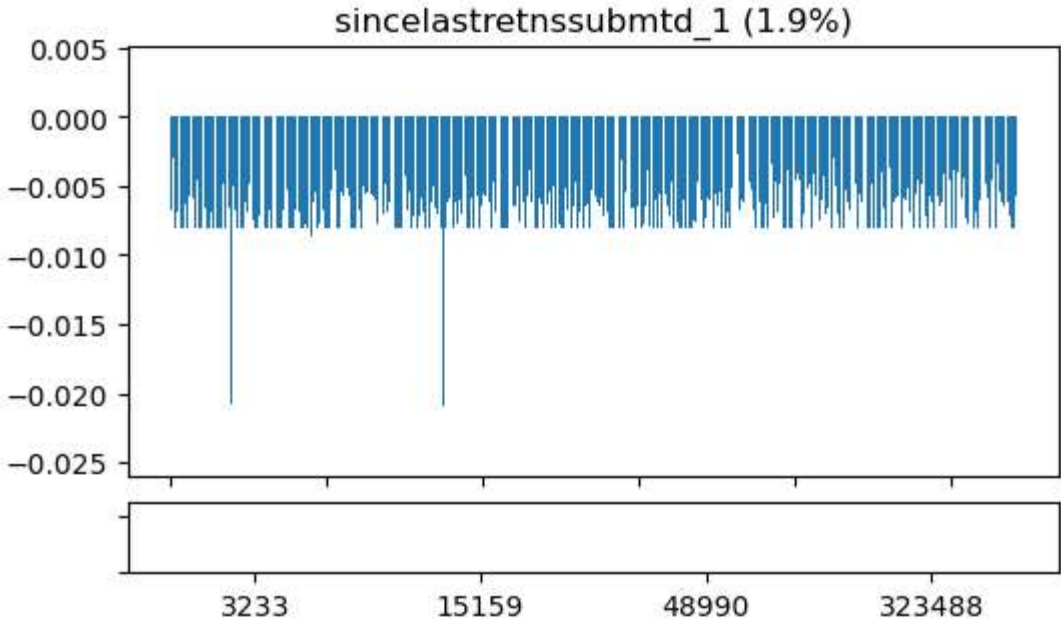
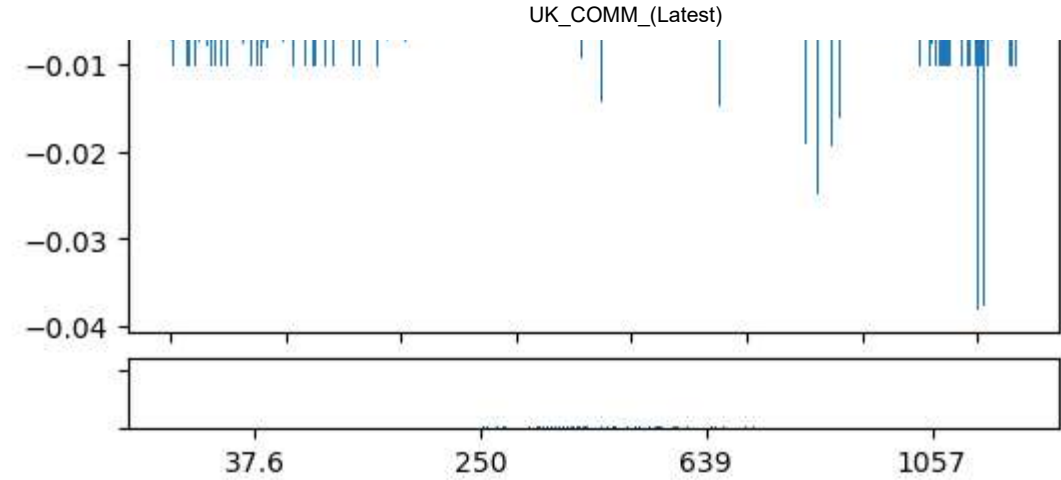
2022-11-03 23:22:01.638956: W tensorflow/core/framework/cpu_allocator_impl.cc:82] Allocation of 1914072192 exceeds 10% of free system memory.
2022-11-03 23:22:06.329700: W tensorflow/core/framework/cpu_allocator_impl.cc:82] Allocation of 1914319680 exceeds 10% of free system memory.
2022-11-03 23:22:11.565525: W tensorflow/core/framework/cpu_allocator_impl.cc:82] Allocation of 1977701832 exceeds 10% of free system memory.
2022-11-03 23:22:15.982688: W tensorflow/core/framework/cpu_allocator_impl.cc:82] Allocation of 1977953400 exceeds 10% of free system memory.
