In [ ]:
```
import covsirphy as cs
import matplotlib.pyplot as plt
from datetime import timedelta
```

SIRF model

Receive Data for specified country (Sweden)

In [ ]:
```
country = "Sweden"
scenario = cs.ODEScenario.auto_build(geo=country, model=cs.SIRFModel)
```

```
100%|██████████| 82/82 [01:46<00:00,  1.30s/it]
```

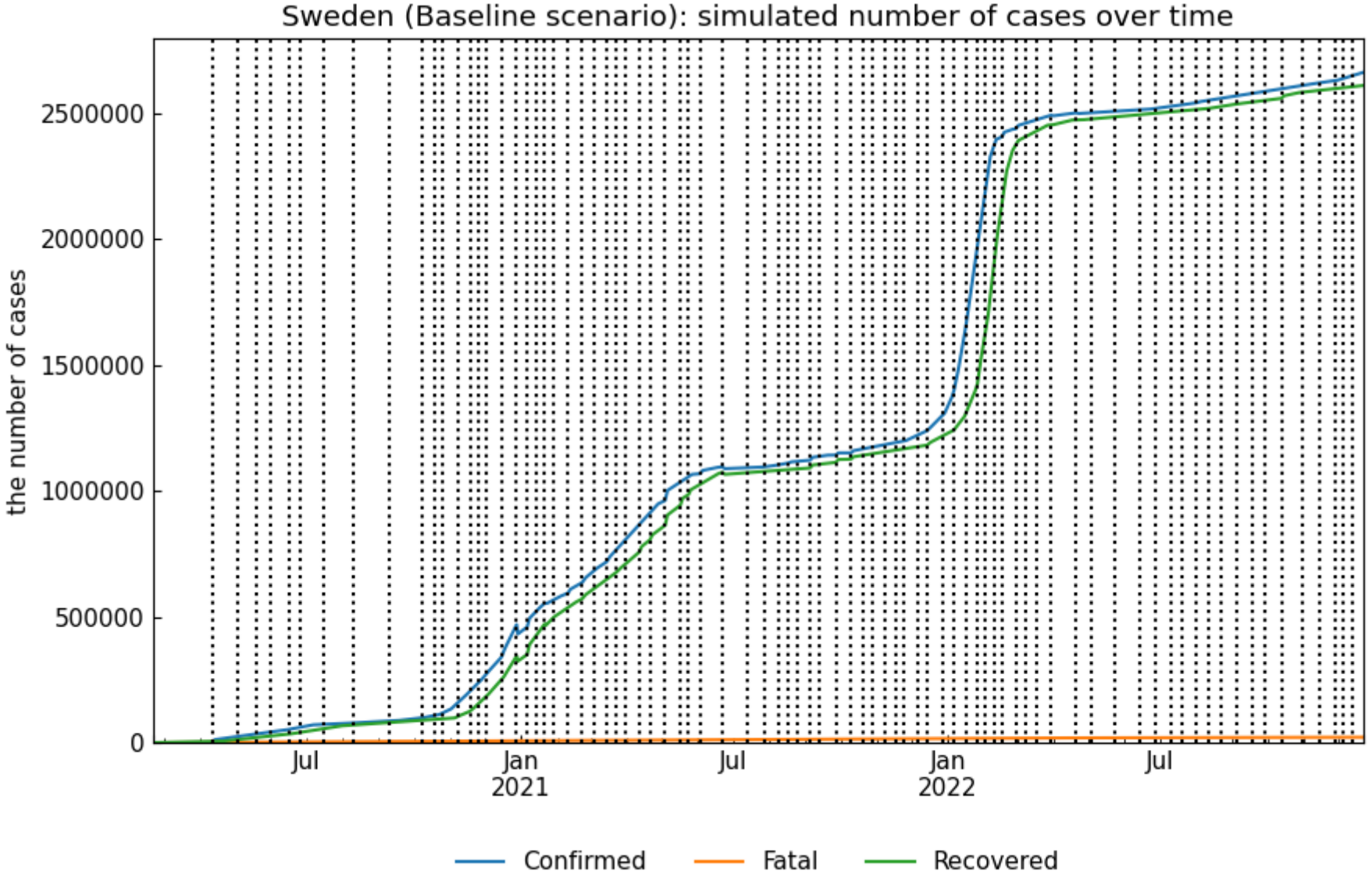
In [ ]:
```
scenario.summary()
```

Out[ ]:

Scenario	Phase	Start	End	Rt	theta	kappa	rho	sigma	alpha1 [-]	1/alpha2 [day]	1/beta [day]	1/gamma [day]	ODE	tau
Baseline	**0th**	2020-02-21	2020-04-11	1.64	0.315843	0.006406	0.095466	0.033435	0.316	156	10	30	SIR-F Model	1440
	1st	2020-04-12	2020-05-03	1.25	0.0009	0.011445	0.078325	0.050945	0.001	87	13	20	SIR-F Model	1440
	2nd	2020-05-04	2020-05-18	1.03	0.011291	0.007056	0.072478	0.0623	0.011	142	14	16	SIR-F Model	1440
	3rd	2020-05-19	2020-05-31	1.08	0.000449	0.005377	0.070392	0.059848	0.0	186	14	17	SIR-F Model	1440
	4th	2020-06-01	2020-06-16	1.95	0.000091	0.003595	0.079211	0.037029	0.0	278	13	27	SIR-F Model	1440
	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	77th	2022-10-31	2022-11-14	1.85	0.131477	0.001462	0.062559	0.027836	0.131	684	16	36	SIR-F Model	1440
	78th	2022-11-15	2022-11-27	1.56	0.032696	0.001401	0.080214	0.048406	0.033	714	12	21	SIR-F Model	1440
	79th	2022-11-28	2022-12-04	2.99	0.000241	0.00141	0.145052	0.047102	0.0	709	7	21	SIR-F Model	1440
	80th	2022-12-05	2022-12-11	6.16	0.003706	0.00153	0.127482	0.019085	0.004	653	8	52	SIR-F Model	1440
	81st	2022-12-12	2022-12-22	5.82	0.013106	0.000178	0.090465	0.015174	0.013	5632	11	66	SIR-F Model	1440

82 rows × 13 columns

In [ ]:
```
scenario.simulate(name="Baseline")
```


Sweden (Baseline scenario): simulated number of cases over time
the number of cases
2500000
2000000
1500000
1000000
500000
0
Jul
Jan
2021
Jul
Jan
2022
Jul
Confirmed
Fatal
Recovered

Out[ ]:

Date	Confirmed	Fatal	Recovered
2020-02-21	1	0.0	1.0
2020-02-22	1	0.0	1.0
2020-02-23	1	0.0	1.0
2020-02-24	1	0.0	1.0
2020-02-25	1	0.0	1.0
...	...	...	...
2022-12-18	2655529	21570.0	2609040.0
2022-12-19	2657238	21597.0	2609428.0
2022-12-20	2659035	21625.0	2609836.0
2022-12-21	2660925	21655.0	2610265.0
2022-12-22	2662912	21686.0	2610717.0

1036 rows × 3 columns

In [ ]:

```
scenario.track()
```

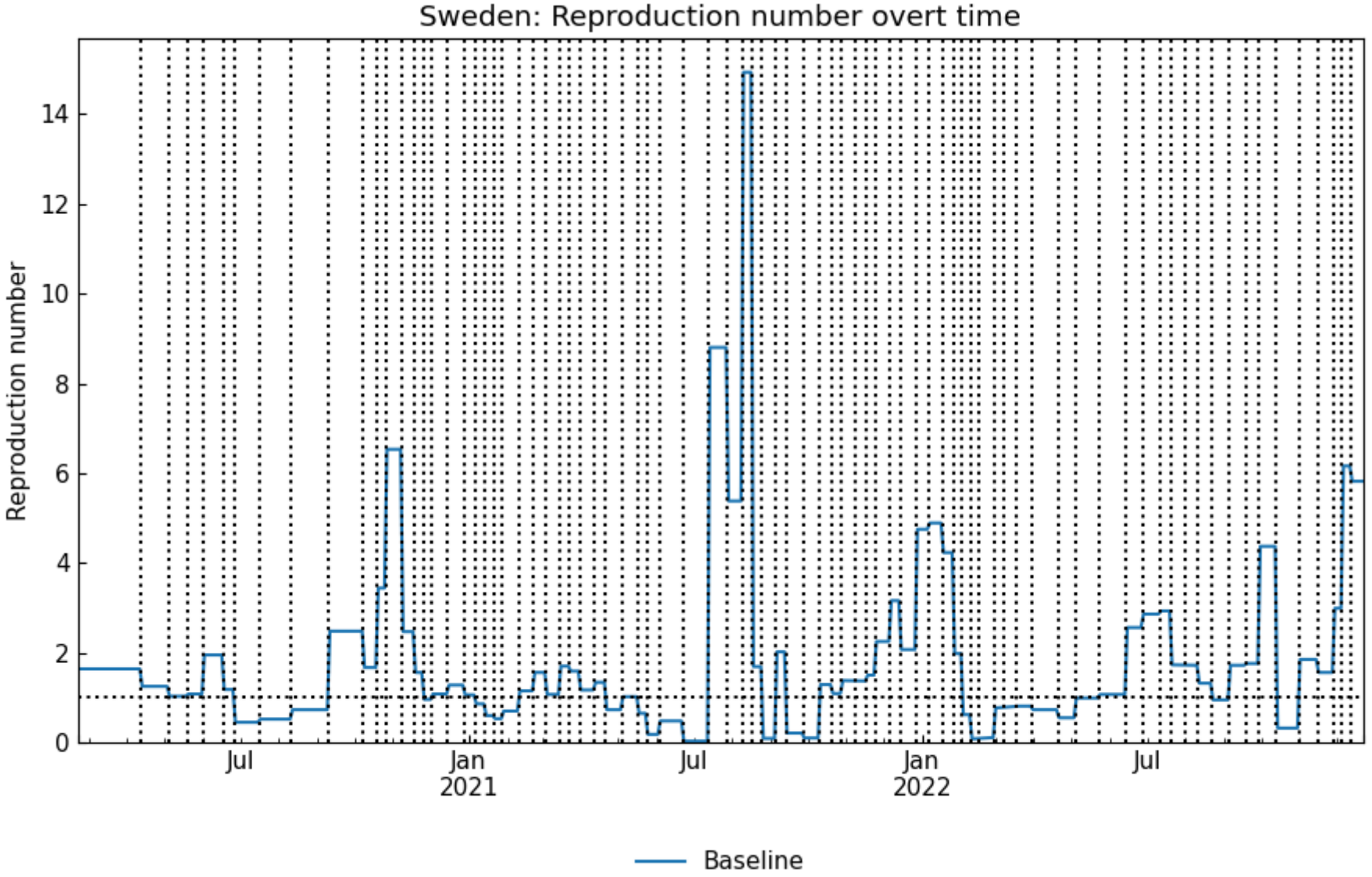
Out[ ]:

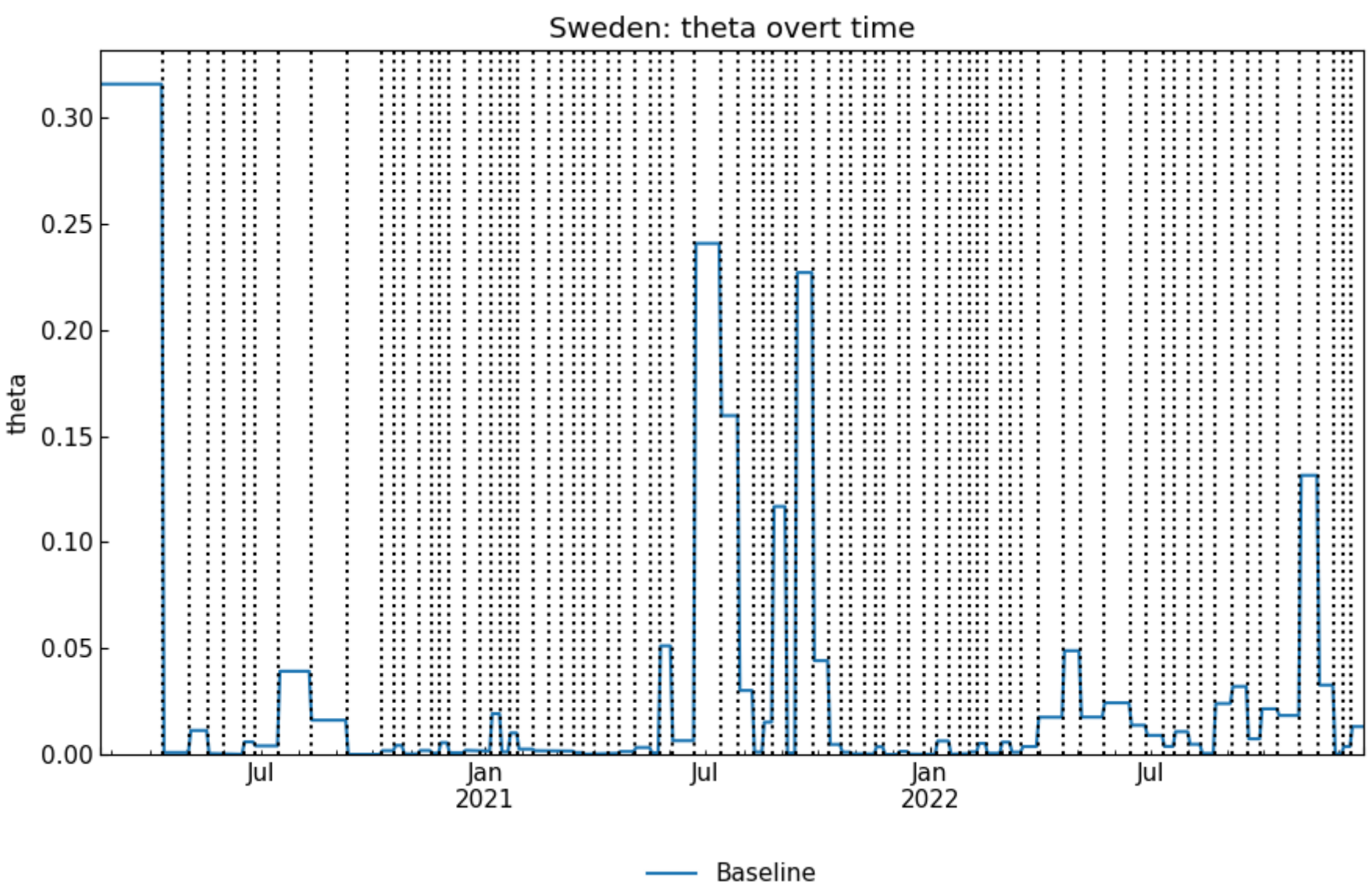
Date	Scenario	Phase	Rt	theta	kappa	rho	sigma	alpha1 [-]	1/alpha2 [day]	1/beta [day]	1/gamma [day]	ODE	tau
2020-02-21	Baseline	0th	1.64	0.315843	0.006406	0.095466	0.033435	0.316	156	10	30	SIR-F Model	1440
2020-02-22	Baseline	0th	1.64	0.315843	0.006406	0.095466	0.033435	0.316	156	10	30	SIR-F Model	1440
2020-02-23	Baseline	0th	1.64	0.315843	0.006406	0.095466	0.033435	0.316	156	10	30	SIR-F Model	1440
2020-02-24	Baseline	0th	1.64	0.315843	0.006406	0.095466	0.033435	0.316	156	10	30	SIR-F Model	1440
2020-02-25	Baseline	0th	1.64	0.315843	0.006406	0.095466	0.033435	0.316	156	10	30	SIR-F Model	1440
...	...	...	...	...	...	...	...	...	...	...	...	...	...
2022-12-18	Baseline	81st	5.82	0.013106	0.000178	0.090465	0.015174	0.013	5632	11	66	SIR-F Model	1440
2022-12-19	Baseline	81st	5.82	0.013106	0.000178	0.090465	0.015174	0.013	5632	11	66	SIR-F Model	1440
2022-12-20	Baseline	81st	5.82	0.013106	0.000178	0.090465	0.015174	0.013	5632	11	66	SIR-F Model	1440
2022-12-21	Baseline	81st	5.82	0.013106	0.000178	0.090465	0.015174	0.013	5632	11	66	SIR-F Model	1440
2022-12-22	Baseline	81st	5.82	0.013106	0.000178	0.090465	0.015174	0.013	5632	11	66	SIR-F Model	1440