2022-11-03 23:22:21.832548: W tensorflow/core/framework/cpu_allocator_impl.cc:82] Allocation of 1902951432 exceeds 10% of free system memory.

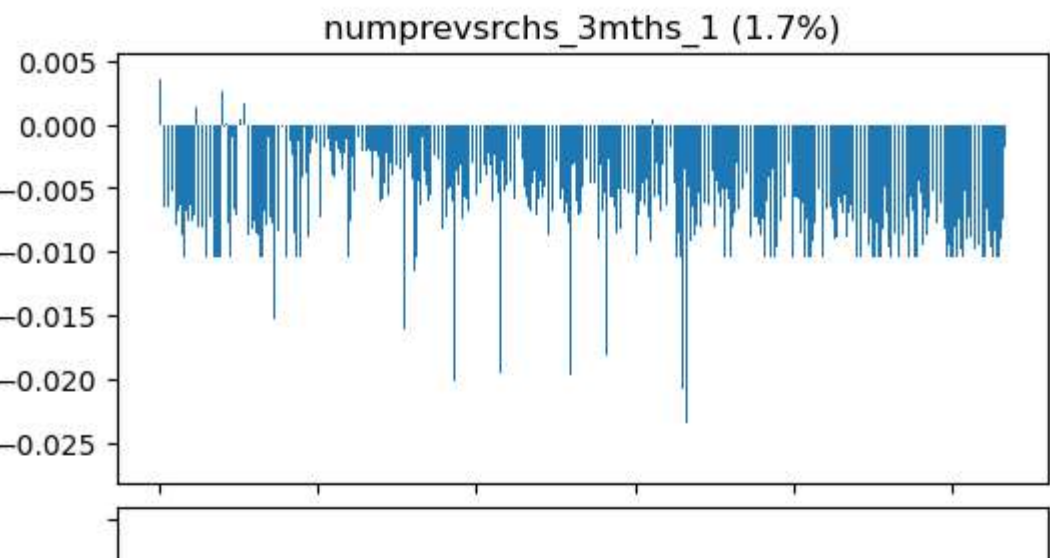
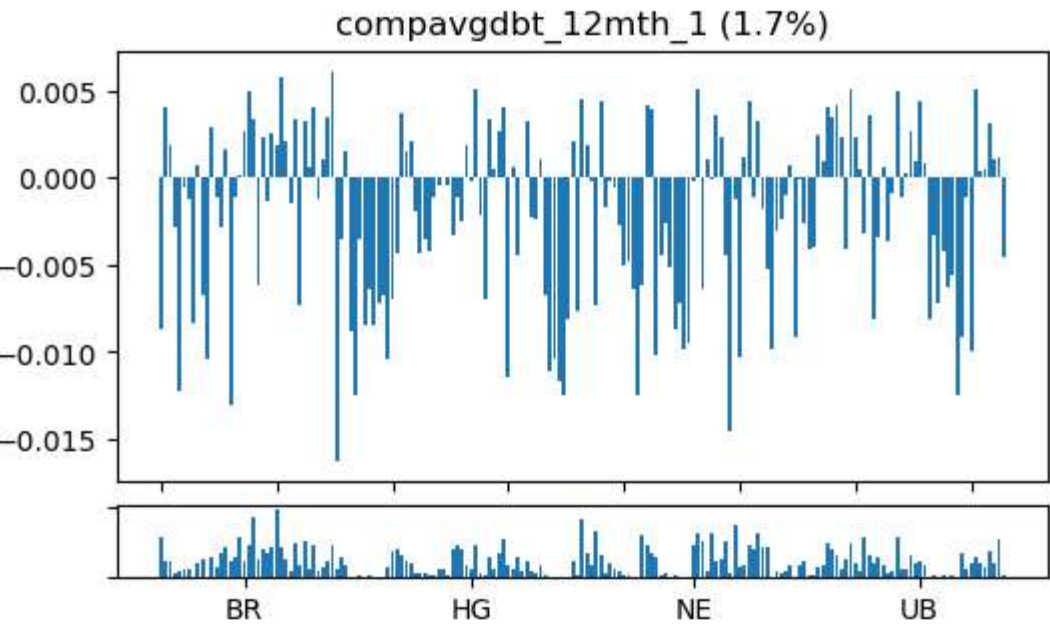
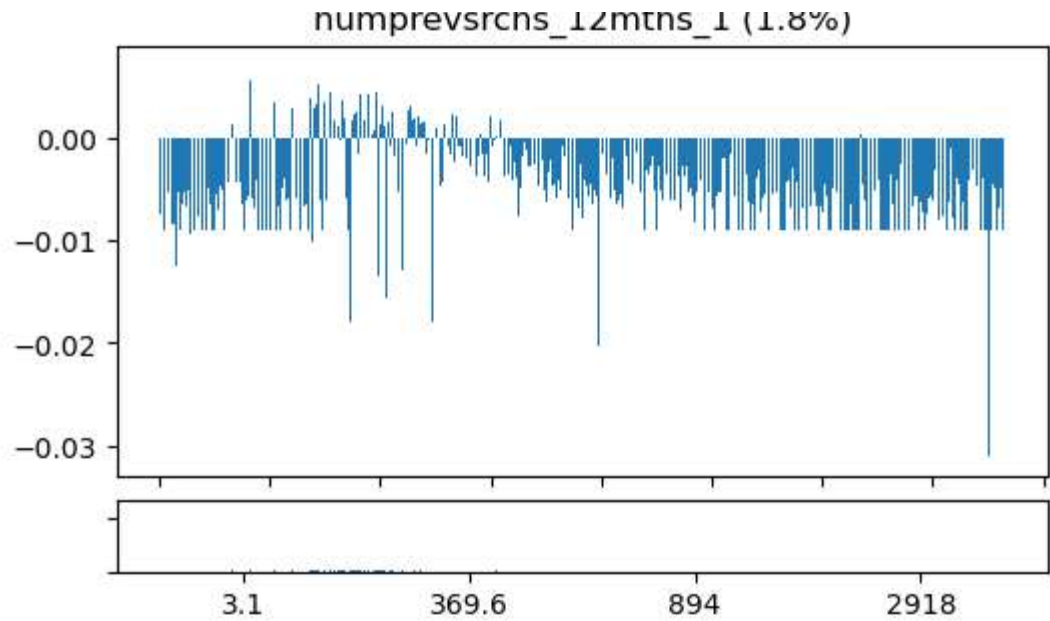
```

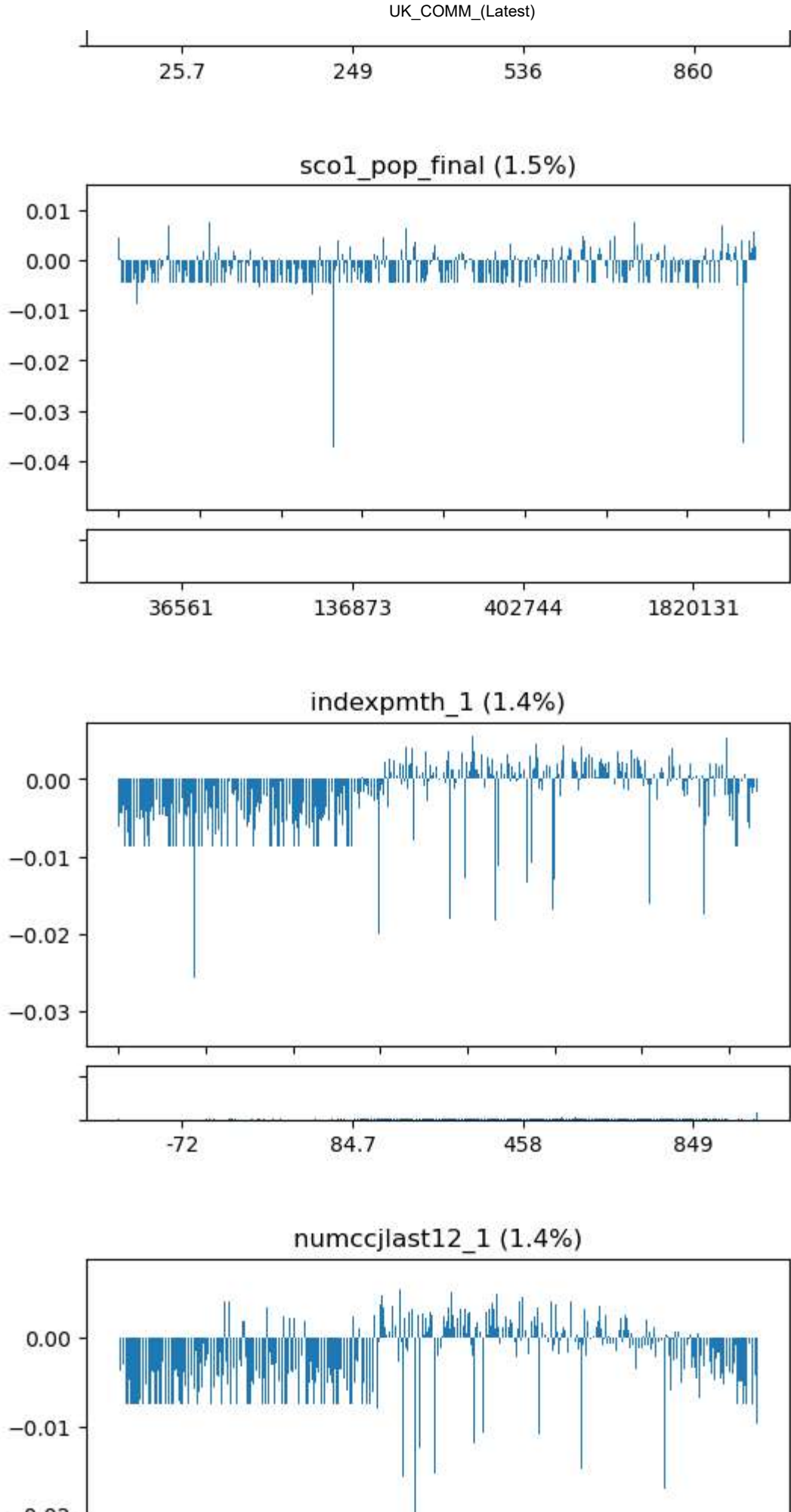


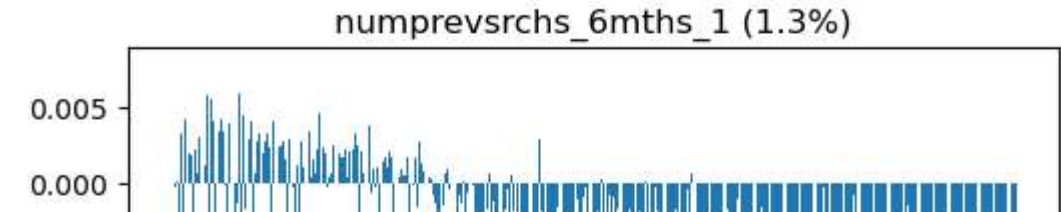
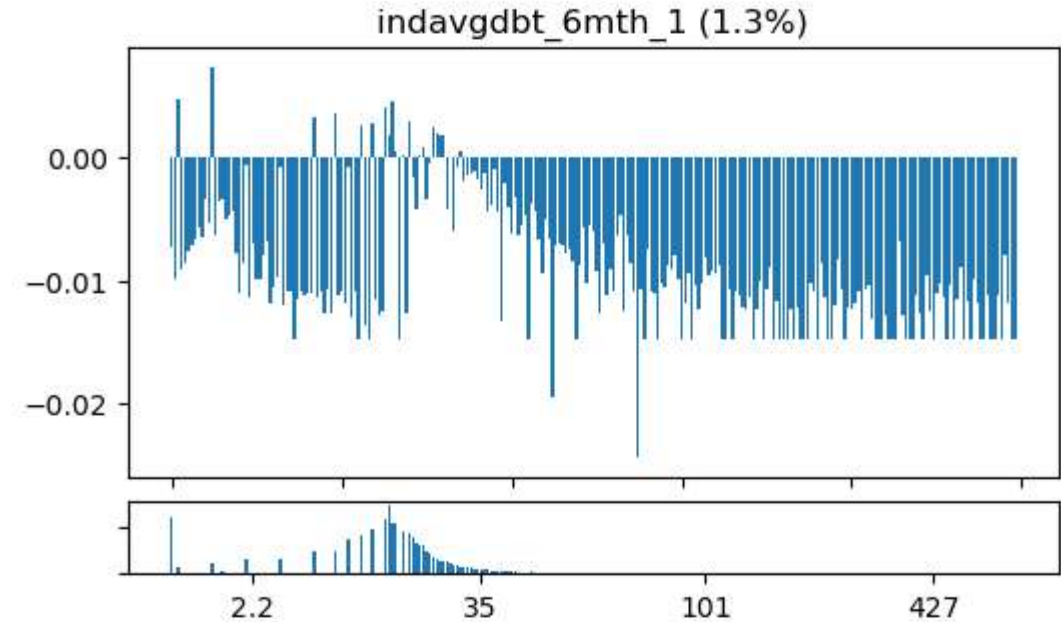
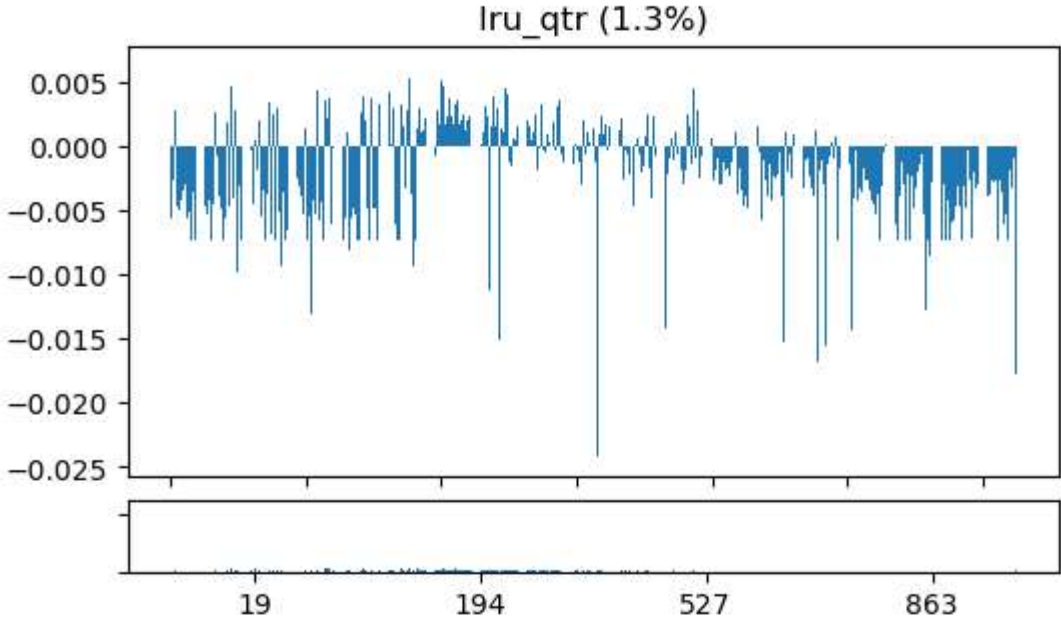
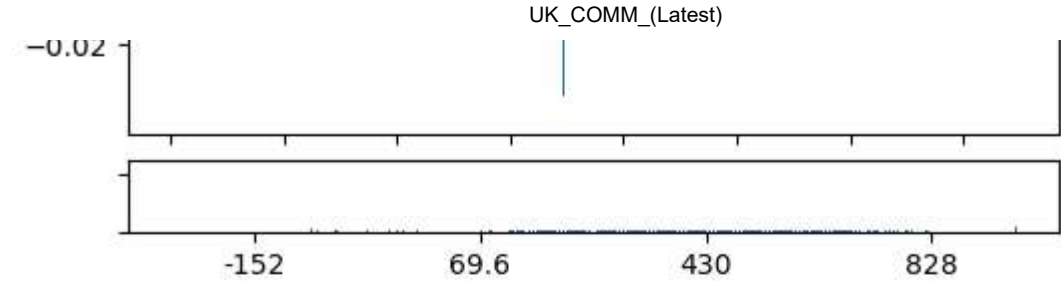


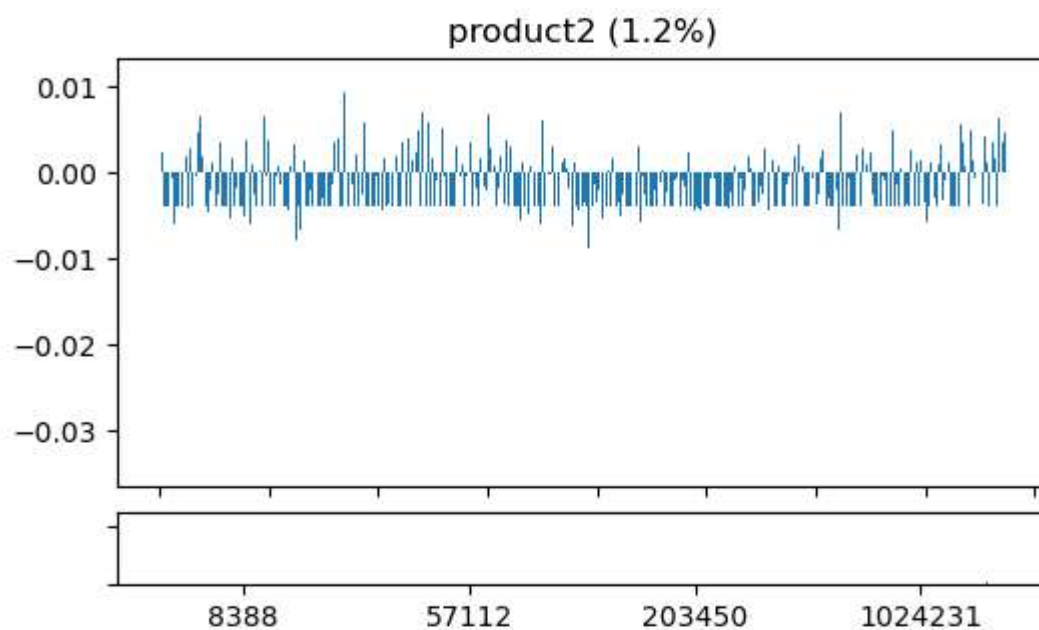
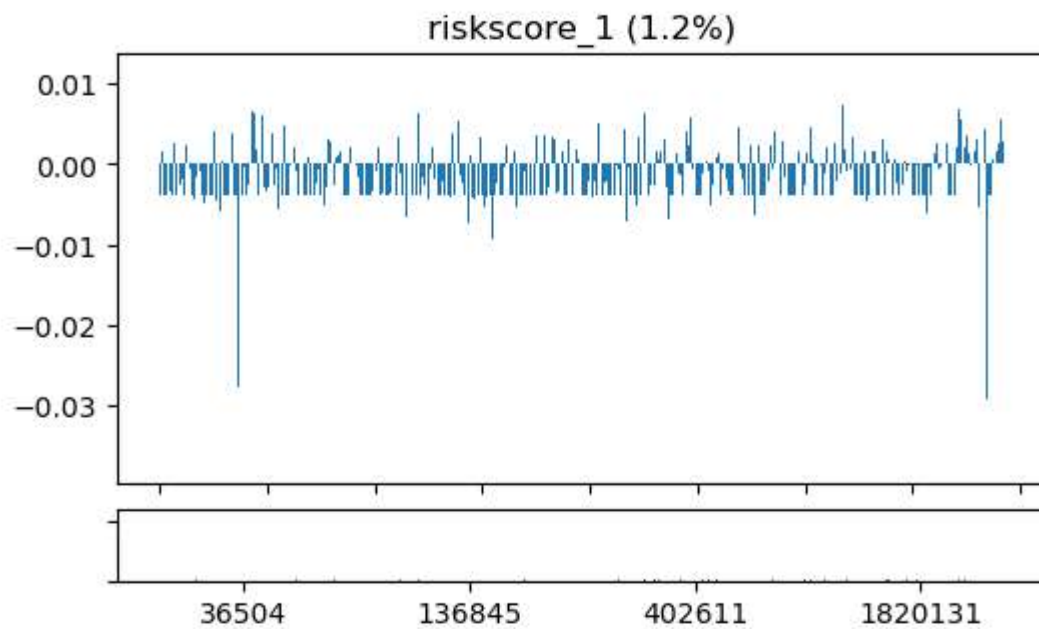
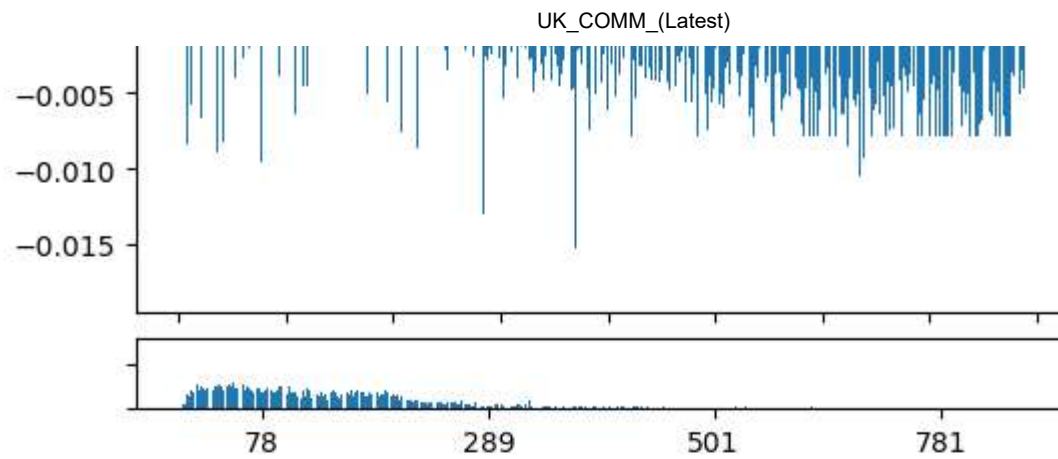