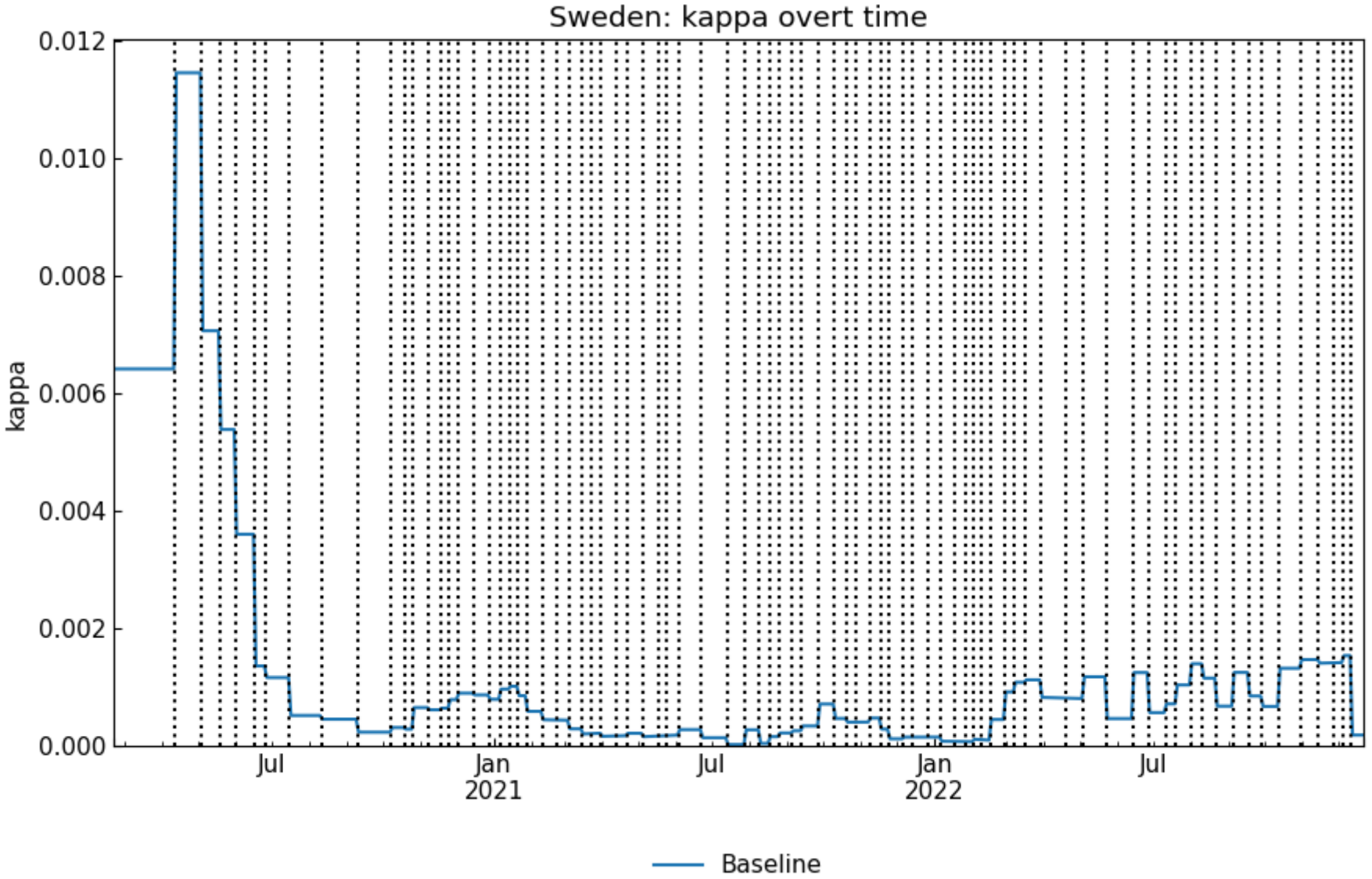
1036 rows × 13 columns

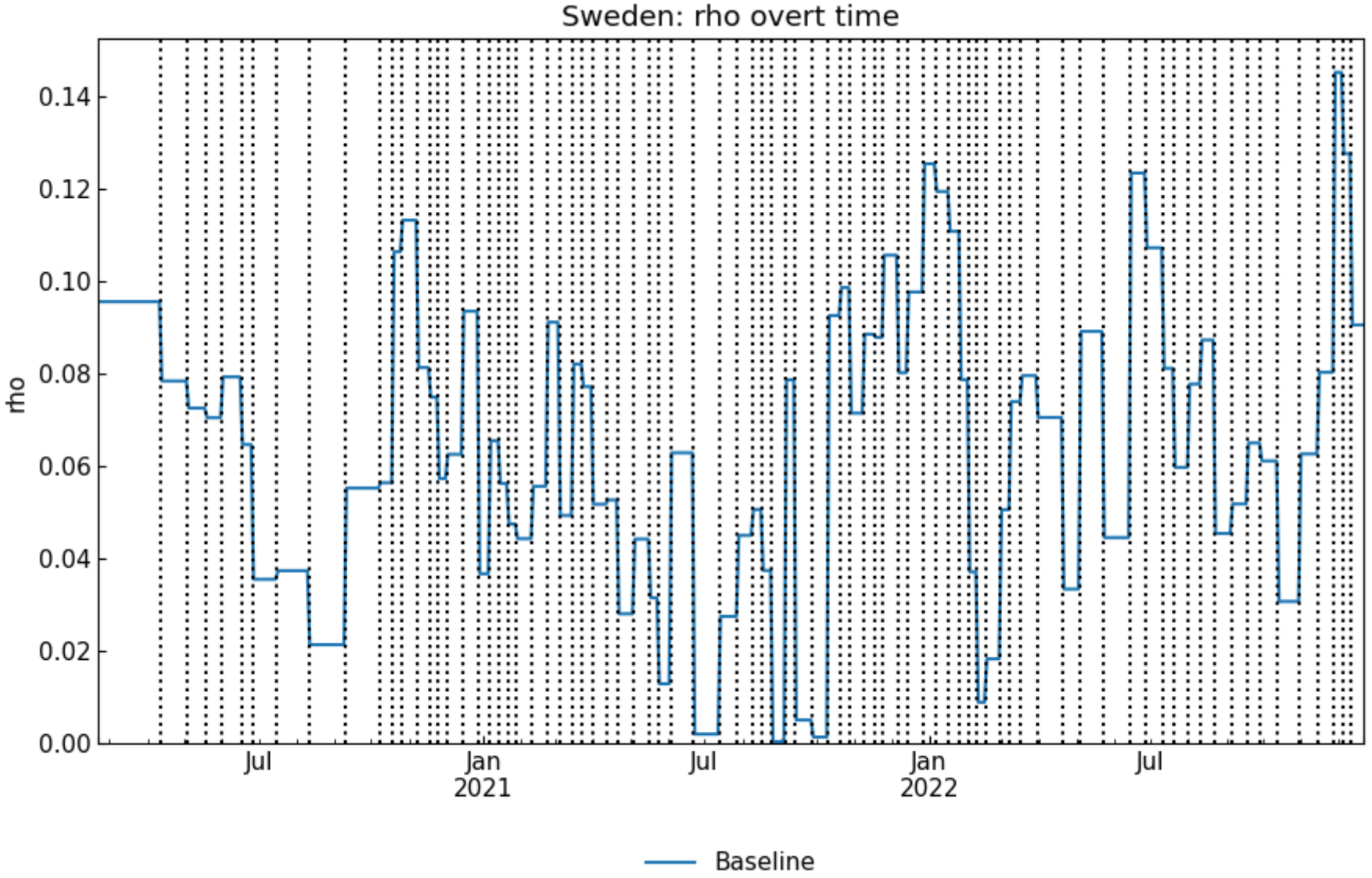
In [ ]:

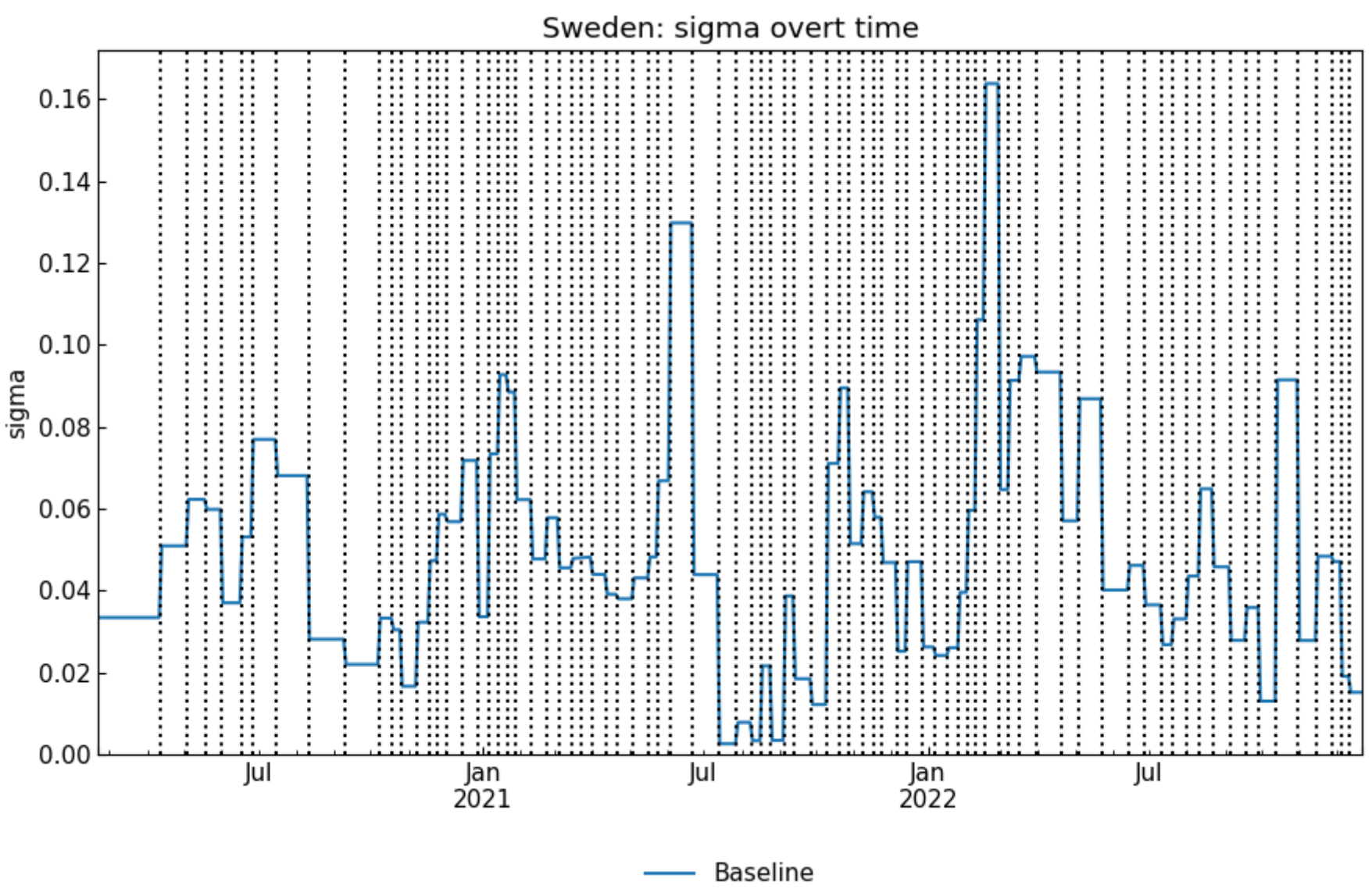
```
scenario.compare_param("Rt")
scenario.compare_param("theta")
scenario.compare_param("kappa")
scenario.compare_param("rho")
scenario.compare_param("sigma")
scenario.compare_param("tau")
```

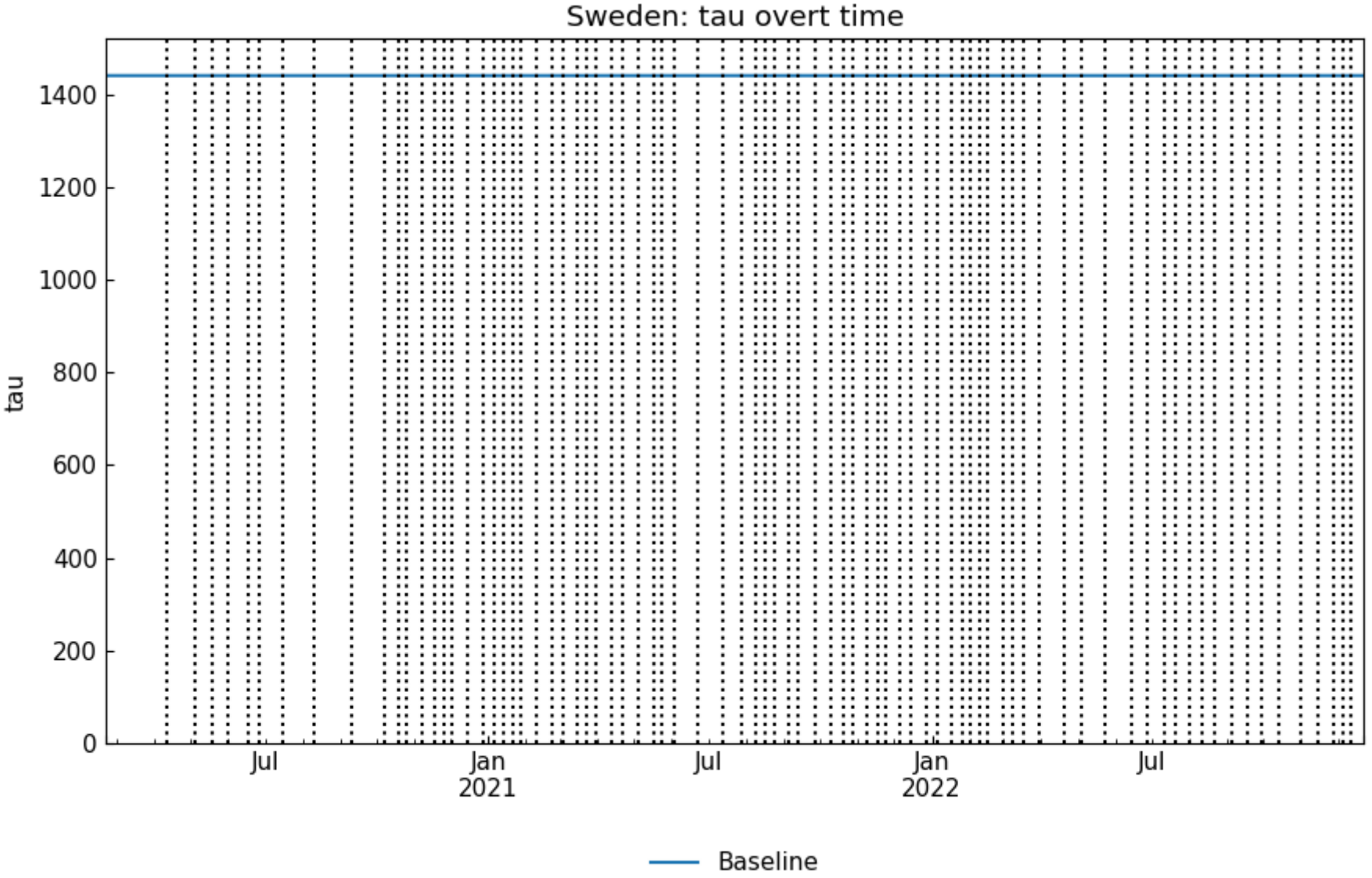

Sweden: Reproduction number overt time
Reproduction number
0
2
4
6
8
10
12
14
Jul
Jan
2021
Jul
Jan
2022
Jul
Baseline


Sweden: theta overt time
theta
0.30
0.25
0.20
0.15
0.10
0.05
0.00
Jul
Jan
2021
Jul
Jan
2022
Jul
Baseline


Sweden: kappa overt time
kappa
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Jul
Jan
2021
Jul
Jan
2022
Jul
Baseline


Sweden: rho overt time
rho
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jul
Jan
2021
Jul
Jan
2022
Jul
Baseline


Sweden: sigma overt time
sigma
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Jul
Jan
2021
Jul
Jan
2022
Jul
Baseline


Sweden: tau overt time
tau
0
200
400
600
800
1000
1200
1400
Jul
Jan
2021
Jul
Jan
2022
Jul
Baseline