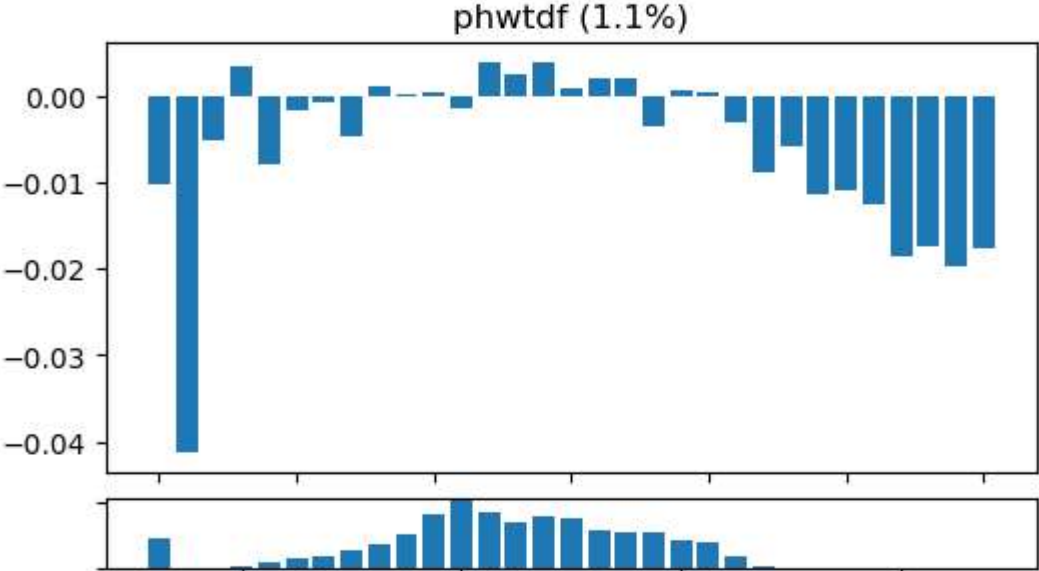
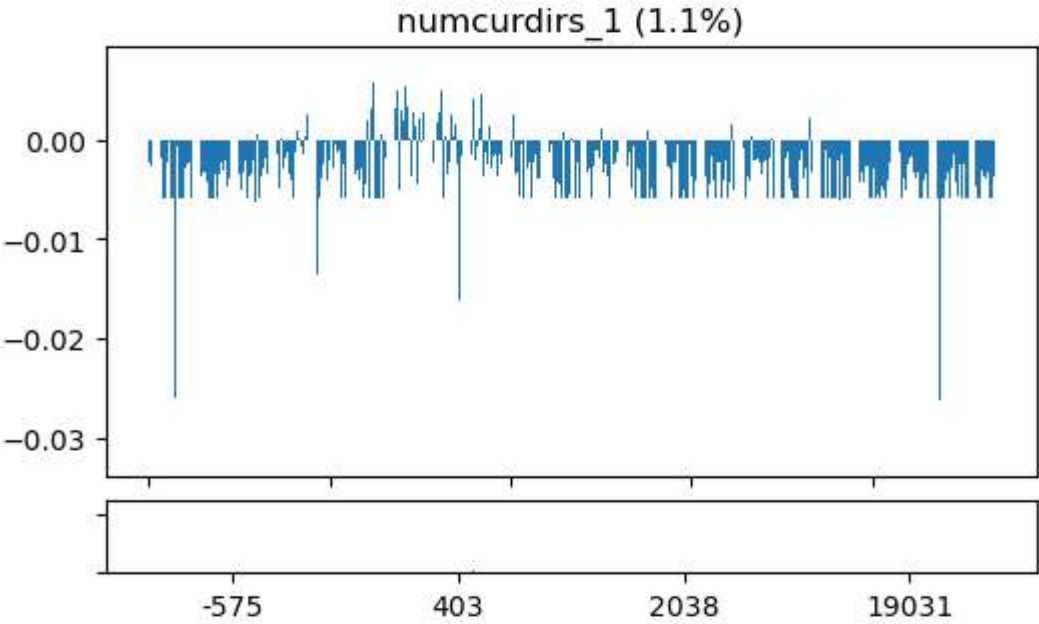
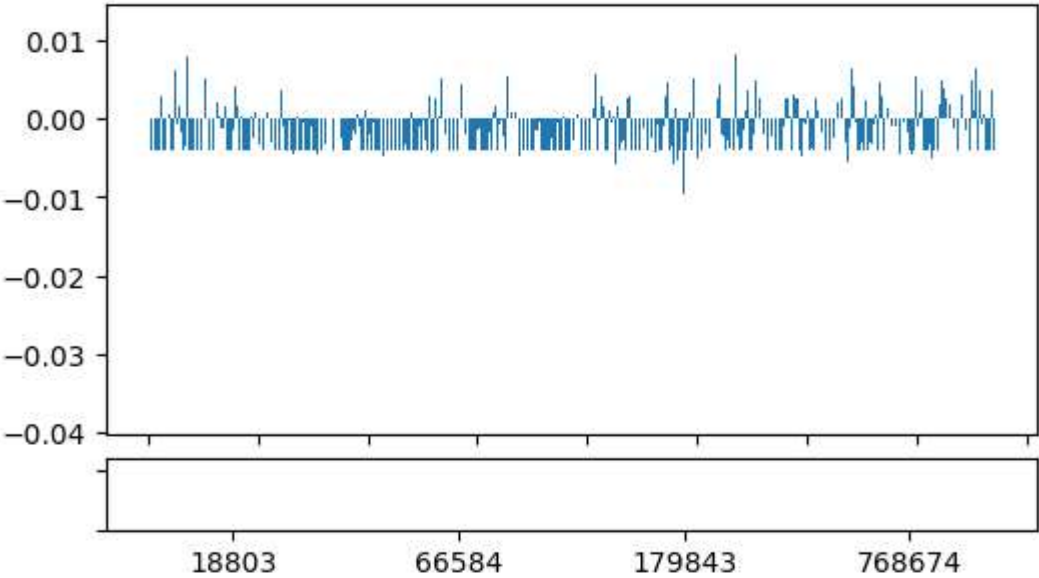


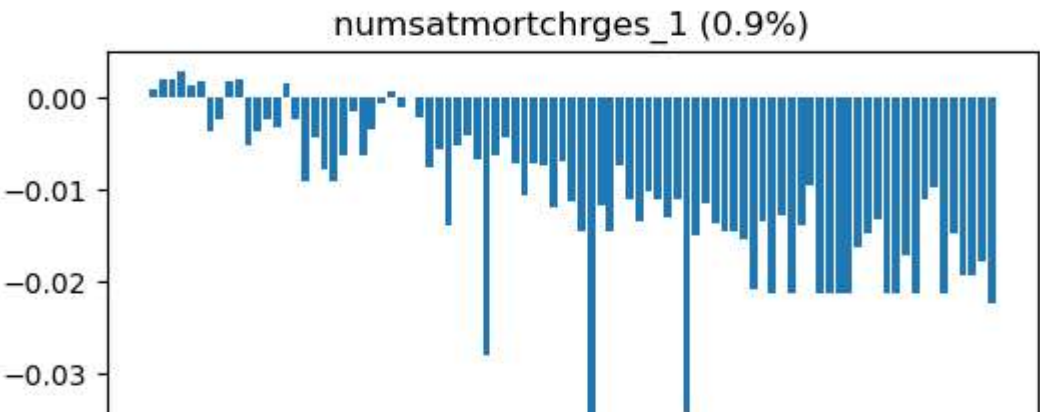
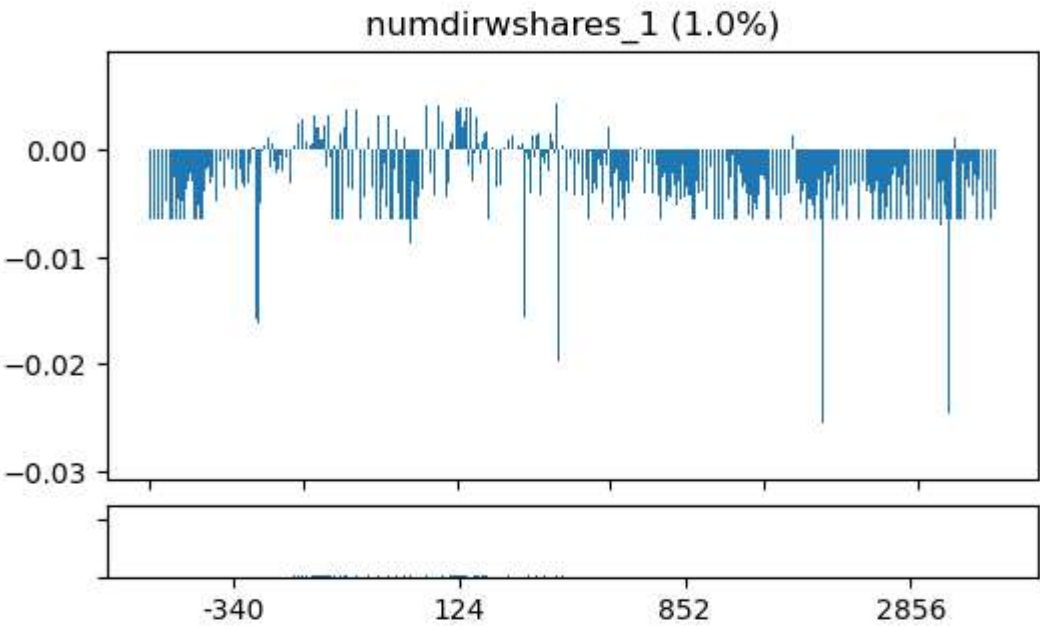
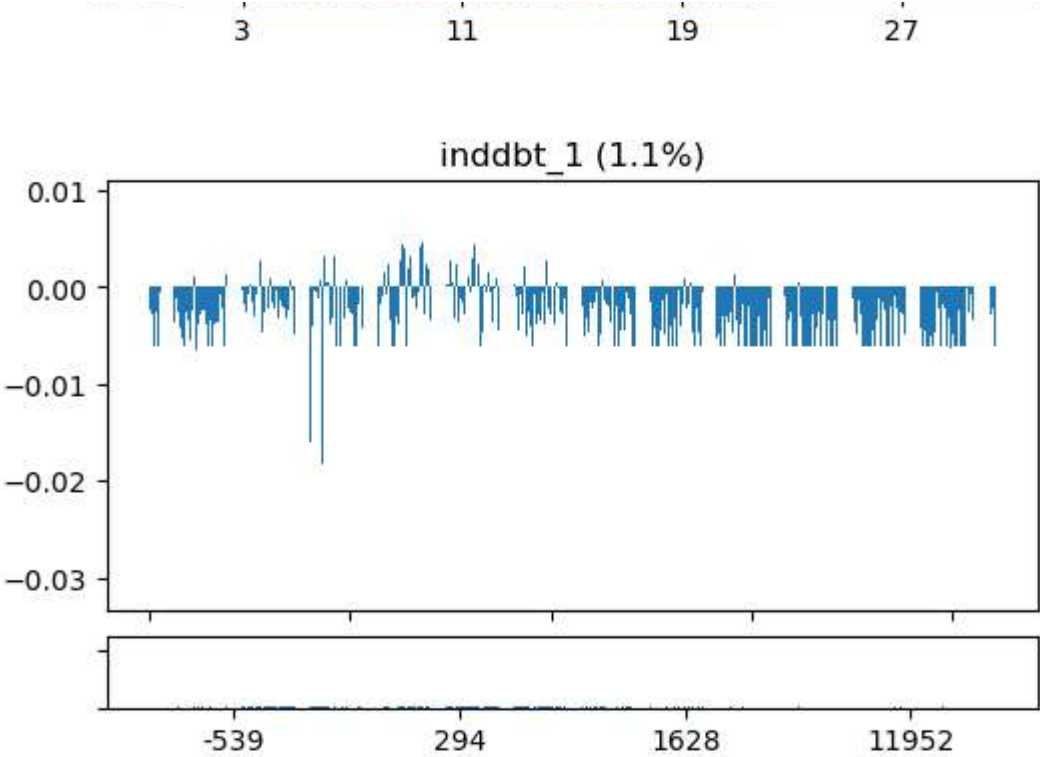


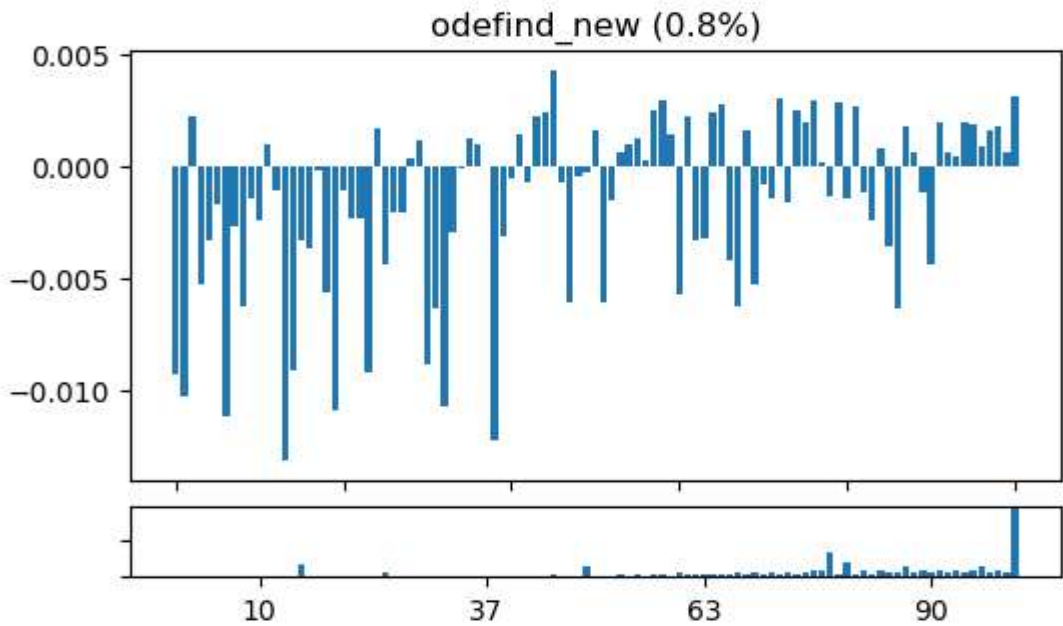
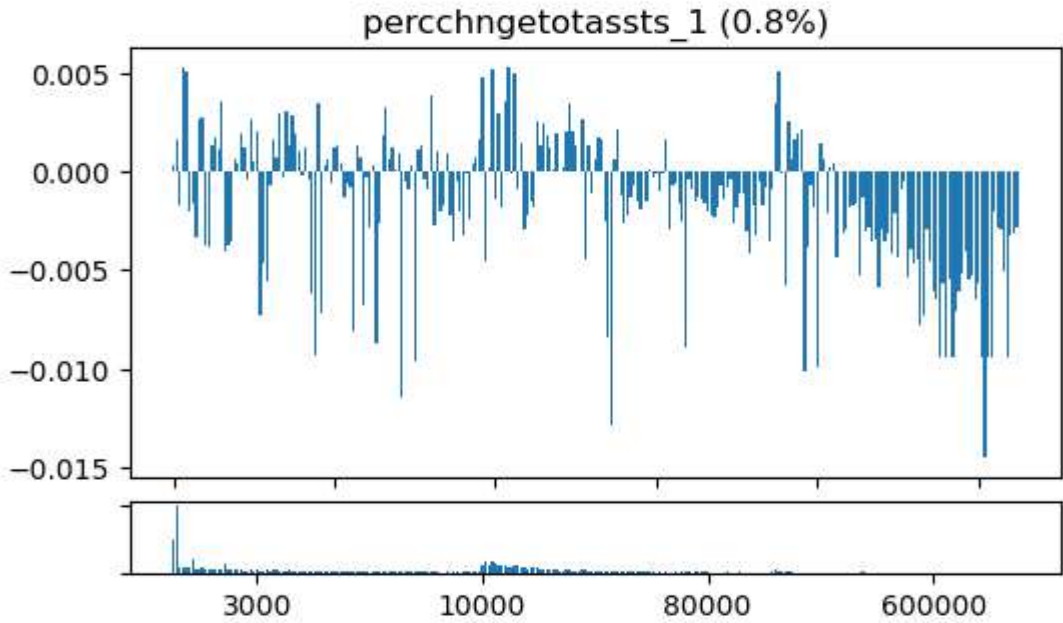
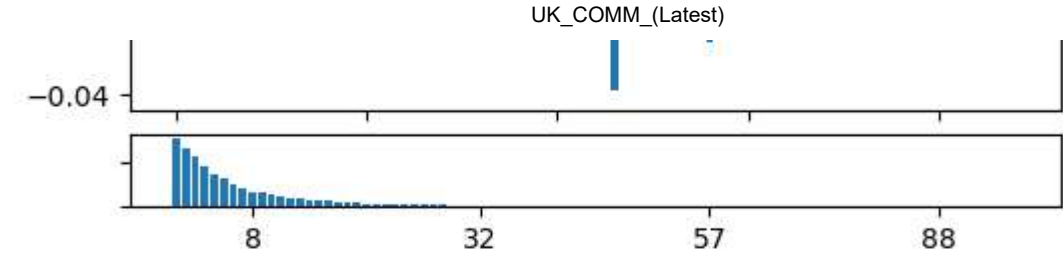


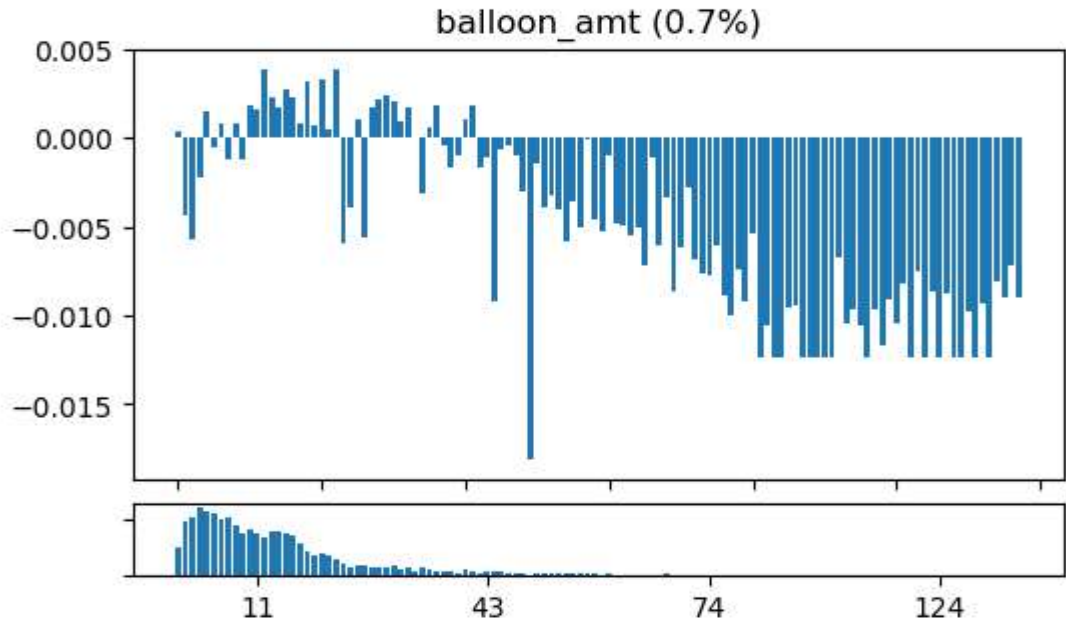
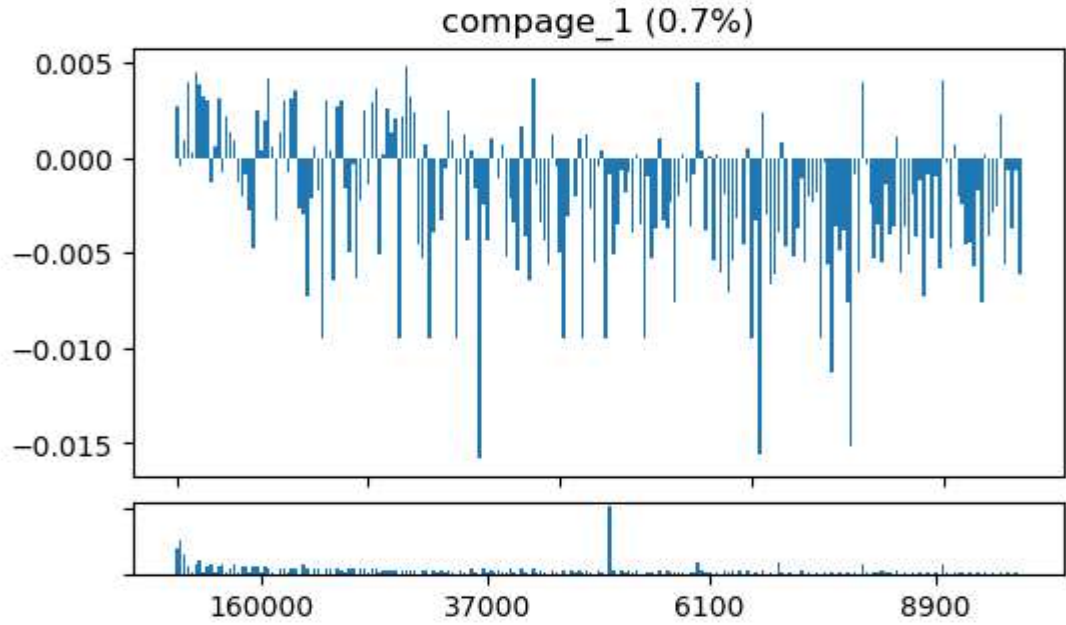
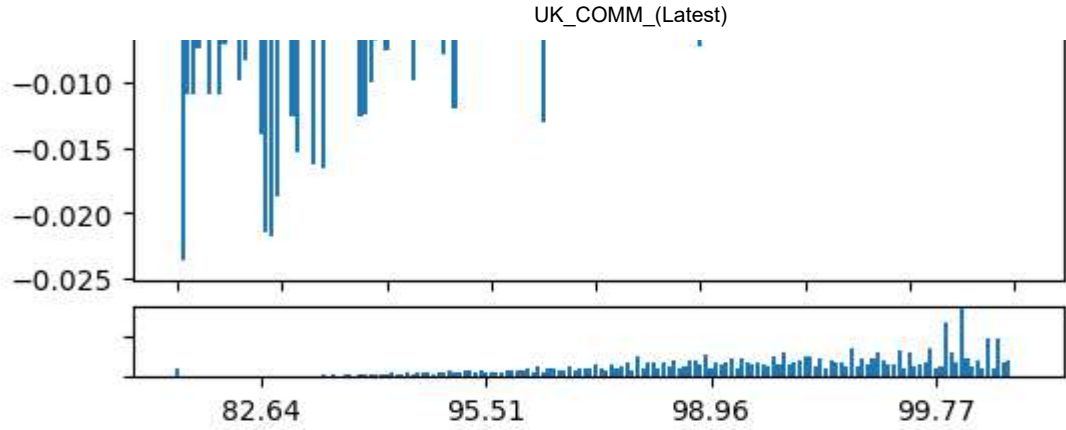


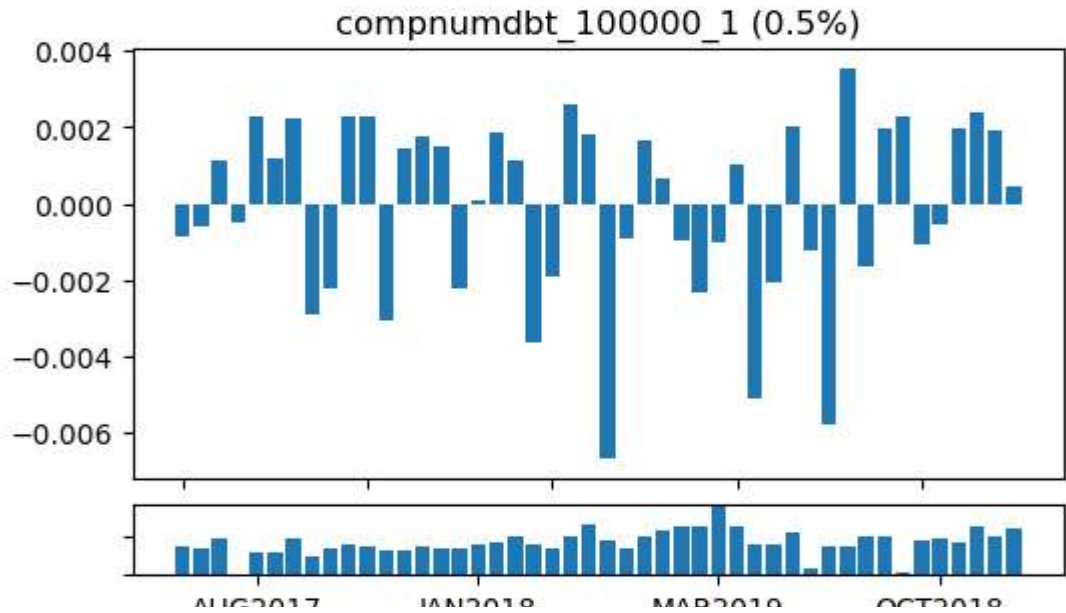
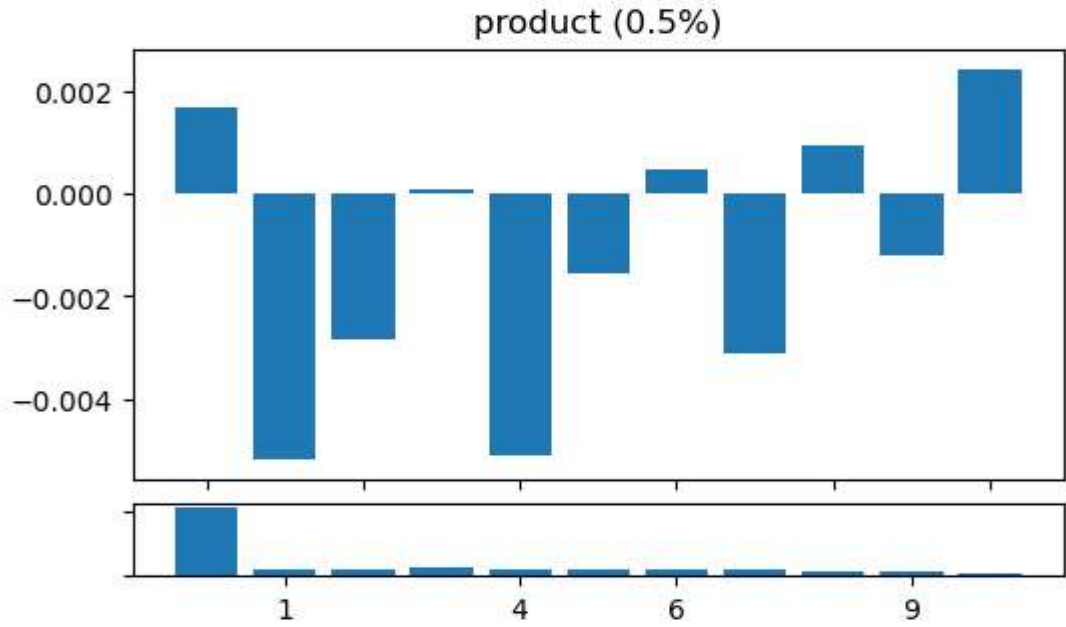
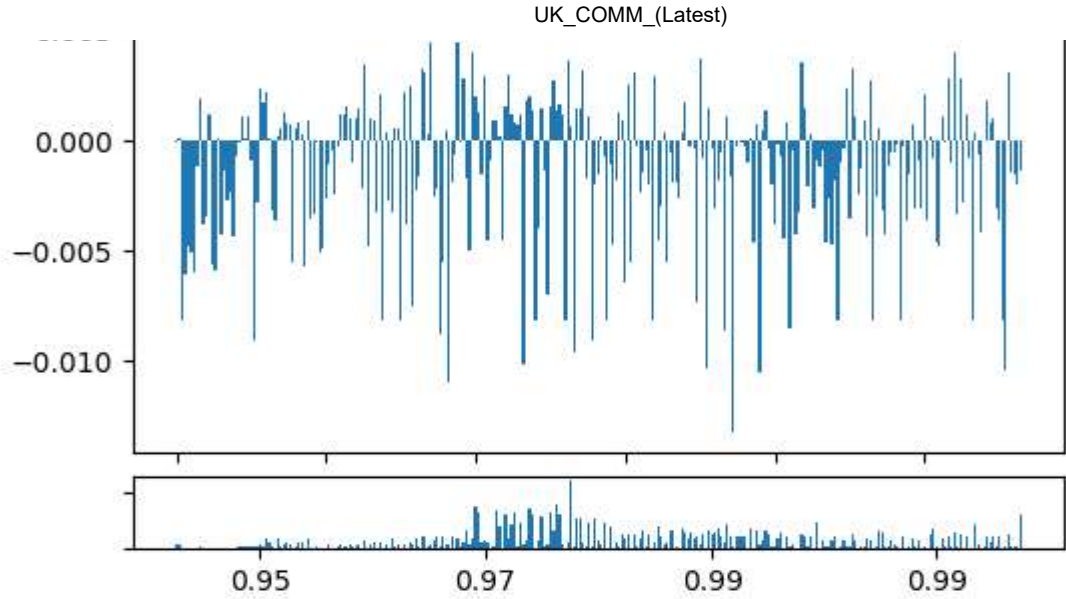
phwtaa (1.2%)