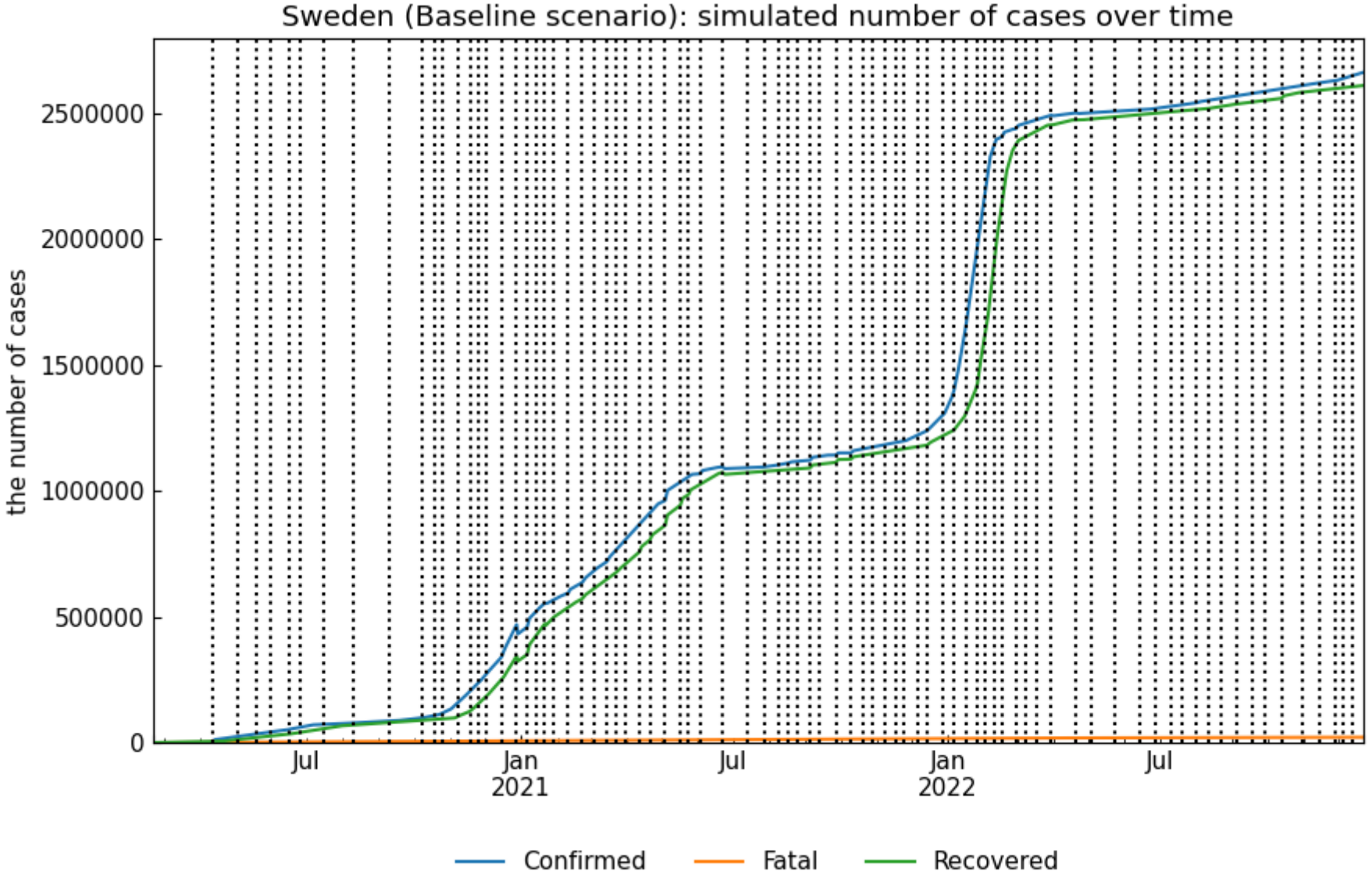
Out[ ]:

Scenario	Baseline
Date	
2020-02-21	1440
2020-02-22	1440
2020-02-23	1440
2020-02-24	1440
2020-02-25	1440
...	...
2022-12-18	1440
2022-12-19	1440
2022-12-20	1440
2022-12-21	1440
2022-12-22	1440

1036 rows × 1 columns

In [ ]:

```
scenario.simulate(name="Baseline")
```


Sweden (Baseline scenario): simulated number of cases over time
the number of cases
2500000
2000000
1500000
1000000
500000
0
Jul
Jan
2021
Jul
Jan
2022
Jul
Confirmed
Fatal
Recovered

Out[ ]:

Date	Confirmed	Fatal	Recovered
2020-02-21	1	0.0	1.0
2020-02-22	1	0.0	1.0
2020-02-23	1	0.0	1.0
2020-02-24	1	0.0	1.0
2020-02-25	1	0.0	1.0
...	...	...	...
2022-12-18	2655529	21570.0	2609040.0
2022-12-19	2657238	21597.0	2609428.0
2022-12-20	2659035	21625.0	2609836.0
2022-12-21	2660925	21655.0	2610265.0
2022-12-22	2662912	21686.0	2610717.0

1036 rows × 3 columns

For prediction

In [ ]:
```
future_start_date = scenario.simulate(display=False).index.max() + timedelta(days=1)
future_start_date
```

Out[ ]:
```
Timestamp('2022-12-23 00:00:00')
```

Predict for 7 days

In [ ]:
```
scenario.build_with_template(name="Predicted", template="Baseline");

scenario.predict(days=7, name="Predicted")
```

```
Using 3 cpus for n_jobs.
Model Number: 1 with model AverageValueNaive in generation 0 of 1
Model Number: 2 with model AverageValueNaive in generation 0 of 1
Model Number: 3 with model AverageValueNaive in generation 0 of 1
Model Number: 4 with model GLS in generation 0 of 1
Model Number: 5 with model GLS in generation 0 of 1
Model Number: 6 with model LastValueNaive in generation 0 of 1
Model Number: 7 with model LastValueNaive in generation 0 of 1
Model Number: 8 with model LastValueNaive in generation 0 of 1
Model Number: 9 with model LastValueNaive in generation 0 of 1
Model Number: 10 with model SeasonalNaive in generation 0 of 1
Model Number: 11 with model SeasonalNaive in generation 0 of 1
Model Number: 12 with model SeasonalNaive in generation 0 of 1
Model Number: 13 with model ConstantNaive in generation 0 of 1
Model Number: 14 with model SeasonalNaive in generation 0 of 1
Model Number: 15 with model SeasonalNaive in generation 0 of 1
Model Number: 16 with model ConstantNaive in generation 0 of 1
Model Number: 17 with model LastValueNaive in generation 0 of 1
Model Number: 18 with model AverageValueNaive in generation 0 of 1
Model Number: 19 with model GLS in generation 0 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 19: GLS
Model Number: 20 with model SeasonalNaive in generation 0 of 1
Model Number: 21 with model SeasonalityMotif in generation 0 of 1
Model Number: 22 with model SeasonalNaive in generation 0 of 1
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'quadratic', 'transformations': {'0': 'Cl
ipOutliers', '1': 'AnomalyRemoval', '2': 'PowerTransformer', '3': 'ClipOutliers', '4': 'AlignLastValue', '5': 'RollingMean100thN'}, 'transf
ormation_params': {'0': {'method': 'clip', 'std_threshold': 3.5, 'fillna': None}, '1': {'method': 'rolling_zscore', 'transform_dict': {'tra
nsformations': {'0': 'DatepartRegression'}, 'transformation_params': {'0': {'datepart_method': 'simple_3', 'regression_model': {'model': 'F
astRidge', 'model_params': {}}}}}, 'method_params': {'distribution': 'norm', 'alpha': 0.05, 'rolling_periods': 300, 'center': False}, 'fill
na': 'ffill'}, '2': {}, '3': {'method': 'clip', 'std_threshold': 2, 'fillna': None}, '4': {'rows': 1, 'lag': 1, 'method': 'additive', 'stre
ngth': 1.0, 'first_value_only': False}, '5': {}}}. fail_on_forecast_nan=True") in model 22: SeasonalNaive
Model Number: 23 with model ConstantNaive in generation 0 of 1
Model Number: 24 with model AverageValueNaive in generation 0 of 1
C:\Users\Lollo\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site-packages\sk
learn\linear_model\_ridge.py:212: LinAlgWarning: Ill-conditioned matrix (rcond=1.03715e-25): result may not be accurate.
  return linalg.solve(A, Xy, assume_a="pos", overwrite_a=True).T
```

```
Model Number: 25 with model ConstantNaive in generation 0 of 1
Model Number: 26 with model SeasonalNaive in generation 0 of 1
Model Number: 27 with model AverageValueNaive in generation 0 of 1
Model Number: 28 with model GLS in generation 0 of 1
Model Number: 29 with model AverageValueNaive in generation 0 of 1
Model Number: 30 with model GLS in generation 0 of 1
Model Number: 31 with model SeasonalityMotif in generation 0 of 1
Model Number: 32 with model SeasonalNaive in generation 0 of 1
Model Number: 33 with model SeasonalityMotif in generation 0 of 1
Model Number: 34 with model ConstantNaive in generation 0 of 1
Model Number: 35 with model AverageValueNaive in generation 0 of 1
Model Number: 36 with model AverageValueNaive in generation 0 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 36: AverageValueNaive
Model Number: 37 with model ConstantNaive in generation 0 of 1
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'ffill_mean_biased', 'transformations':
{'0': 'RollingMeanTransformer', '1': 'Round', '2': 'ClipOutliers', '3': 'RobustScaler', '4': 'AlignLastValue', '5': 'AlignLastValue'}, 'tra
nsformation_params': {'0': {'fixed': True, 'window': 3}, '1': {'decimals': 0, 'on_transform': True, 'on_inverse': True}, '2': {'method': 'c
lip', 'std_threshold': 3, 'fillna': None}, '3': {}, '4': {'rows': 1, 'lag': 1, 'method': 'additive', 'strength': 1.0, 'first_value_only': F
alse}, '5': {'rows': 7, 'lag': 1, 'method': 'multiplicative', 'strength': 0.7, 'first_value_only': False}}}. fail_on_forecast_nan=True") in
model 37: ConstantNaive
Model Number: 38 with model SeasonalNaive in generation 0 of 1
Model Number: 39 with model SeasonalityMotif in generation 0 of 1
Model Number: 40 with model SeasonalNaive in generation 0 of 1
Model Number: 41 with model LastValueNaive in generation 0 of 1
Model Number: 42 with model GLS in generation 0 of 1
Model Number: 43 with model ConstantNaive in generation 0 of 1
Model Number: 44 with model LastValueNaive in generation 0 of 1
Model Number: 45 with model GLS in generation 0 of 1
New Generation: 1 of 1
Model Number: 46 with model AverageValueNaive in generation 1 of 1
Model Number: 47 with model SeasonalNaive in generation 1 of 1
Model Number: 48 with model LastValueNaive in generation 1 of 1
Model Number: 49 with model AverageValueNaive in generation 1 of 1
Model Number: 50 with model ConstantNaive in generation 1 of 1
Model Number: 51 with model SeasonalNaive in generation 1 of 1
Model Number: 52 with model LastValueNaive in generation 1 of 1
Model Number: 53 with model GLS in generation 1 of 1
Model Number: 54 with model LastValueNaive in generation 1 of 1
Model Number: 55 with model LastValueNaive in generation 1 of 1
Model Number: 56 with model AverageValueNaive in generation 1 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 56: AverageValueNaive
Model Number: 57 with model SeasonalNaive in generation 1 of 1
Model Number: 58 with model SeasonalNaive in generation 1 of 1
Model Number: 59 with model AverageValueNaive in generation 1 of 1
Model Number: 60 with model LastValueNaive in generation 1 of 1
Model Number: 61 with model SeasonalityMotif in generation 1 of 1
```

```
Model Number: 62 with model SeasonalityMotif in generation 1 of 1
Model Number: 63 with model GLS in generation 1 of 1
Model Number: 64 with model AverageValueNaive in generation 1 of 1
Model Number: 65 with model AverageValueNaive in generation 1 of 1
Model Number: 66 with model SeasonalityMotif in generation 1 of 1
Model Number: 67 with model ConstantNaive in generation 1 of 1
Model Number: 68 with model GLS in generation 1 of 1
Model Number: 69 with model AverageValueNaive in generation 1 of 1
Model Number: 70 with model AverageValueNaive in generation 1 of 1
Model Number: 71 with model AverageValueNaive in generation 1 of 1
Model Number: 72 with model SeasonalNaive in generation 1 of 1
Model Number: 73 with model AverageValueNaive in generation 1 of 1
Model Number: 74 with model LastValueNaive in generation 1 of 1
Model Number: 75 with model GLS in generation 1 of 1
Validation Round: 1
Model Number: 1 of 12 with model GLS for Validation 1
📈 1 - GLS with avg smape 46.72:
Model Number: 2 of 12 with model SeasonalNaive for Validation 1
2 - SeasonalNaive with avg smape 46.72:
Model Number: 3 of 12 with model GLS for Validation 1
3 - GLS with avg smape 46.72:
Model Number: 4 of 12 with model AverageValueNaive for Validation 1
4 - AverageValueNaive with avg smape 46.72:
Model Number: 5 of 12 with model LastValueNaive for Validation 1
5 - LastValueNaive with avg smape 46.72:
Model Number: 6 of 12 with model AverageValueNaive for Validation 1
6 - AverageValueNaive with avg smape 46.72:
Model Number: 7 of 12 with model AverageValueNaive for Validation 1
7 - AverageValueNaive with avg smape 46.72:
Model Number: 8 of 12 with model LastValueNaive for Validation 1
8 - LastValueNaive with avg smape 46.72:
Model Number: 9 of 12 with model LastValueNaive for Validation 1
9 - LastValueNaive with avg smape 46.98:
Model Number: 10 of 12 with model ConstantNaive for Validation 1
📈 10 - ConstantNaive with avg smape 46.64:
Model Number: 11 of 12 with model ConstantNaive for Validation 1
11 - ConstantNaive with avg smape 46.72:
Model Number: 12 of 12 with model GLS for Validation 1
12 - GLS with avg smape 49.63:
Validation Round: 2
Model Number: 1 of 12 with model GLS for Validation 2
📈 1 - GLS with avg smape 40.19:
Model Number: 2 of 12 with model SeasonalNaive for Validation 2
2 - SeasonalNaive with avg smape 40.19:
Model Number: 3 of 12 with model GLS for Validation 2
3 - GLS with avg smape 40.19:
```

```
Model Number: 4 of 12 with model AverageValueNaive for Validation 2
4 - AverageValueNaive with avg smape 40.19:
Model Number: 5 of 12 with model LastValueNaive for Validation 2
5 - LastValueNaive with avg smape 40.19:
Model Number: 6 of 12 with model AverageValueNaive for Validation 2
6 - AverageValueNaive with avg smape 40.25:
Model Number: 7 of 12 with model AverageValueNaive for Validation 2
7 - AverageValueNaive with avg smape 40.19:
Model Number: 8 of 12 with model LastValueNaive for Validation 2
8 - LastValueNaive with avg smape 40.19:
Model Number: 9 of 12 with model LastValueNaive for Validation 2
📈 9 - LastValueNaive with avg smape 40.18:
Model Number: 10 of 12 with model ConstantNaive for Validation 2
10 - ConstantNaive with avg smape 59.51:
Model Number: 11 of 12 with model ConstantNaive for Validation 2
11 - ConstantNaive with avg smape 40.19:
Model Number: 12 of 12 with model GLS for Validation 2
12 - GLS with avg smape 57.09:
Model Number: 1 with model Ensemble in generation 0 of Horizontal Ensembles
```