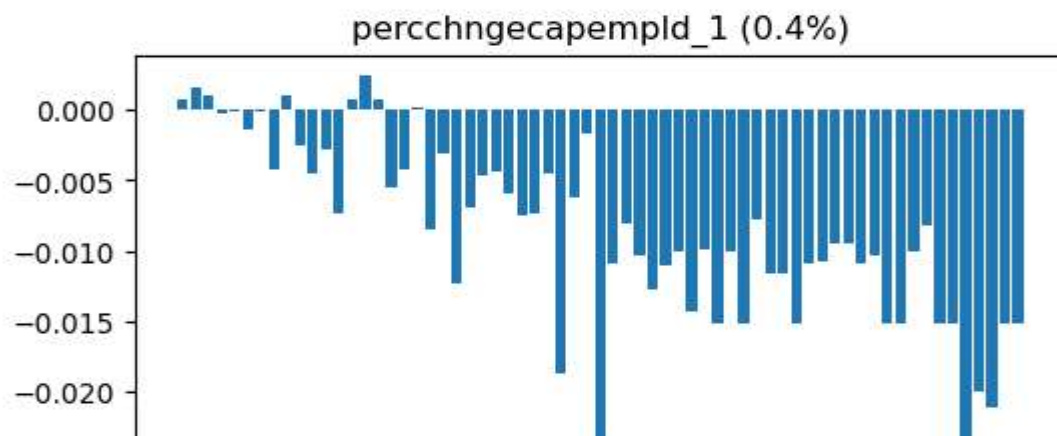
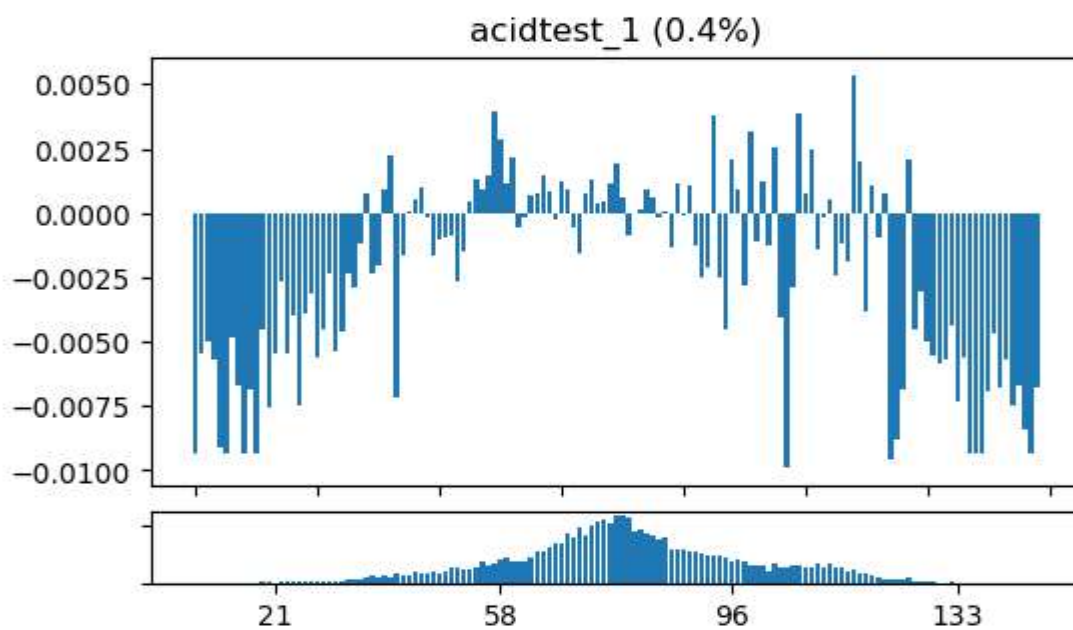
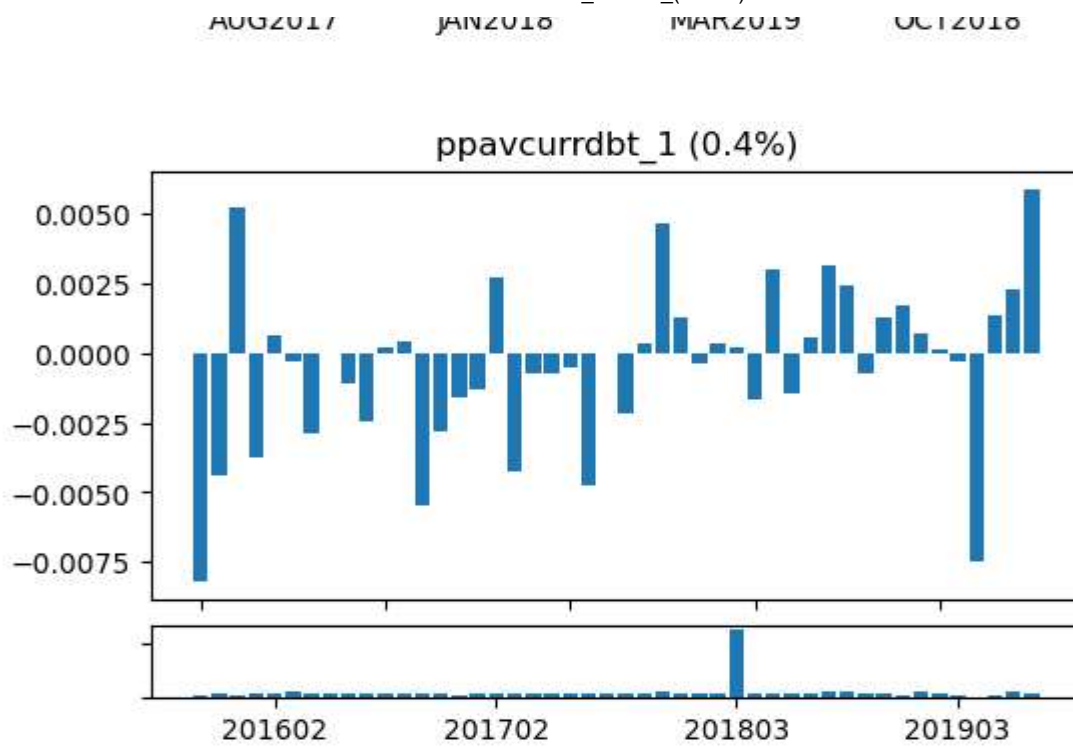


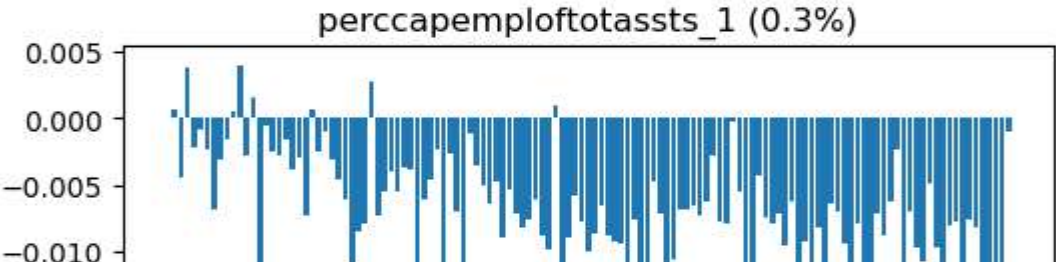
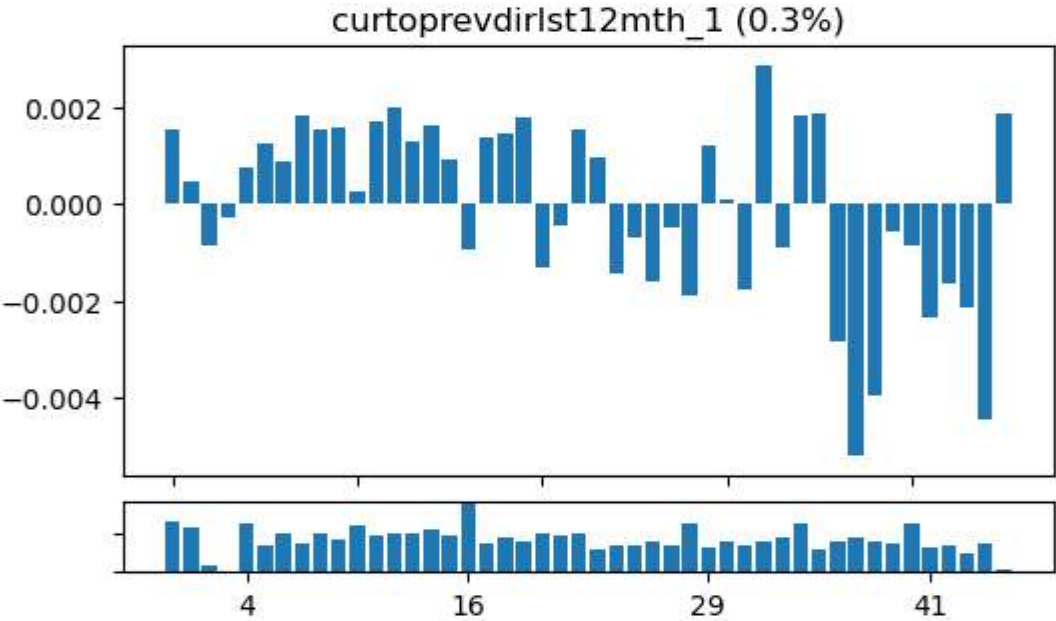
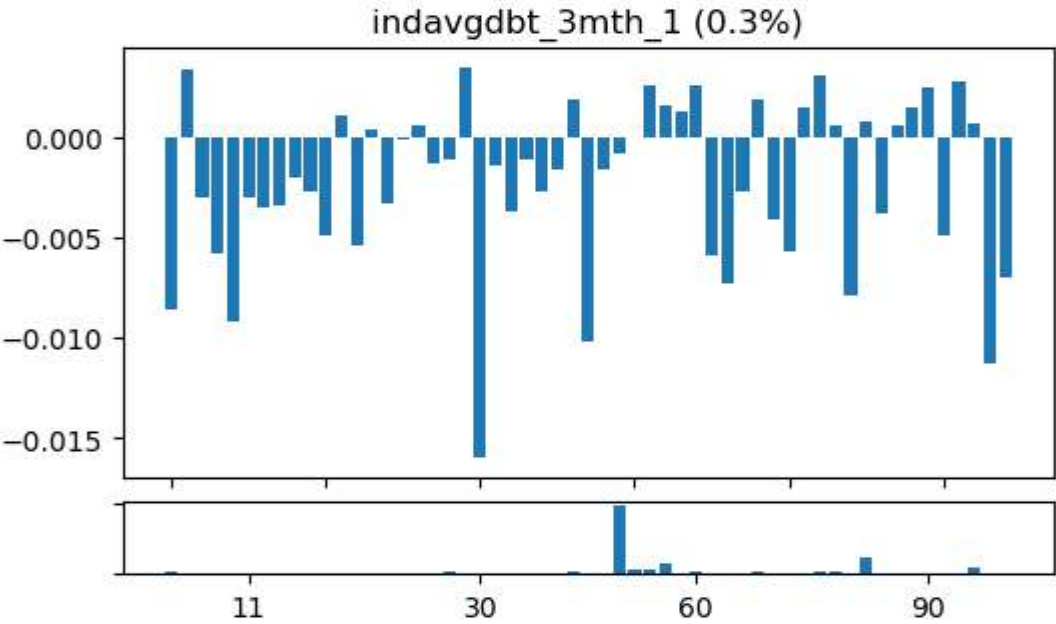
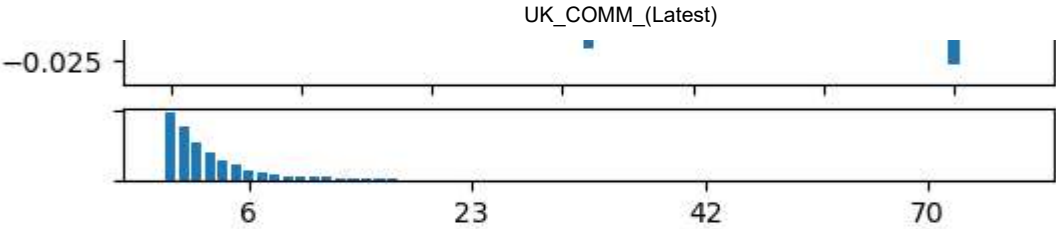


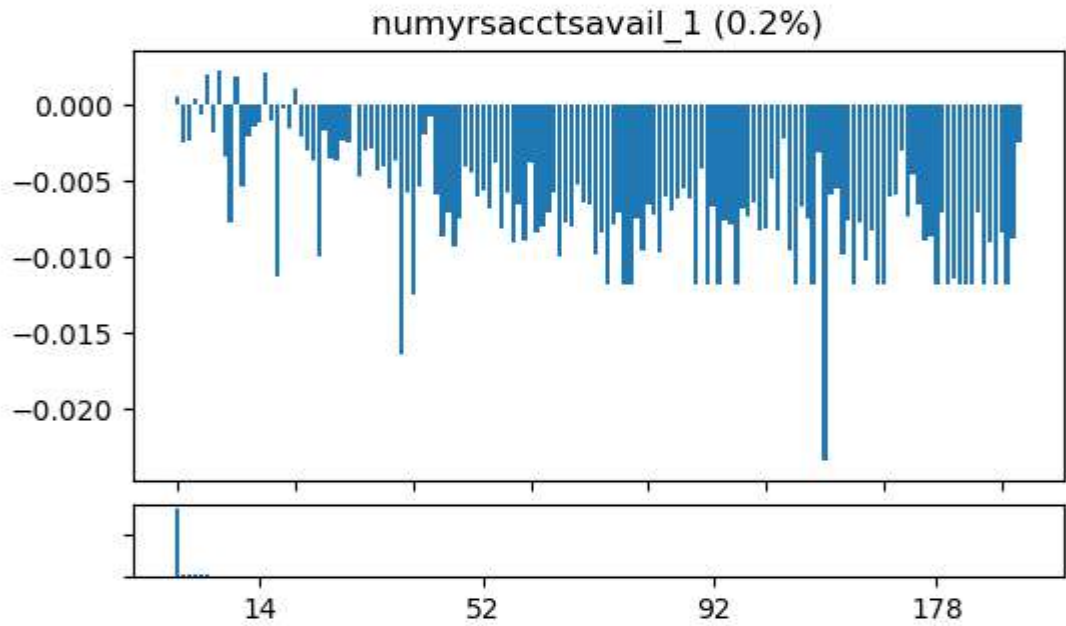
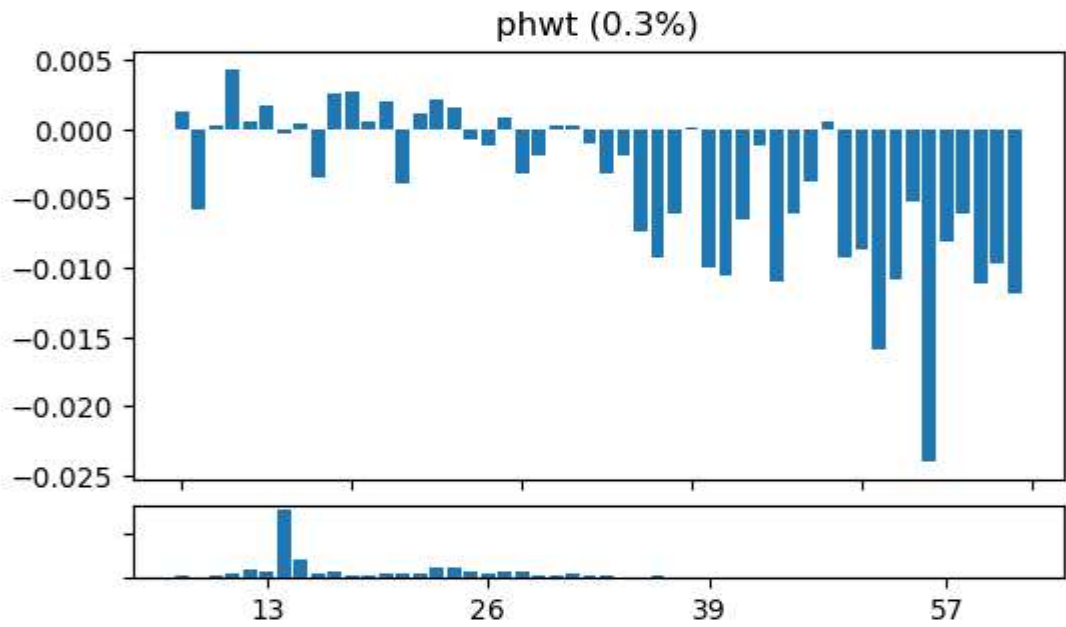
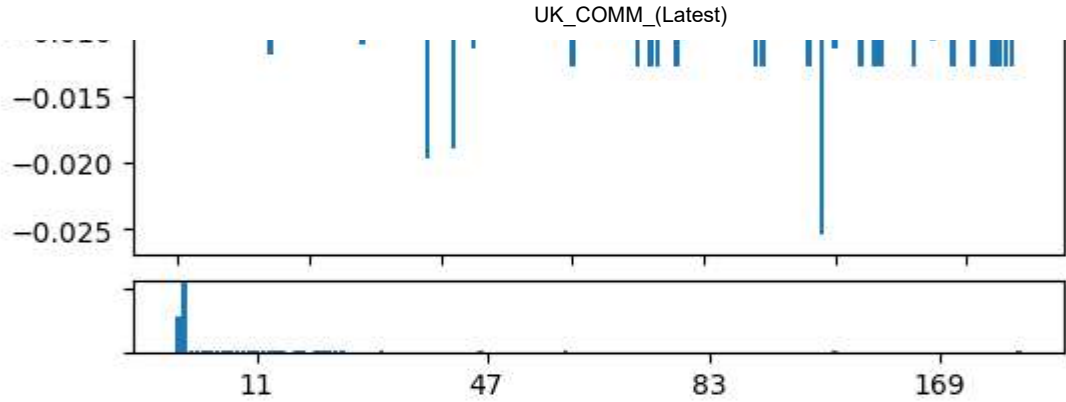


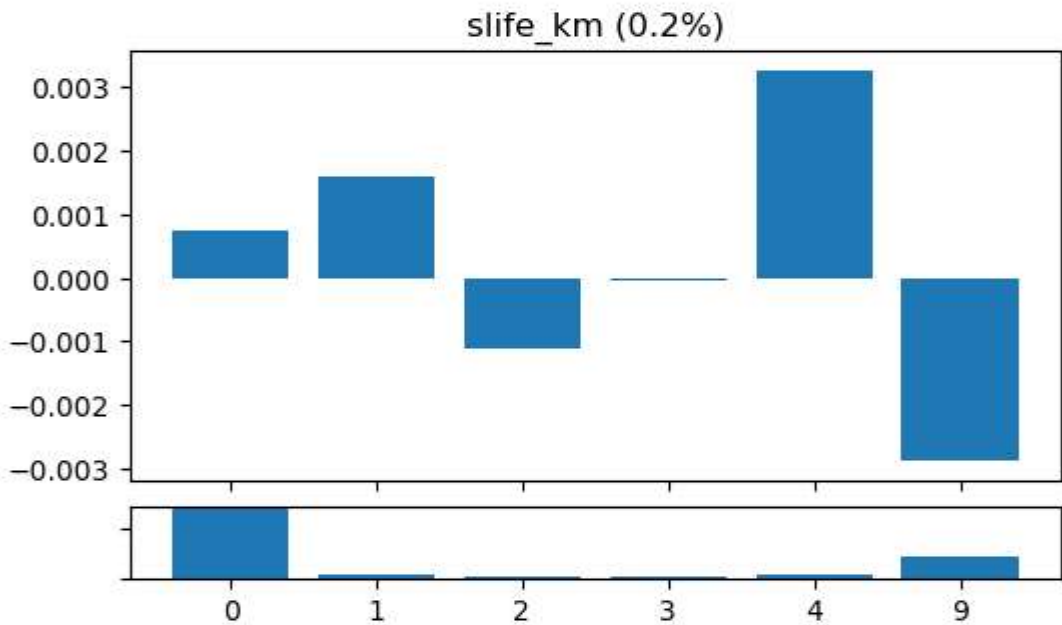
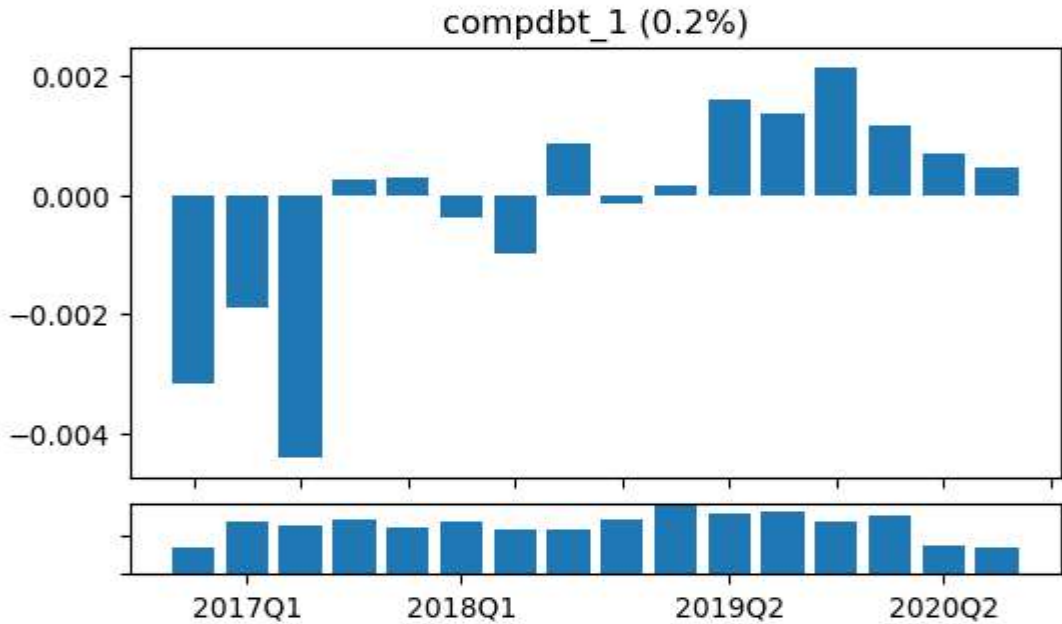
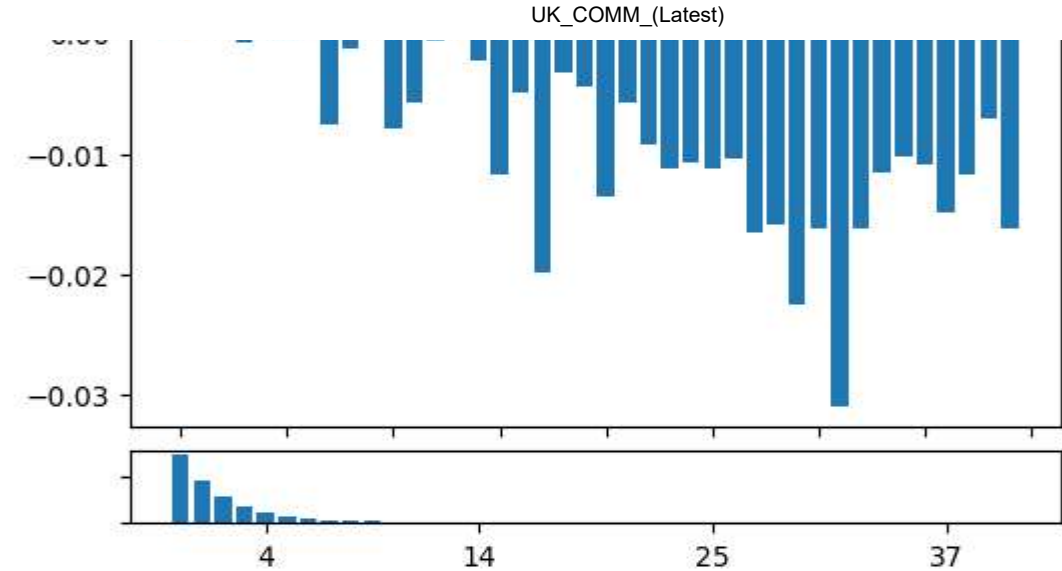


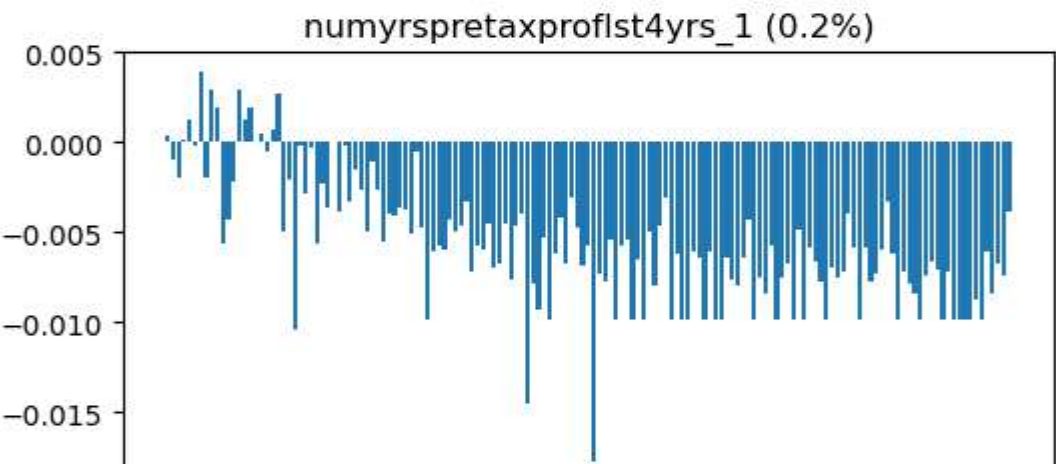
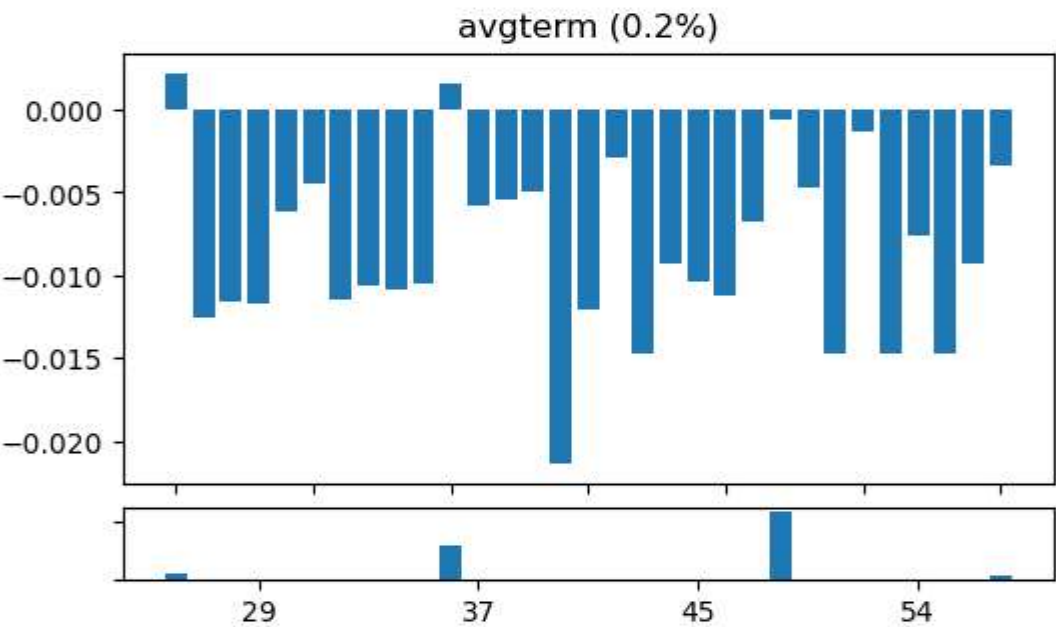
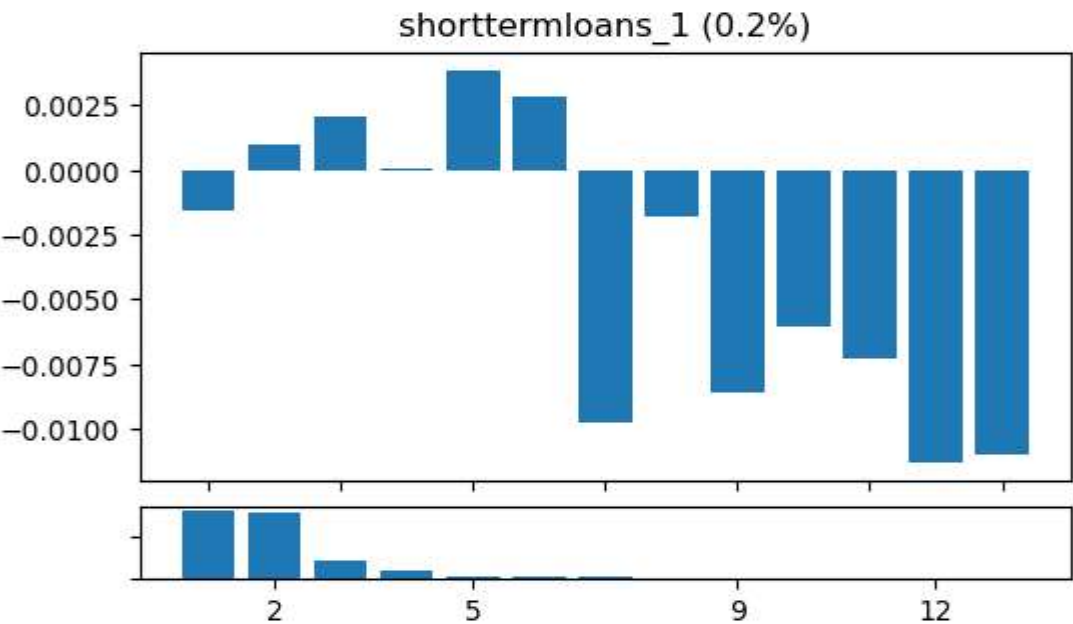


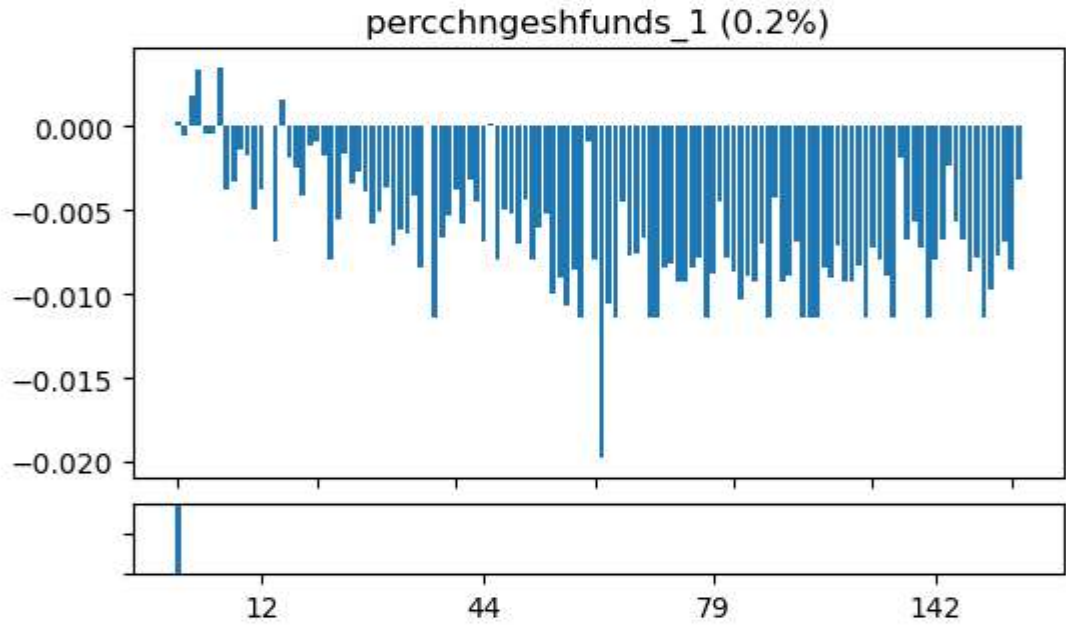
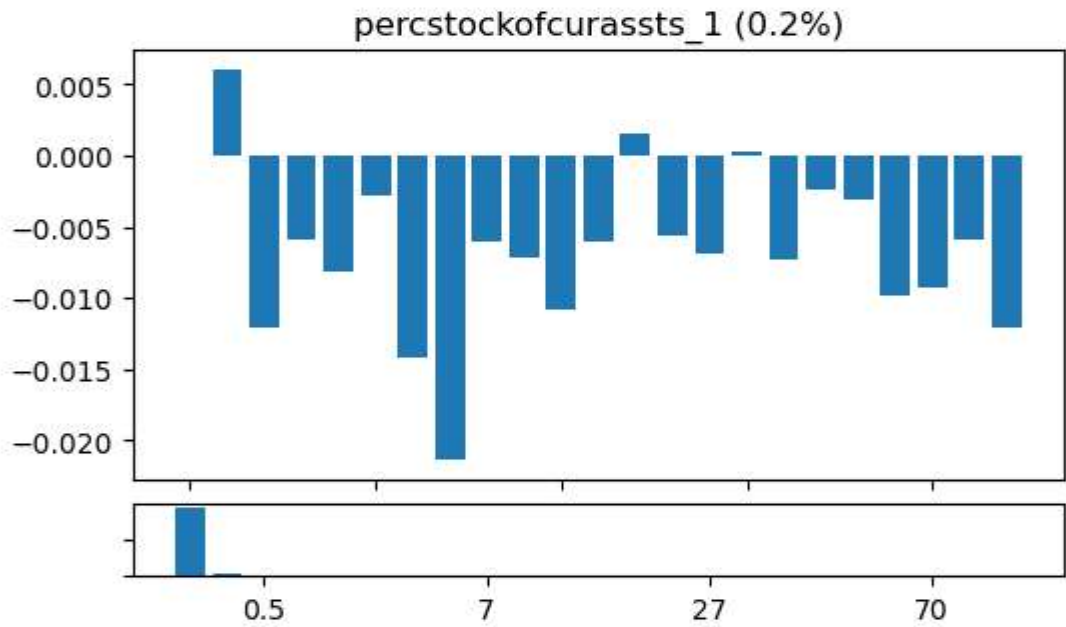
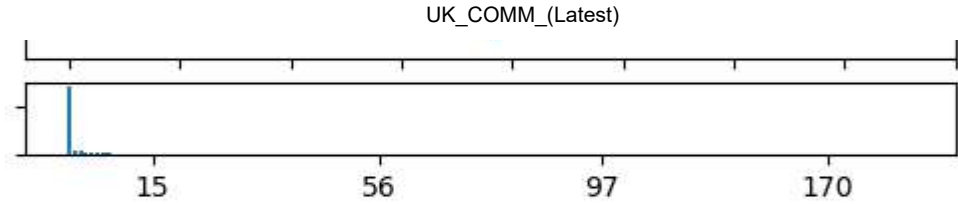


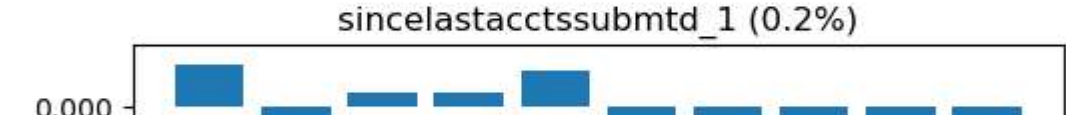
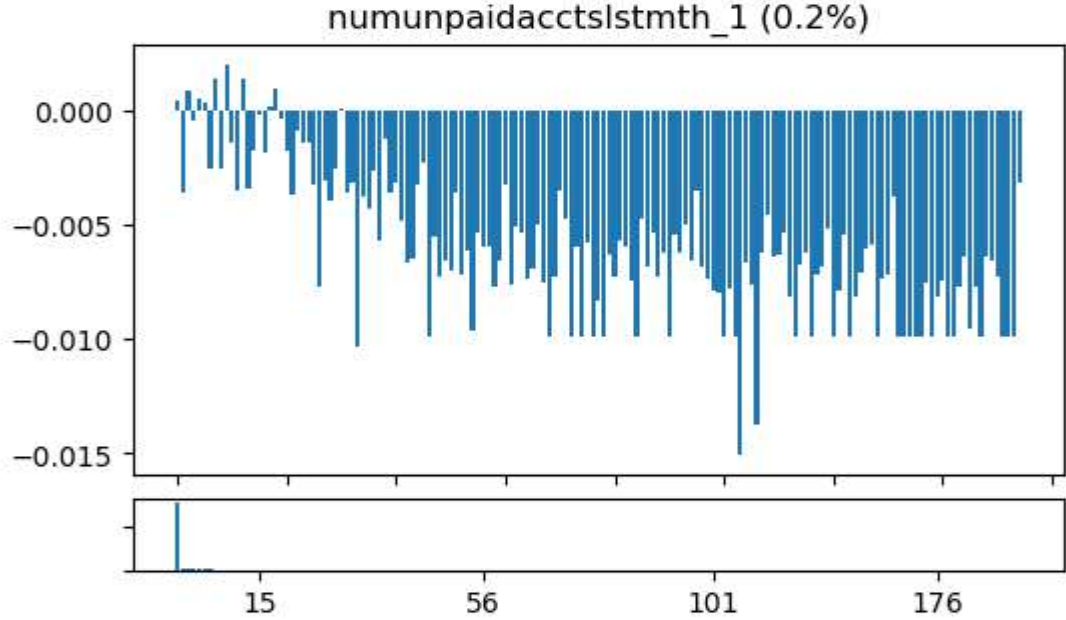
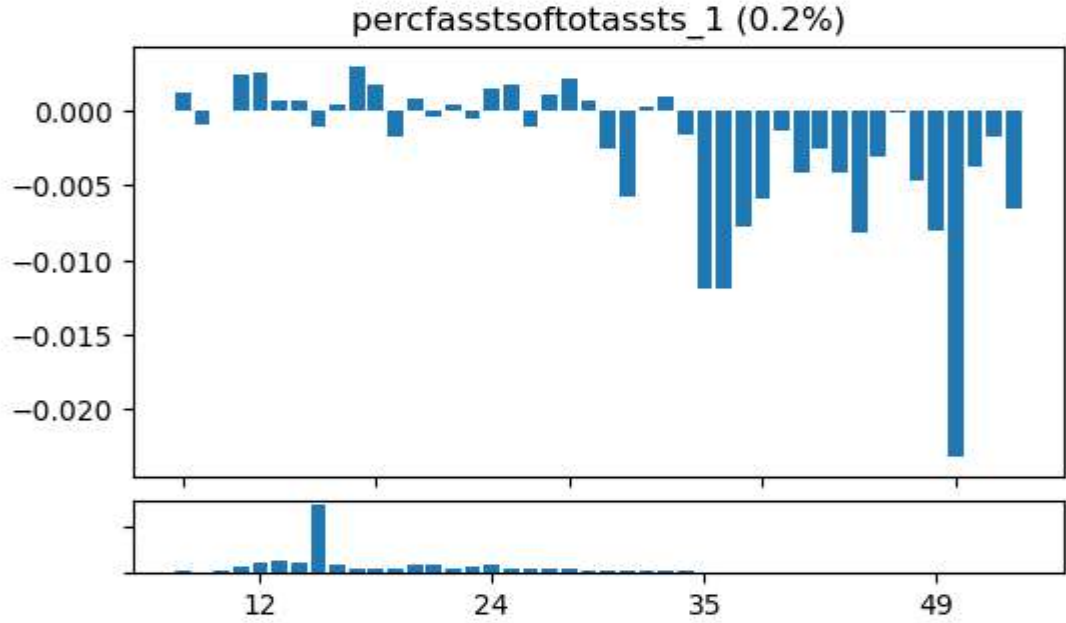
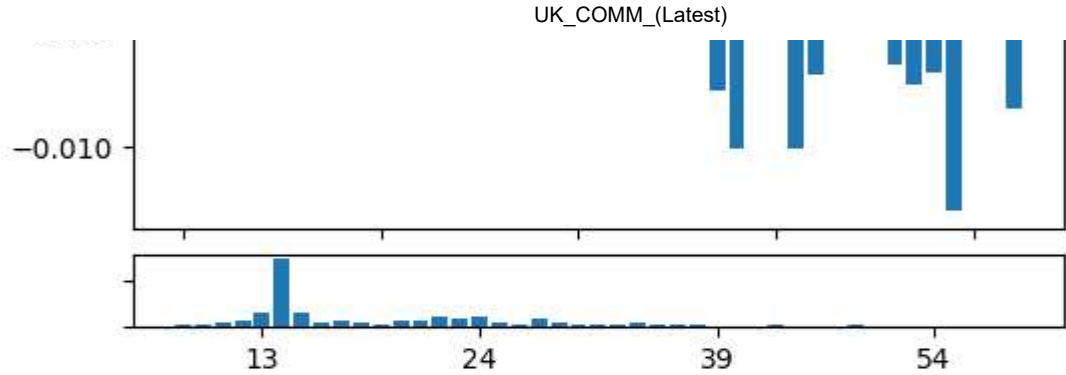


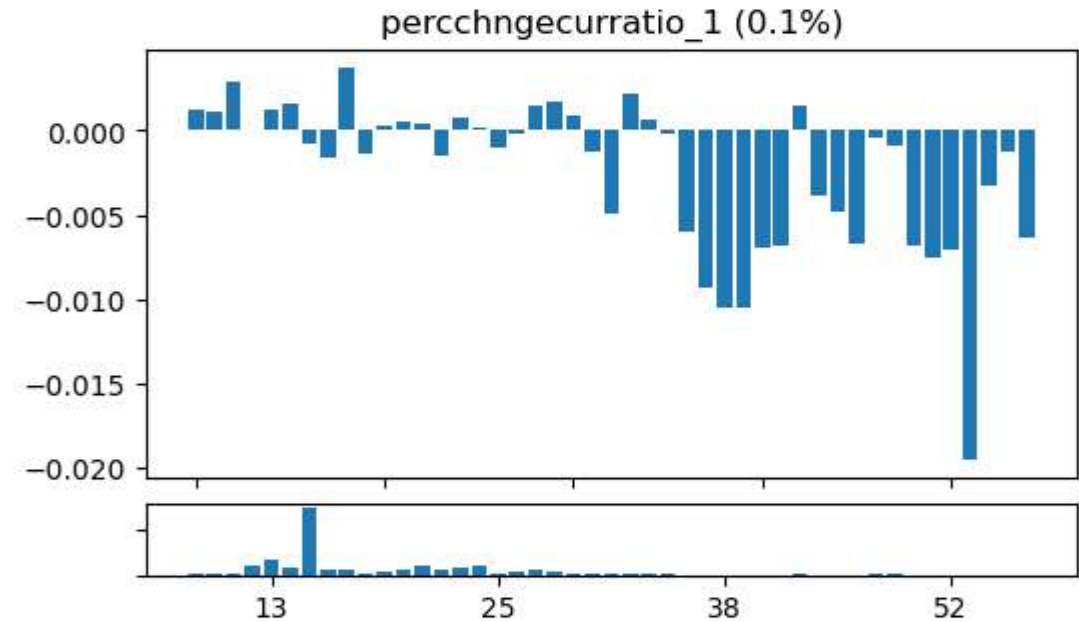
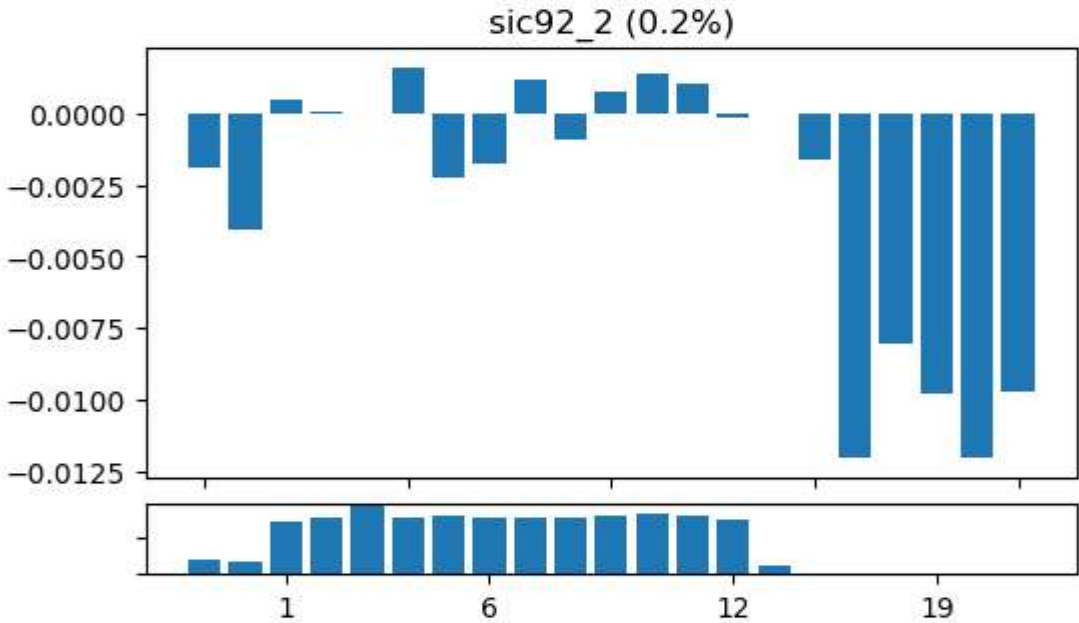
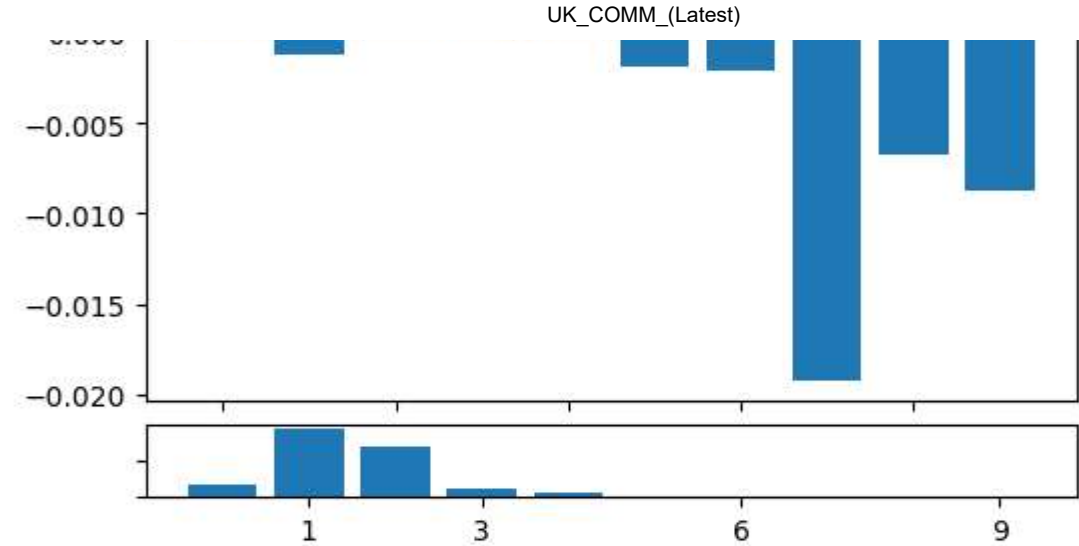


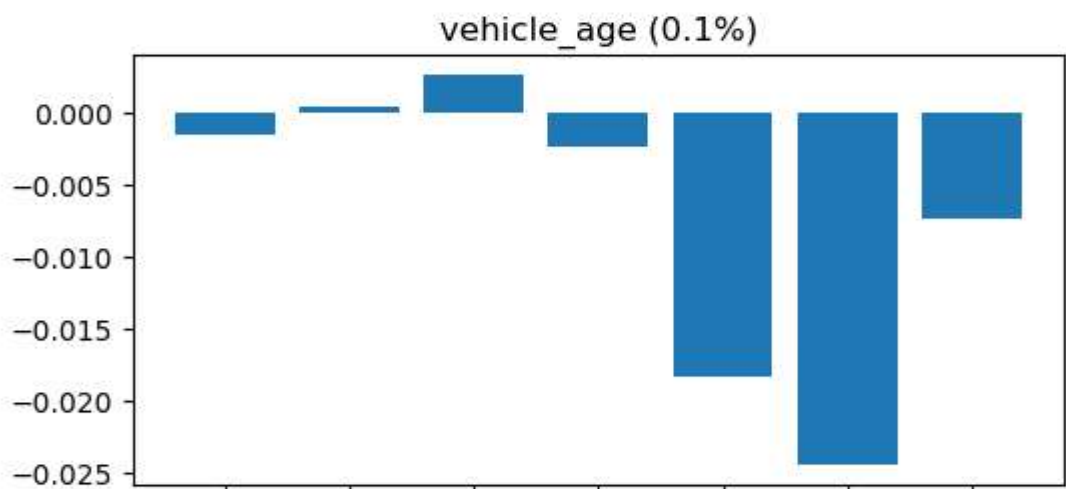
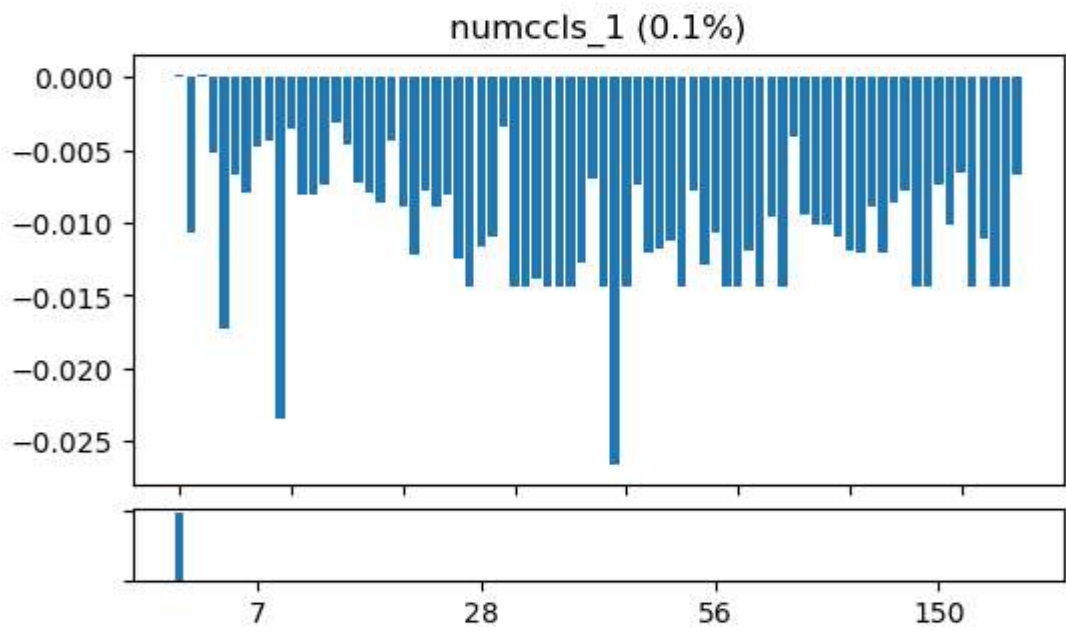
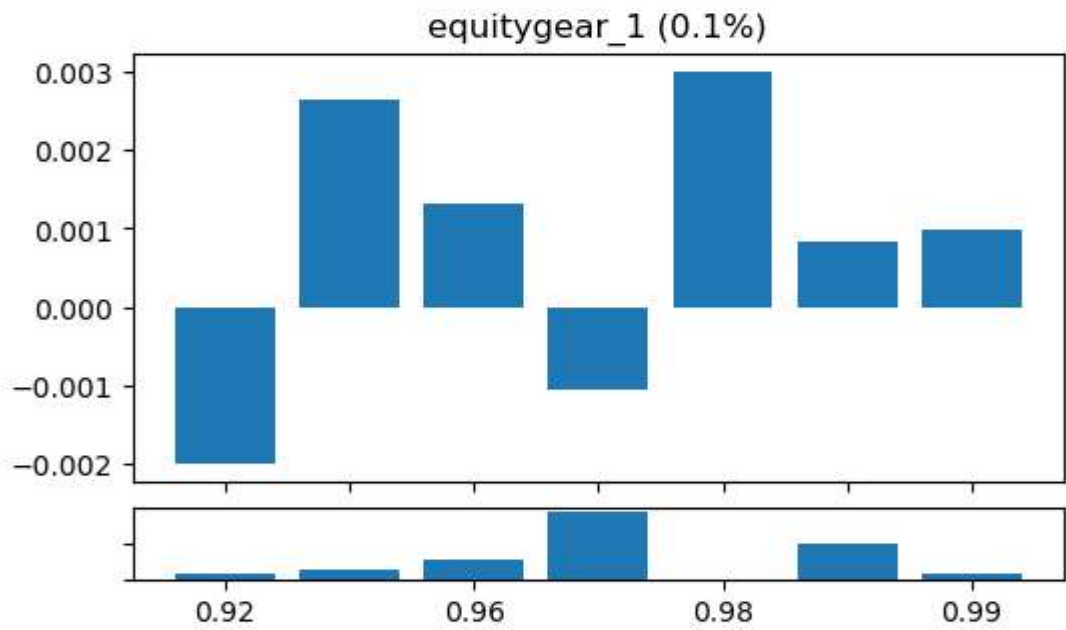


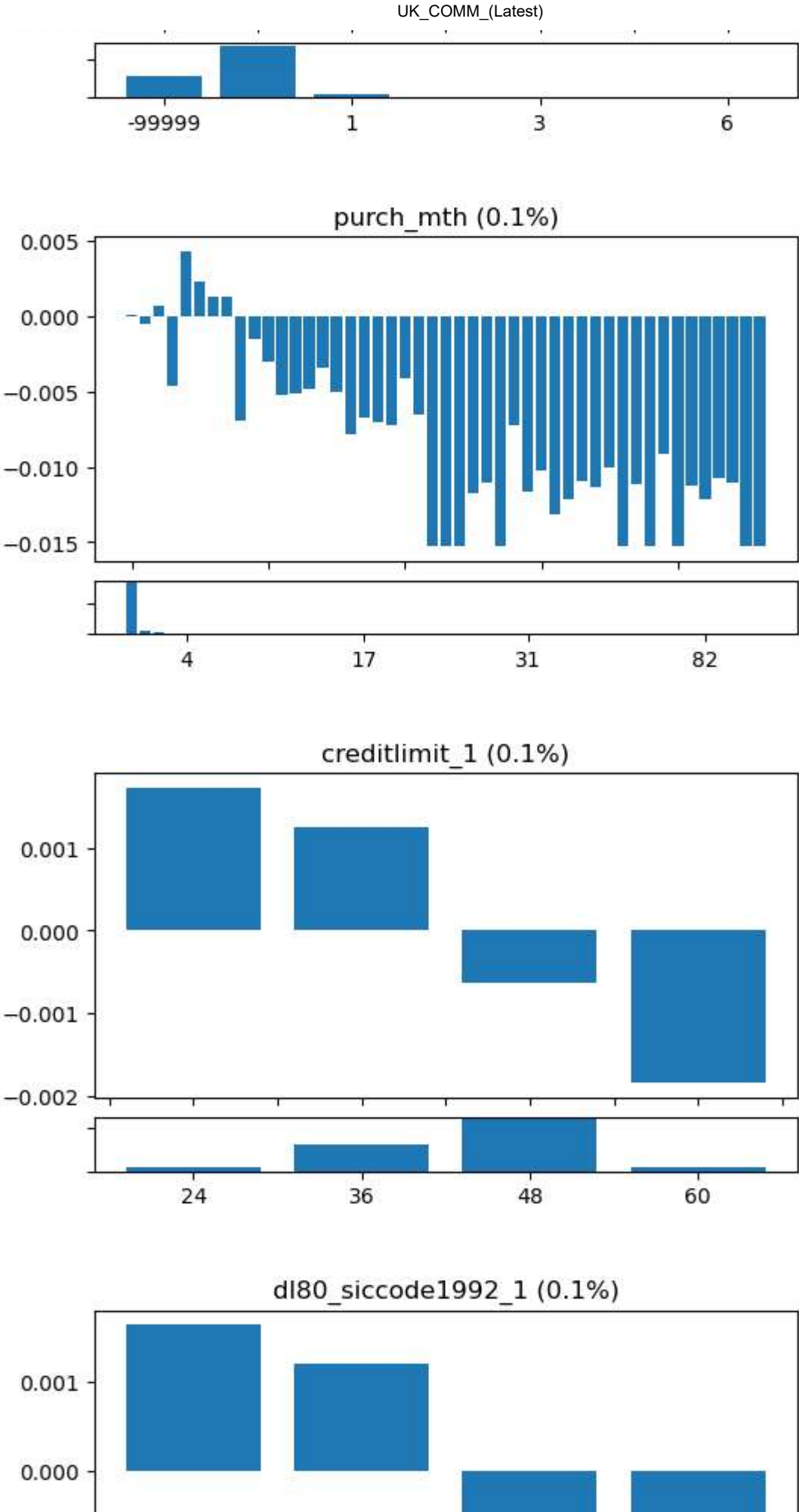


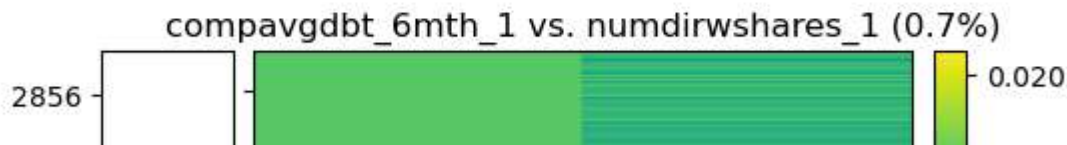
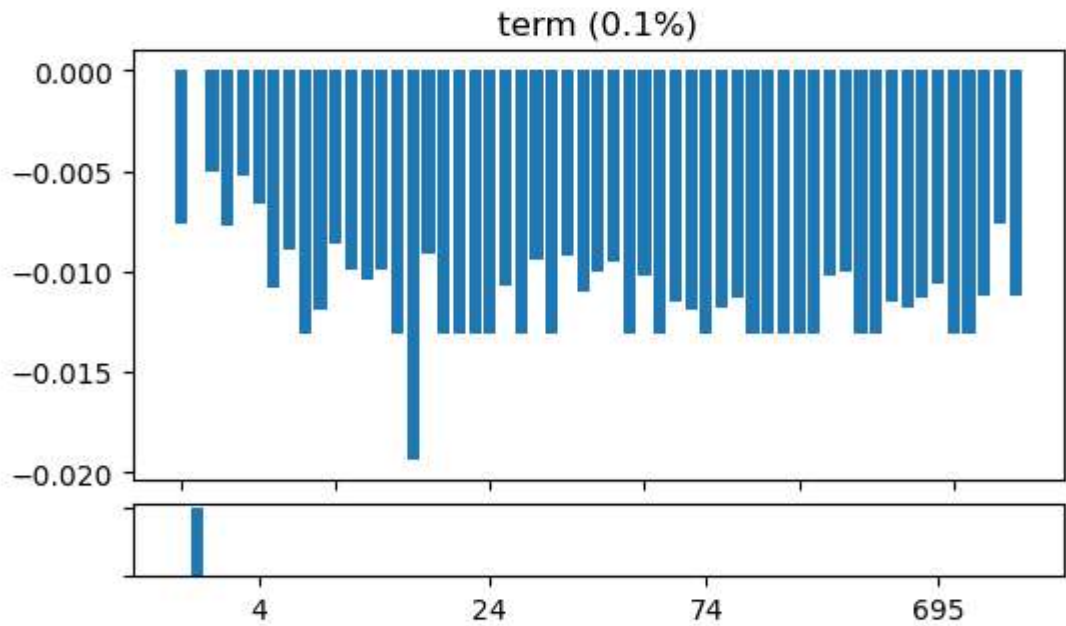
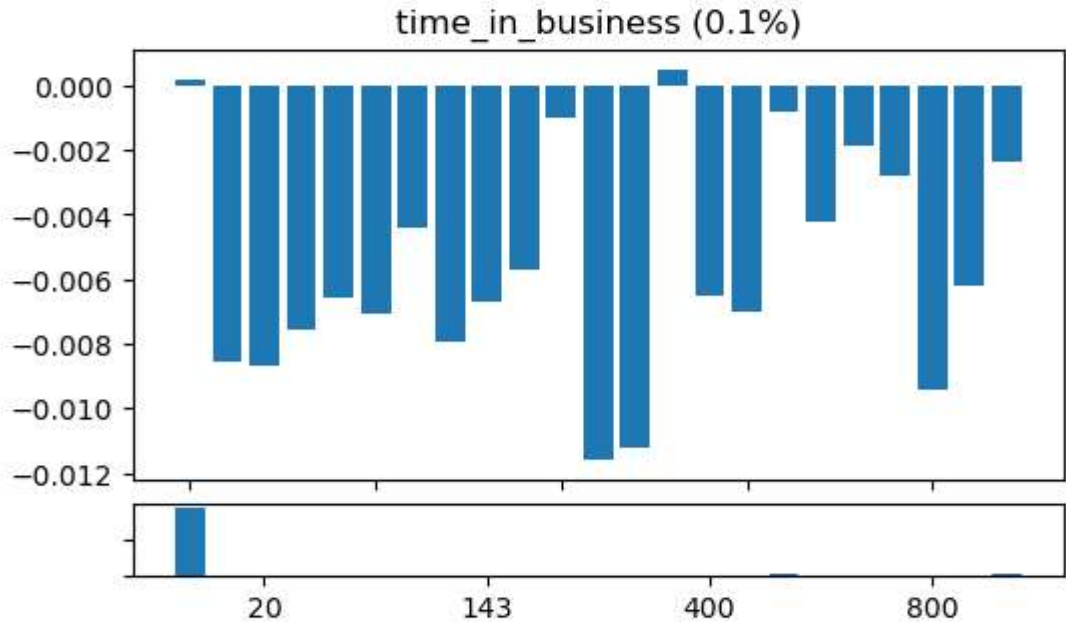
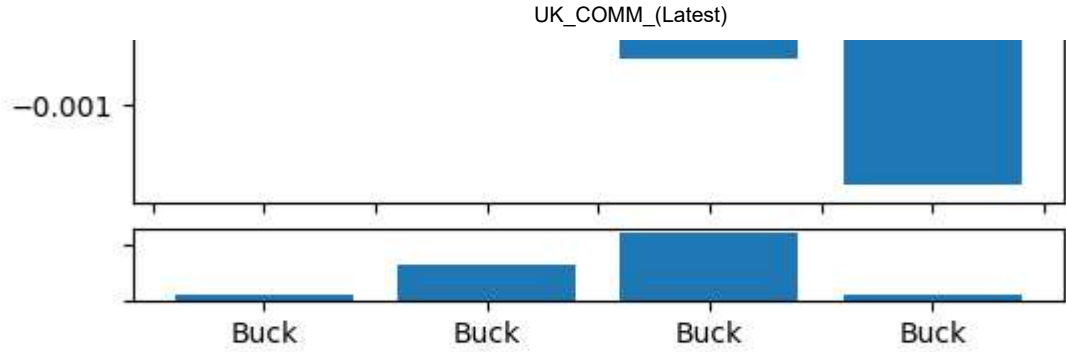


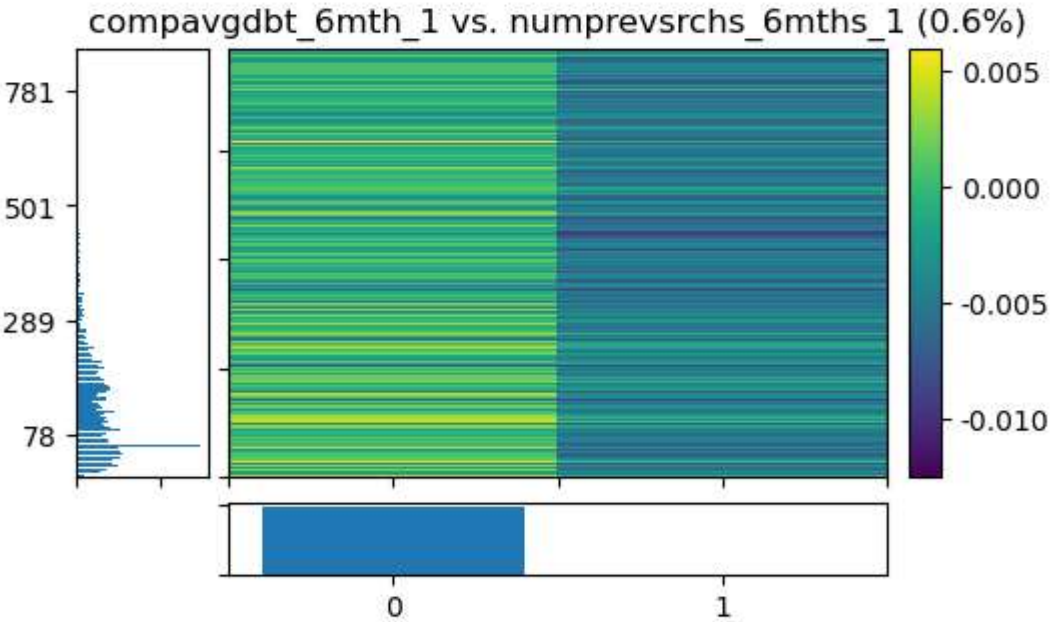
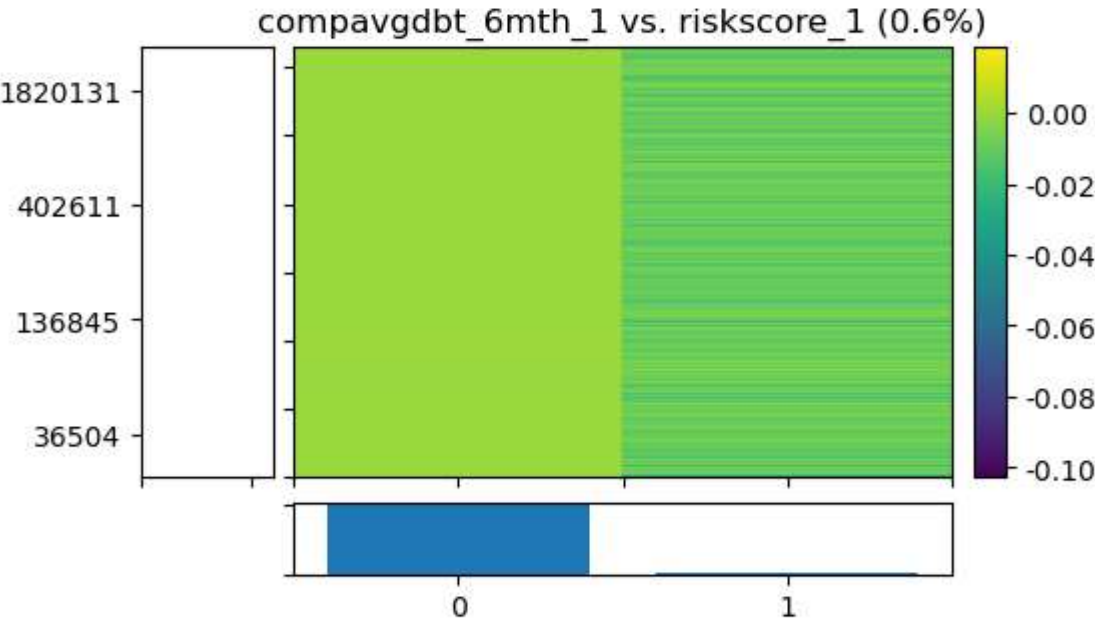
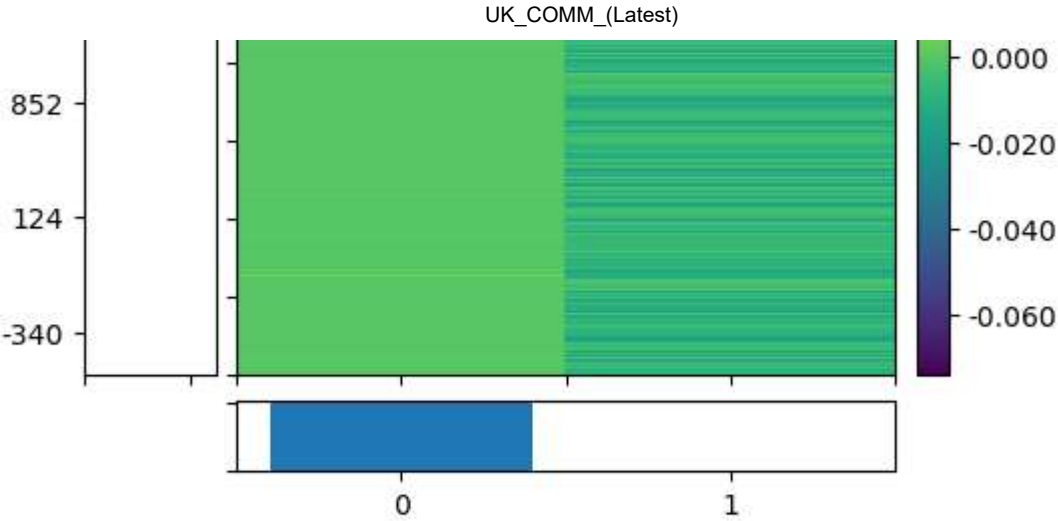


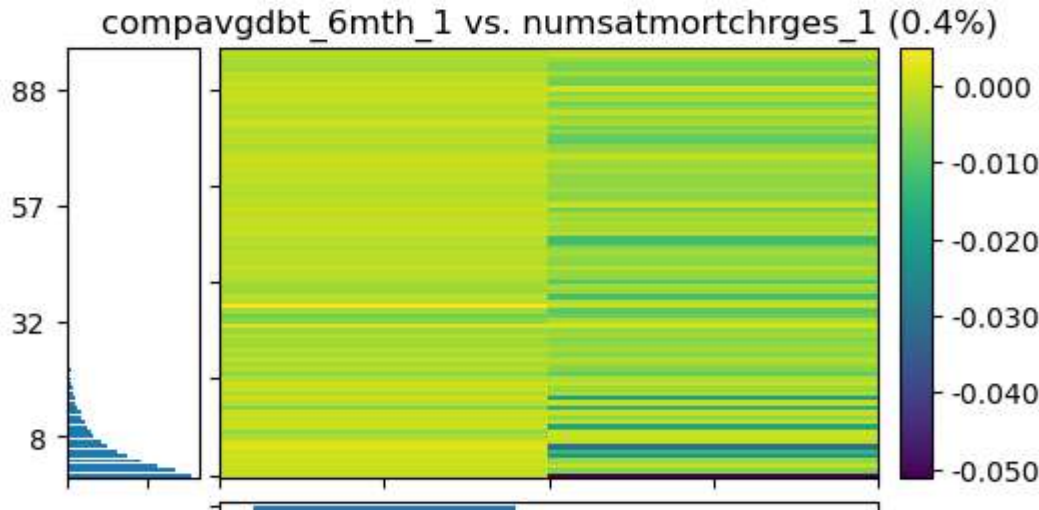
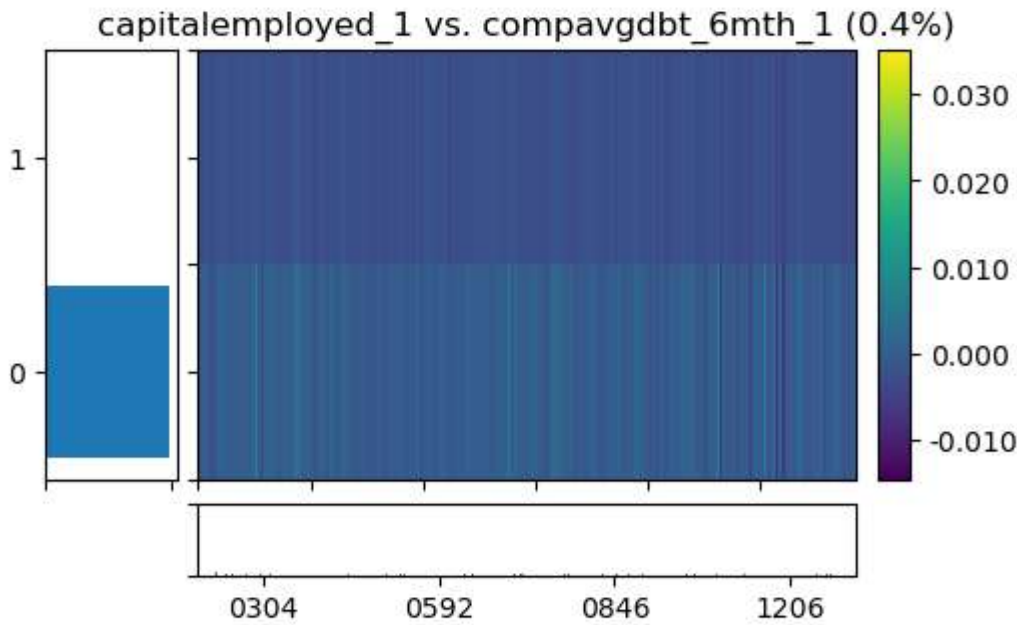
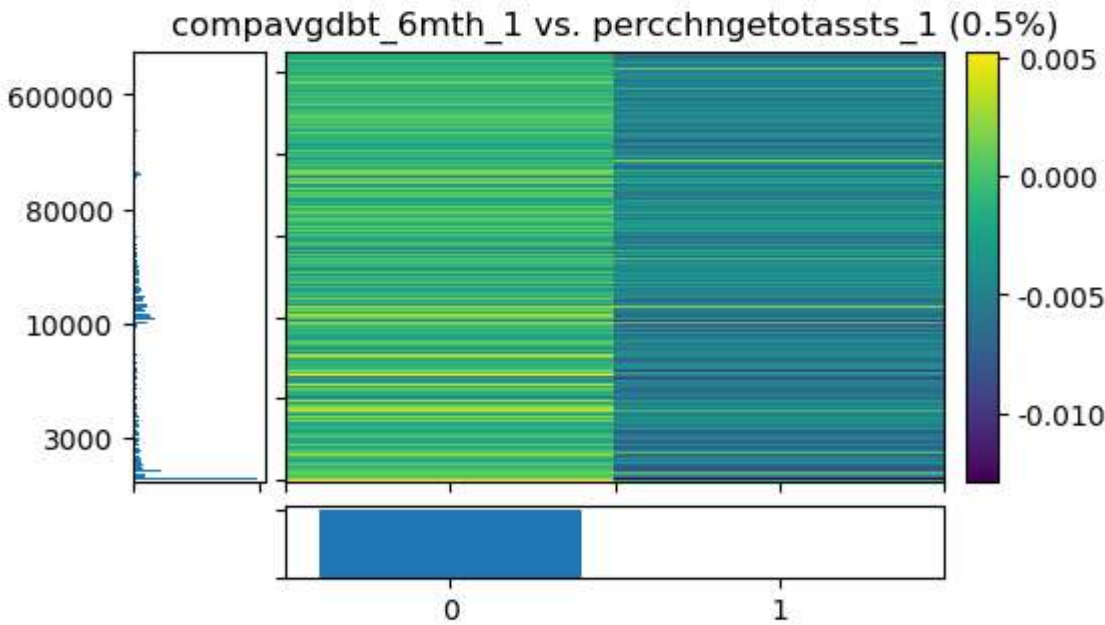


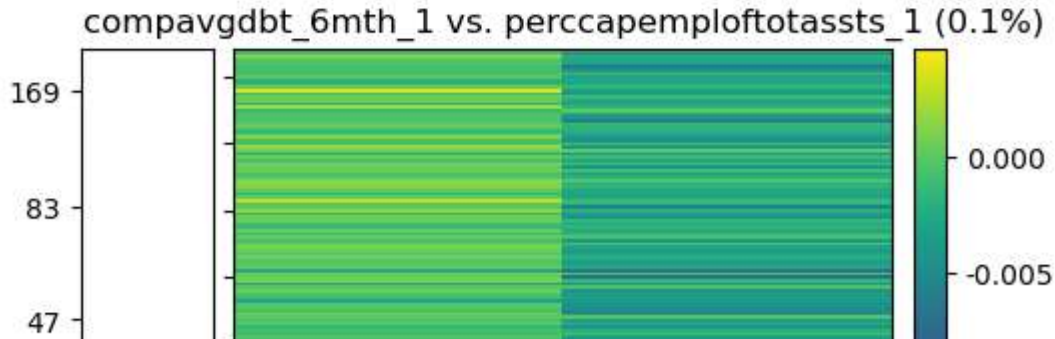
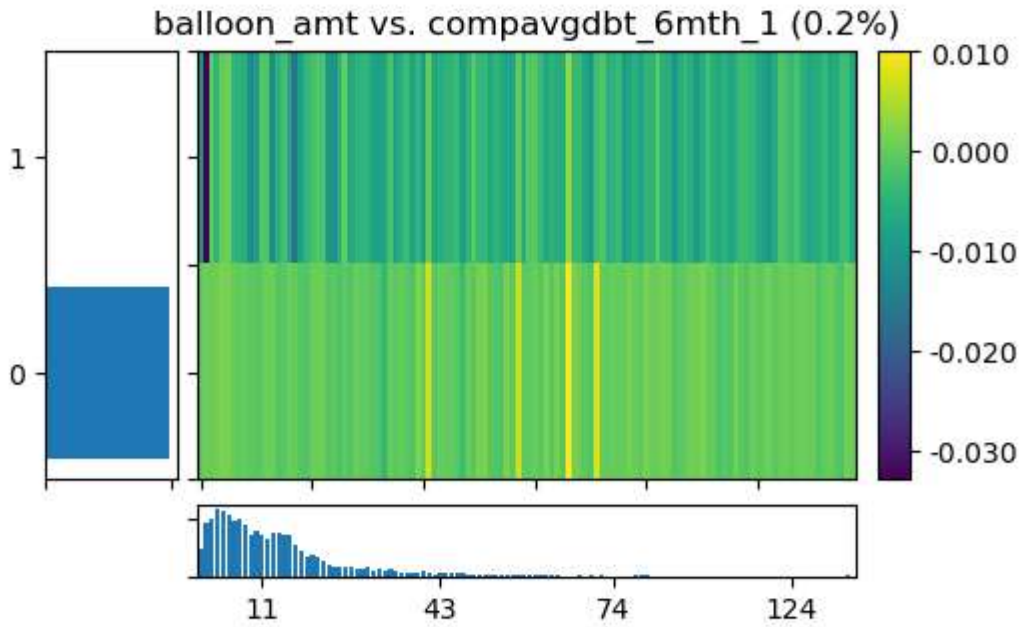
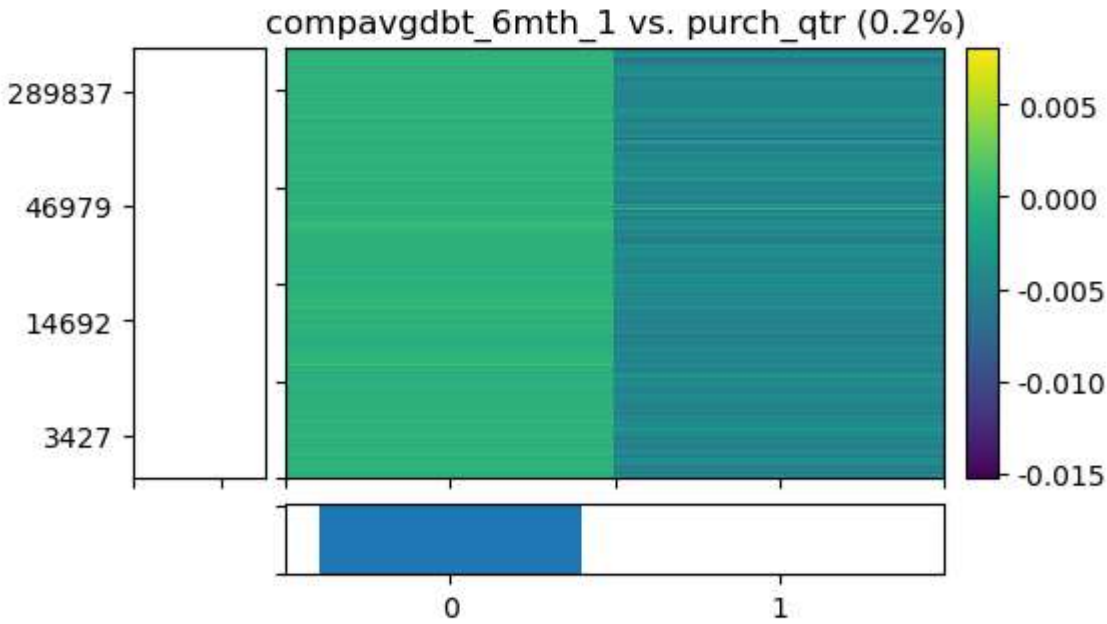
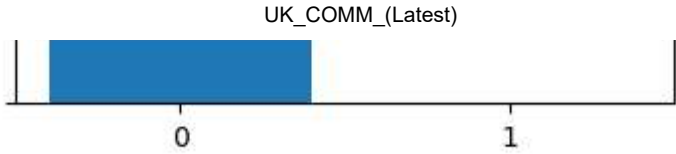


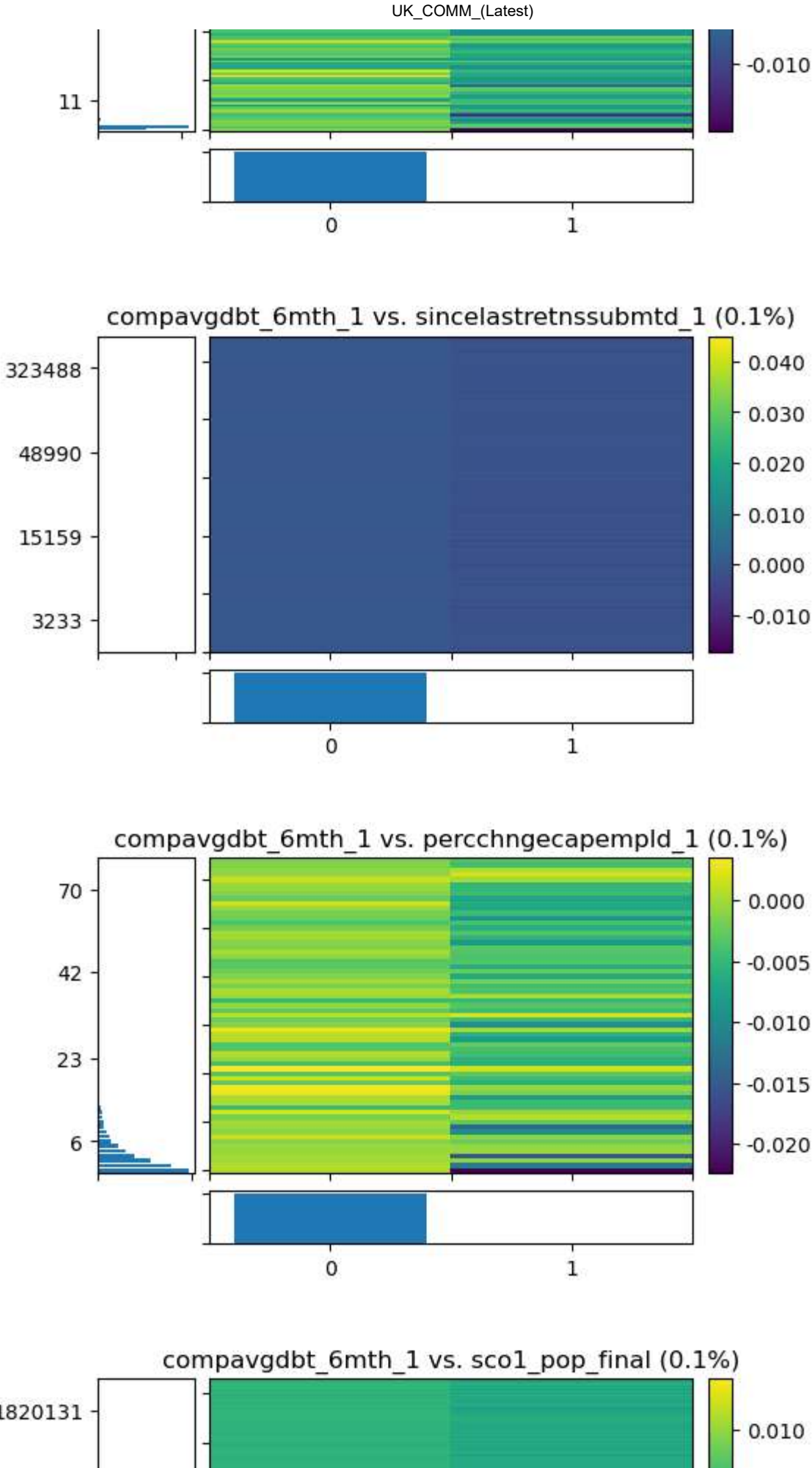


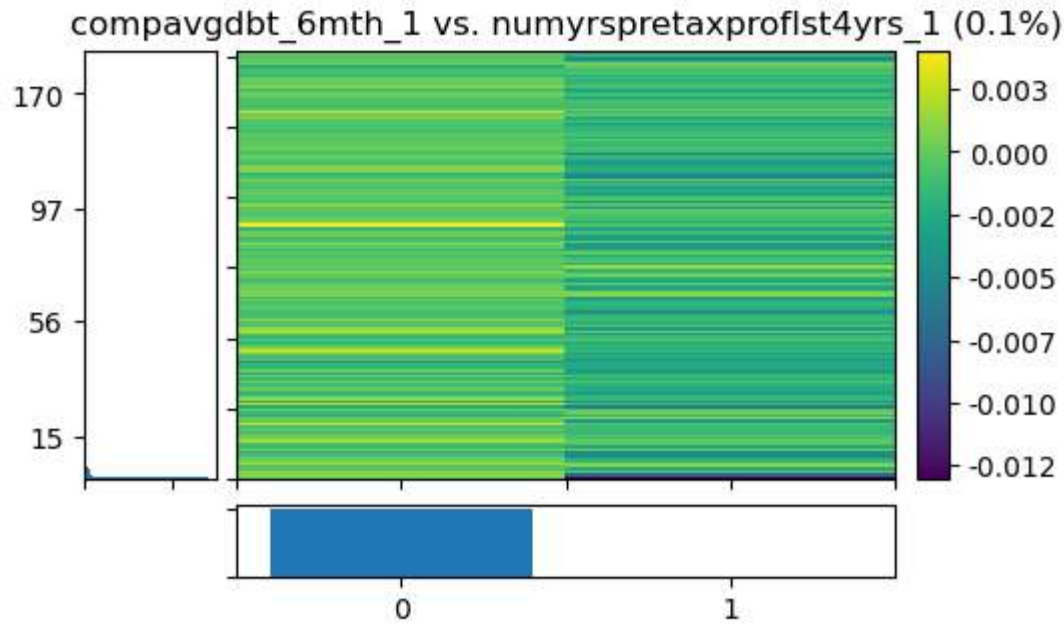
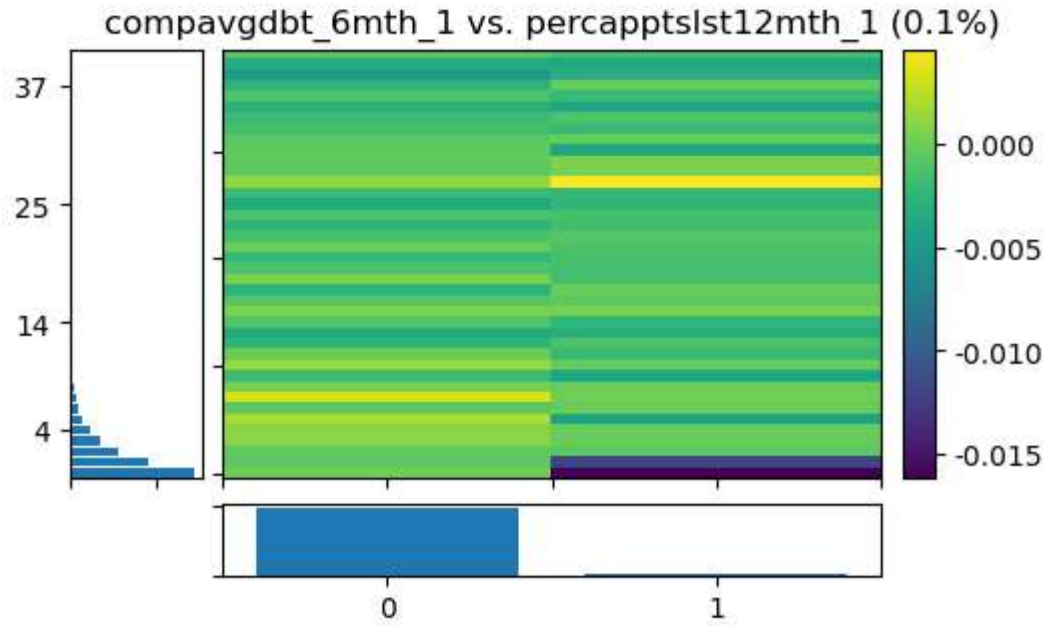
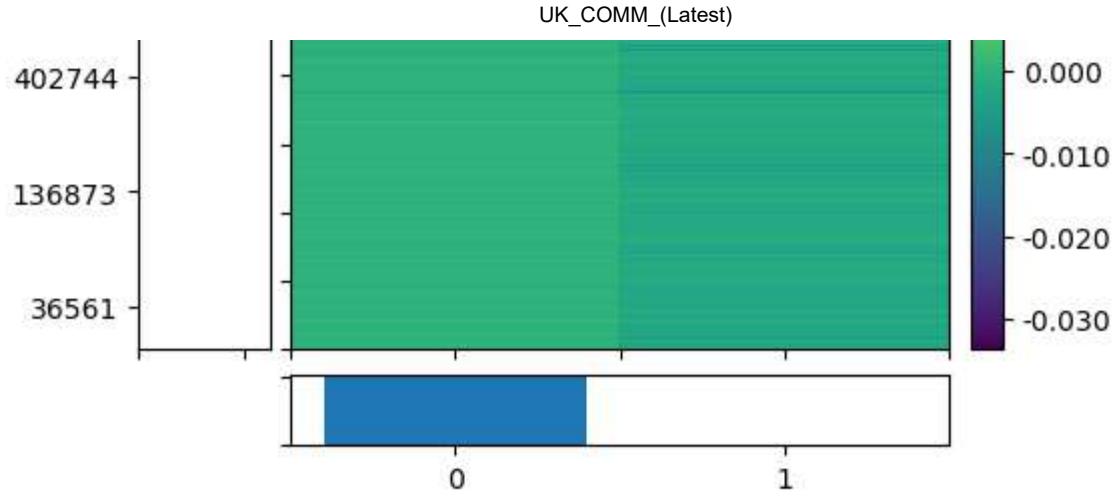


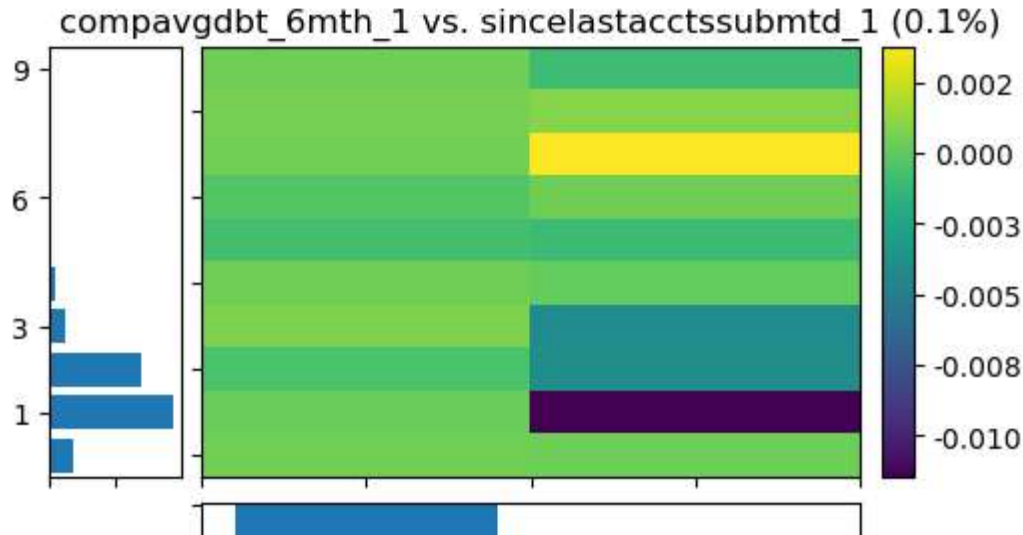
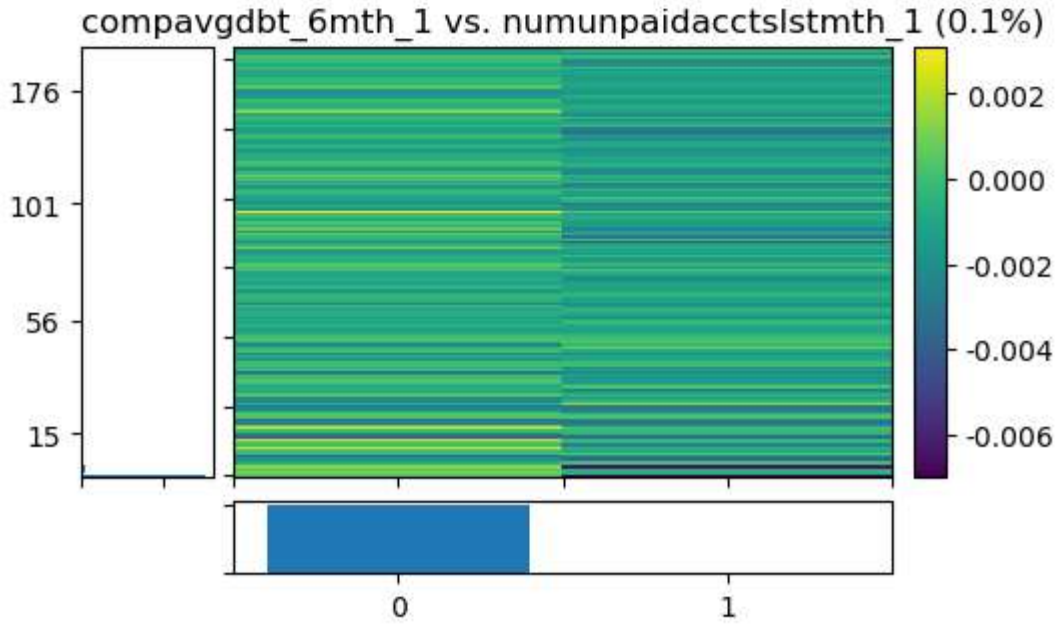
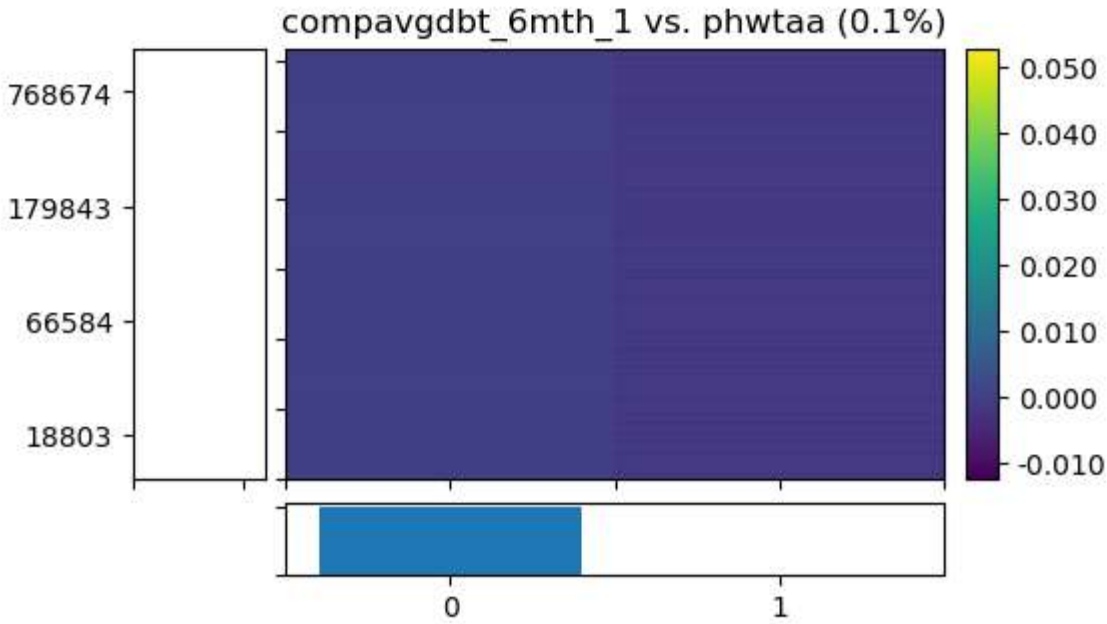


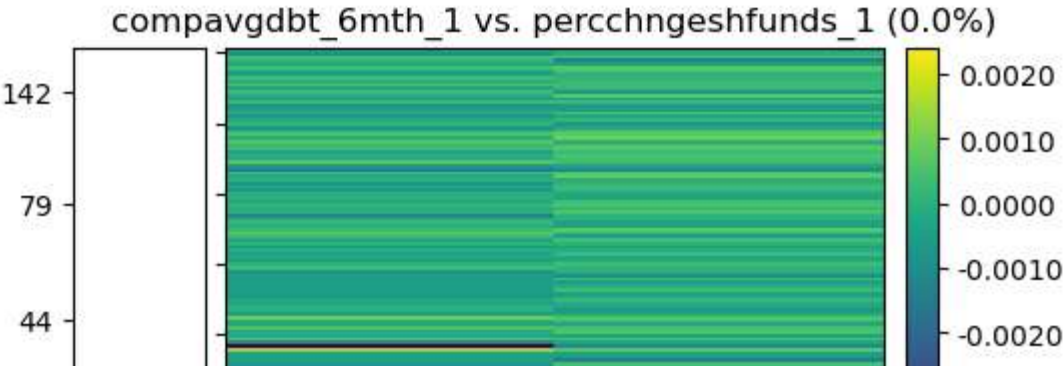
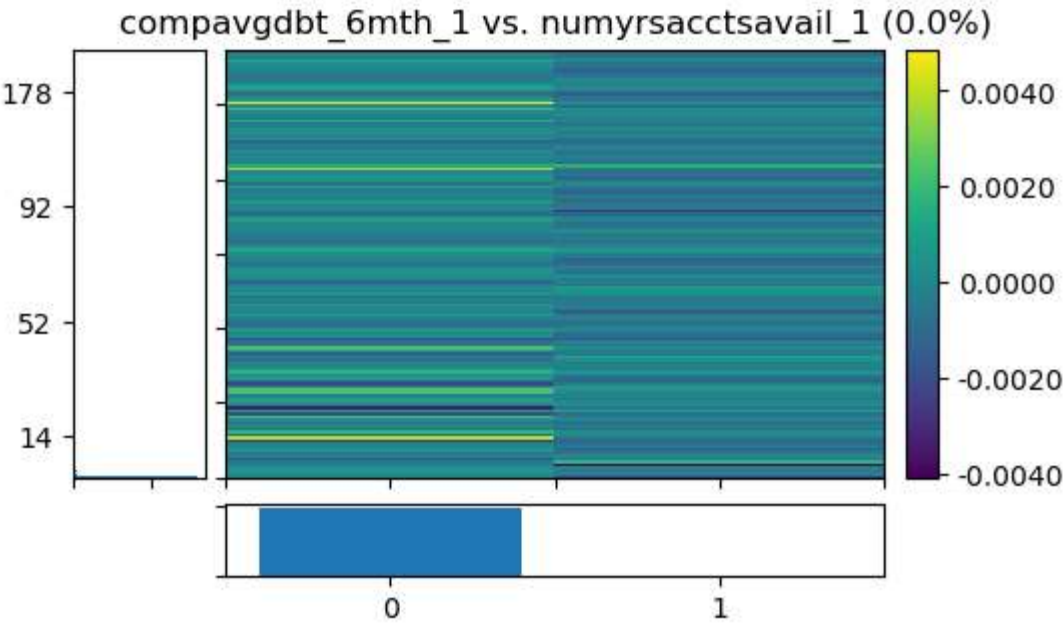
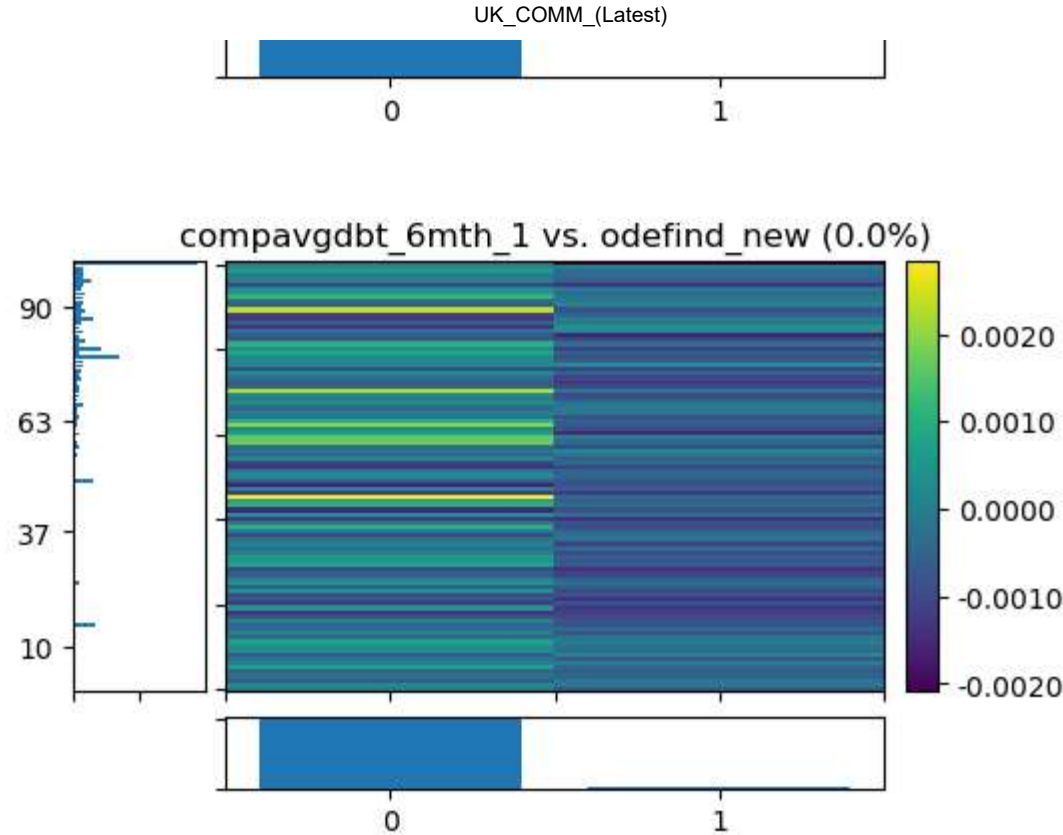


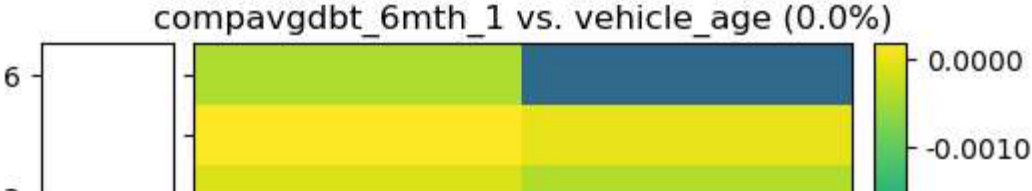
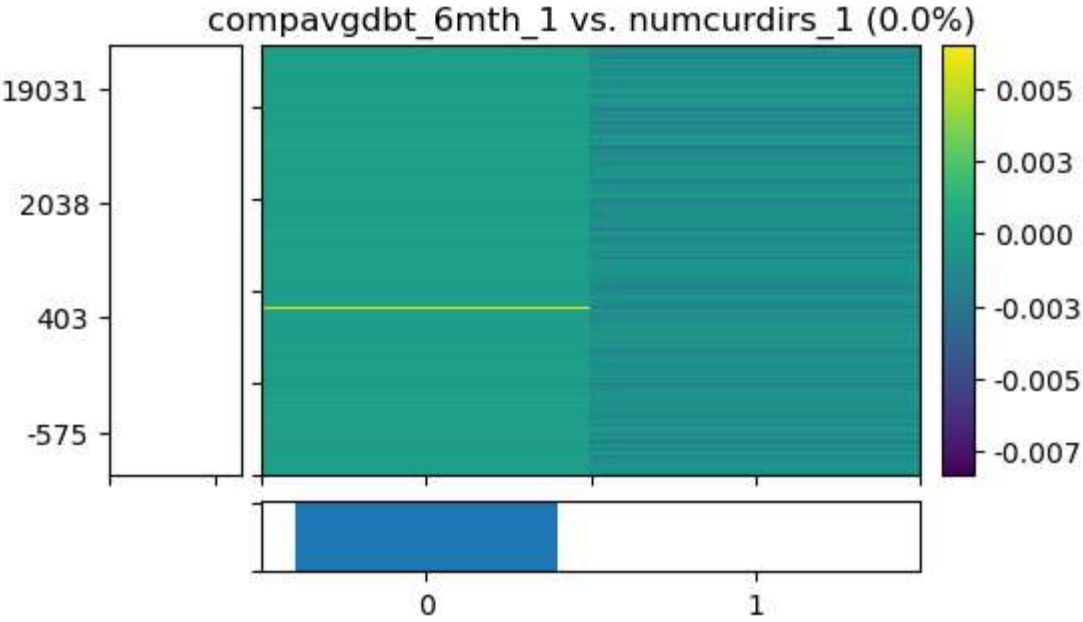
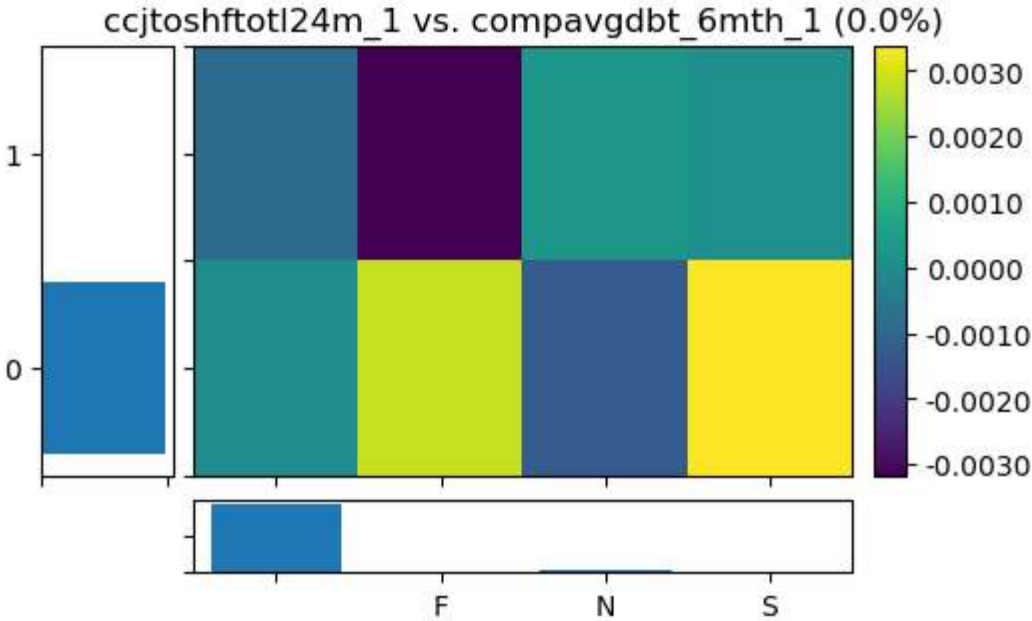
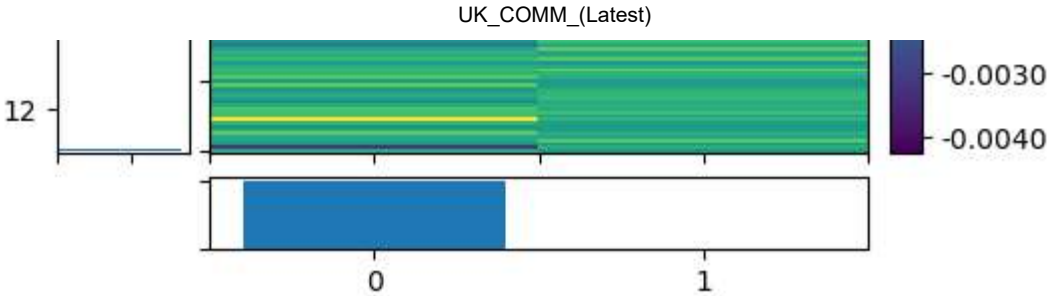


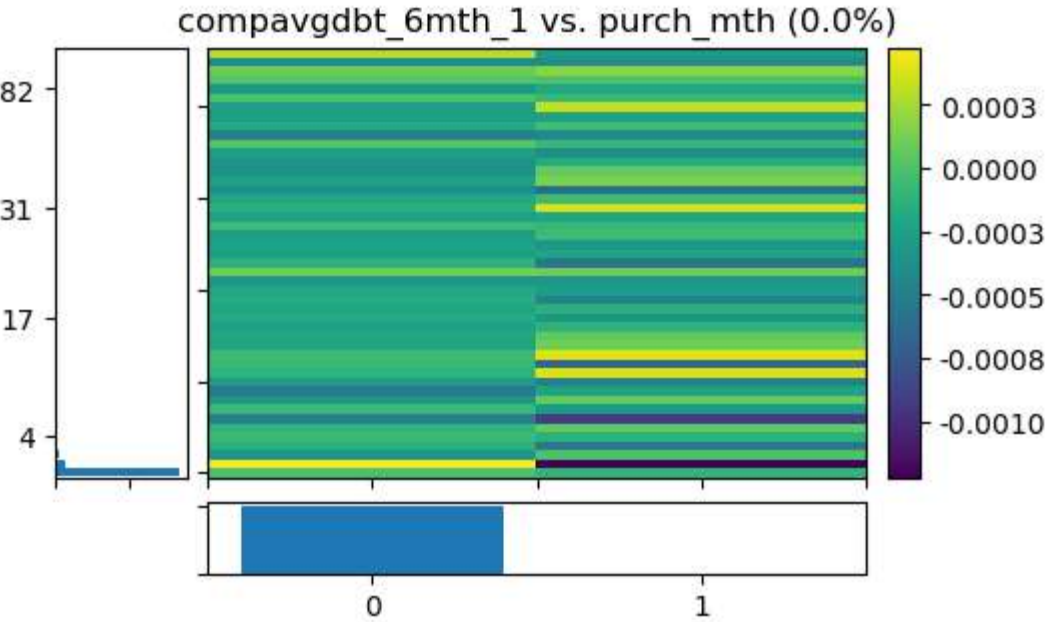
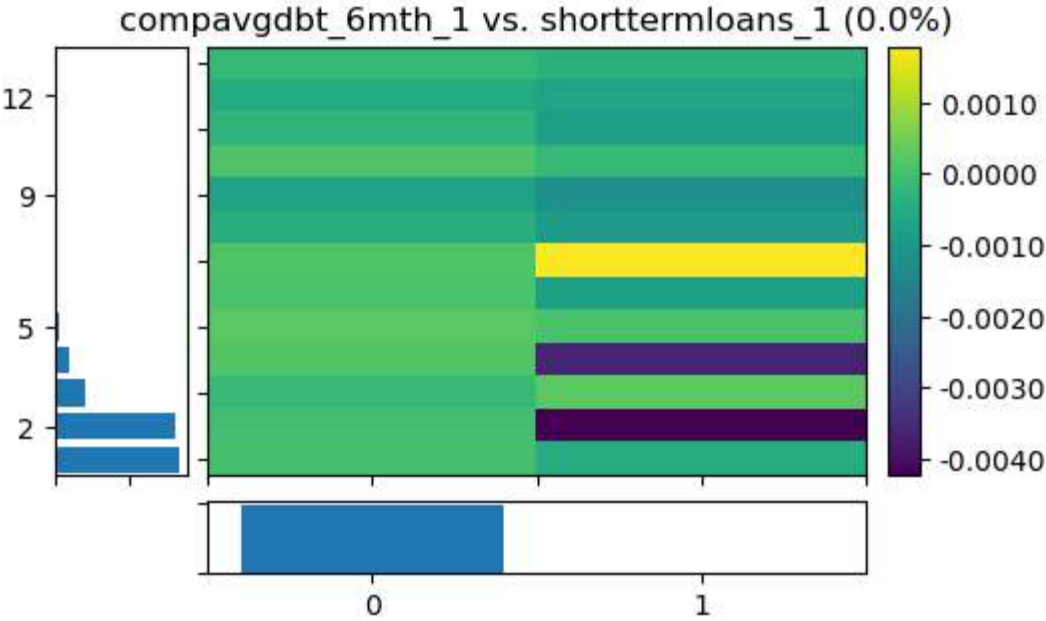
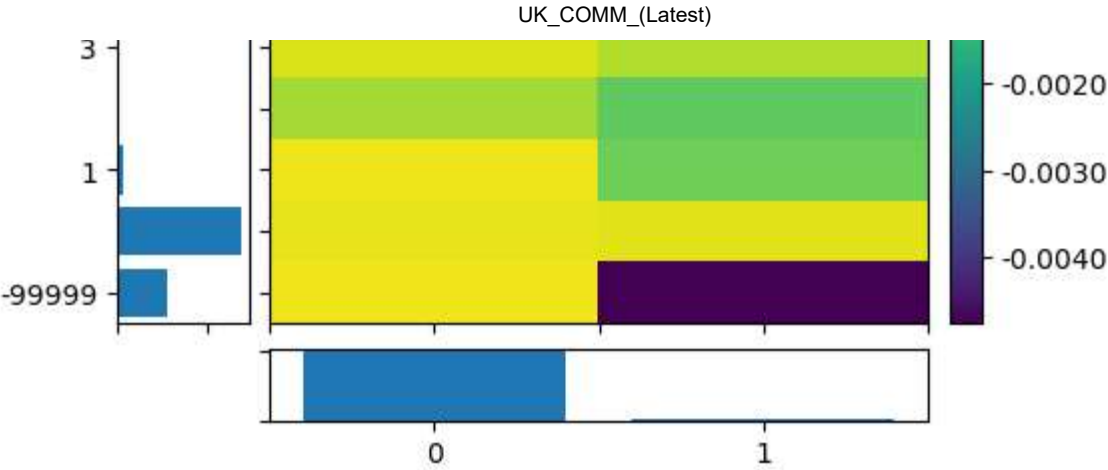




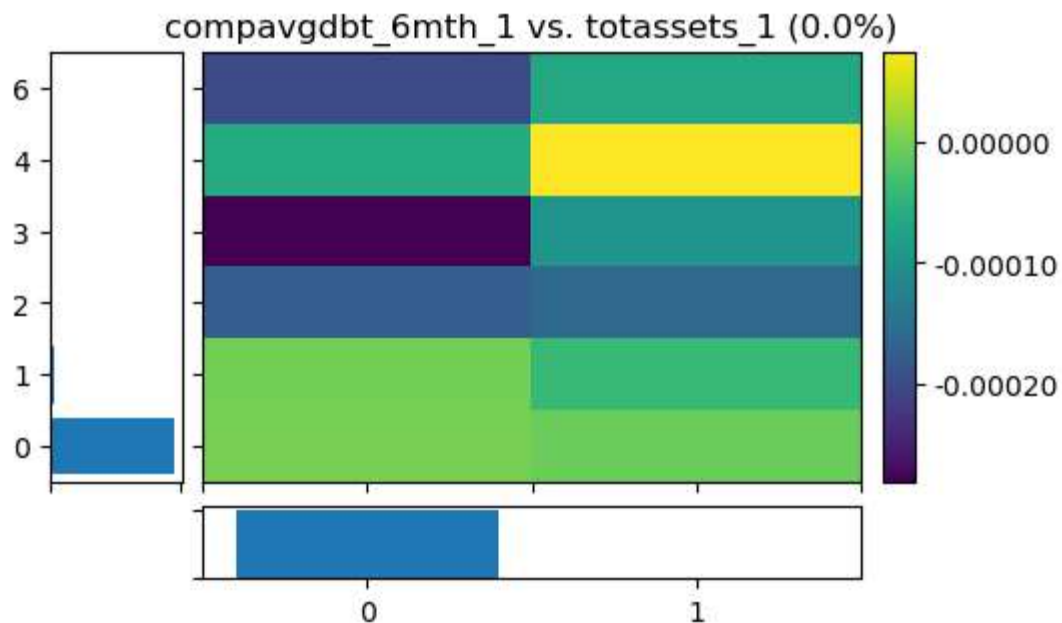
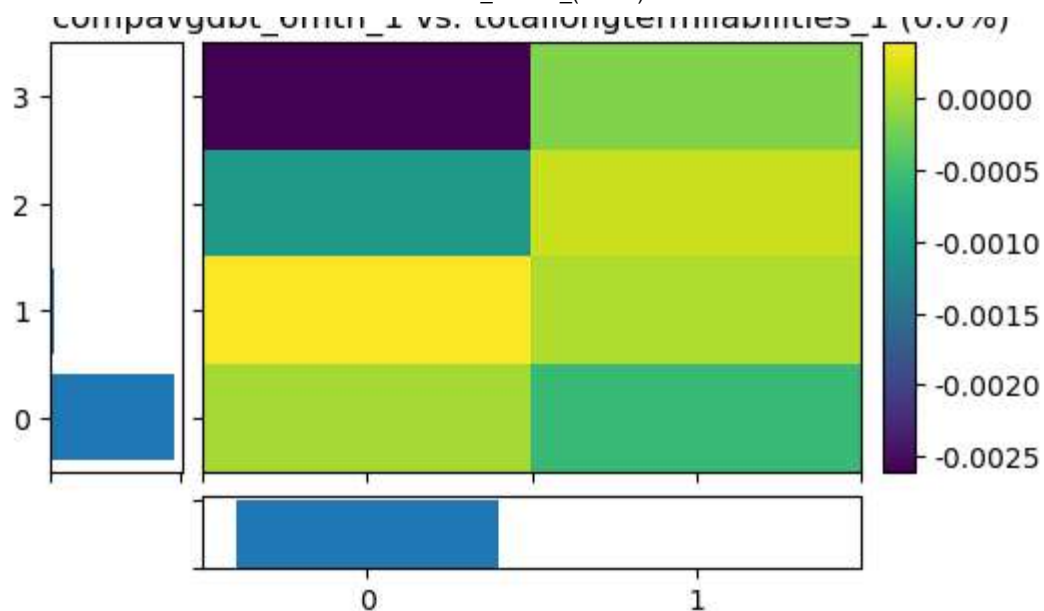




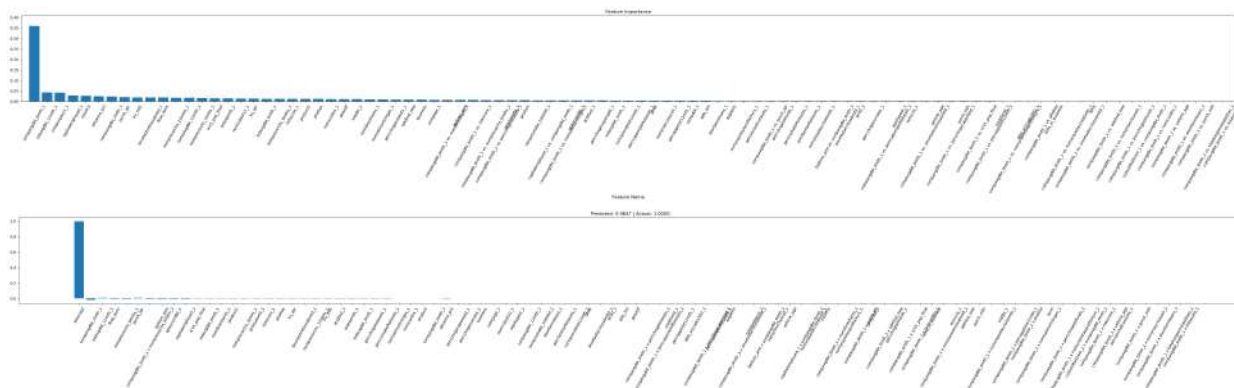




compavgdbt_6mth_1 vs. totallongtermliabilities_1 (0.0%)



```
In [16]: feature_importance_visualize(data_dict_global)
data_dict_local = model.local_explain(test_x[[0]], test_y[[0]], save_dict=False)
local_visualize(data_dict_local[0], save_png=False)
```



```
In [17]: model.save(folder=".", name="mod01")
```

```
In [ ]: pred_train = model.predict(train_x)
        pred_test = model.predict(test_x)
        print(r2_score(test_y, pred_test))
        print(r2_score(train_y, pred_train))
```

```
In [ ]:
```