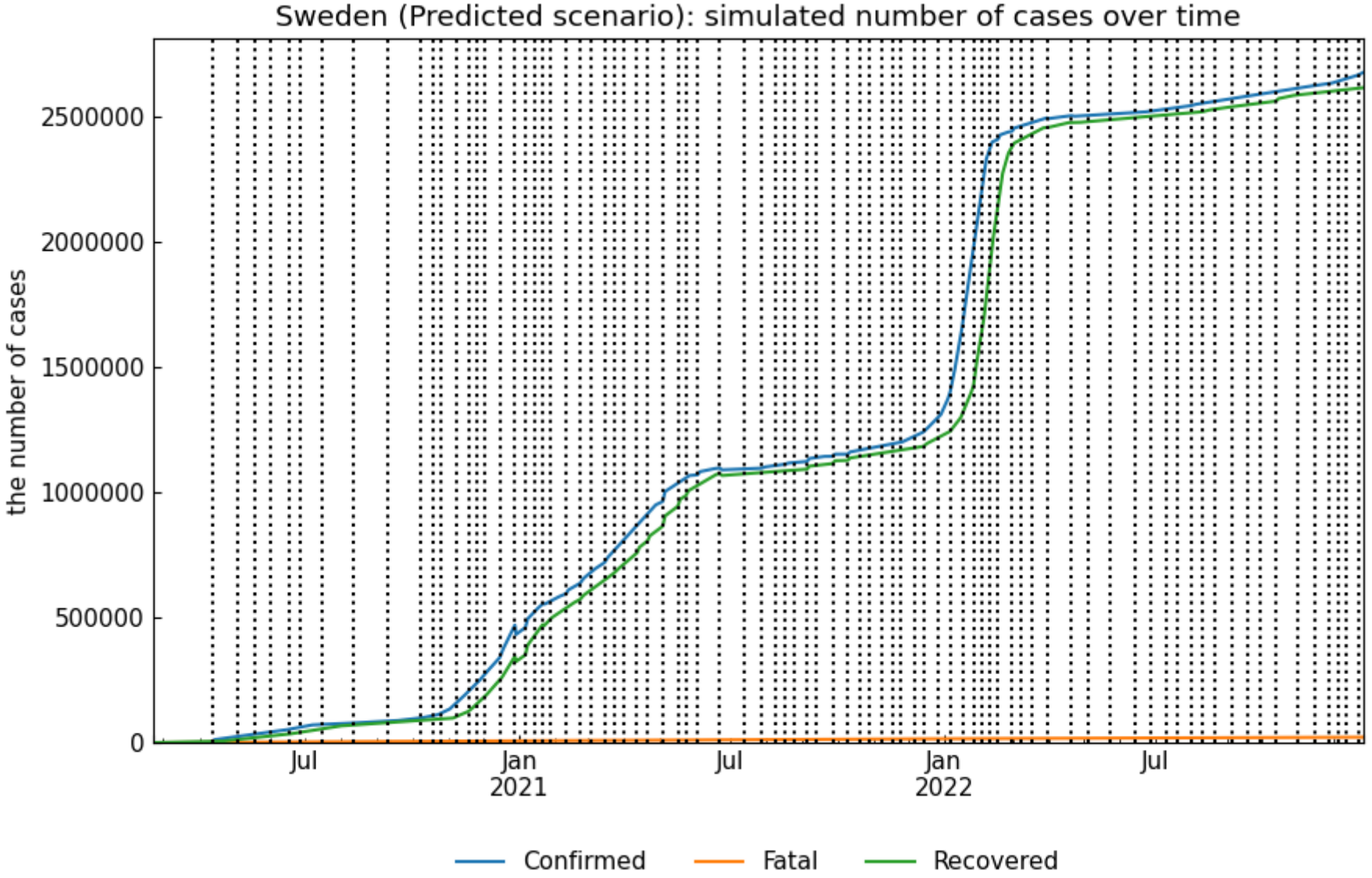
Out[ ]:
```
<covsirphy.science.ode_scenario.ODEScenario at 0x20e44c430a0>
```

In [ ]:
```
df = scenario.append().summary()
df.loc[df["Start"] >= future_start_date]
```

Out[ ]:

Scenario	Phase	Start	End	Rt	theta	kappa	rho	sigma	alpha1 [-]	1/alpha2 [day]	1/beta [day]	1/gamma [day]	ODE	tau
Predicted	**82nd**	2022-12-23	2022-12-27	5.83	0.013106	0.00013	0.090465	0.015174	0.013	7706	11	66	SIR-F Model	1440

In [ ]:
```
scenario.simulate(name="Predicted")
```


Sweden (Predicted scenario): simulated number of cases over time
the number of cases
2500000
2000000
1500000
1000000
500000
0
Jul
Jan
2021
Jul
Jan
2022
Jul
Confirmed
Fatal
Recovered

Out[ ]:

Date	Confirmed	Fatal	Recovered
2020-02-21	1	0.0	1.0
2020-02-22	1	0.0	1.0
2020-02-23	1	0.0	1.0
2020-02-24	1	0.0	1.0
2020-02-25	1	0.0	1.0
...	...	...	...
2022-12-23	2665002	21719.0	2611192.0
2022-12-24	2667199	21752.0	2611691.0
2022-12-25	2669511	21787.0	2612217.0
2022-12-26	2671939	21823.0	2612769.0
2022-12-27	2674496	21862.0	2613351.0

1041 rows × 3 columns

Predict for 30 days

In [ ]:

```
scenario.build_with_template(name="Predicted", template="Baseline")

scenario.predict(days=30, name="Predicted")
```

```
Using 3 cpus for n_jobs.
Model Number: 1 with model AverageValueNaive in generation 0 of 1
Model Number: 2 with model AverageValueNaive in generation 0 of 1
Model Number: 3 with model AverageValueNaive in generation 0 of 1
Model Number: 4 with model GLS in generation 0 of 1
Model Number: 5 with model GLS in generation 0 of 1
Model Number: 6 with model LastValueNaive in generation 0 of 1
Model Number: 7 with model LastValueNaive in generation 0 of 1
Model Number: 8 with model LastValueNaive in generation 0 of 1
Model Number: 9 with model LastValueNaive in generation 0 of 1
Model Number: 10 with model SeasonalNaive in generation 0 of 1
Model Number: 11 with model SeasonalNaive in generation 0 of 1
Model Number: 12 with model SeasonalNaive in generation 0 of 1
Model Number: 13 with model ConstantNaive in generation 0 of 1
Model Number: 14 with model SeasonalNaive in generation 0 of 1
Model Number: 15 with model SeasonalNaive in generation 0 of 1
Model Number: 16 with model ConstantNaive in generation 0 of 1
Model Number: 17 with model LastValueNaive in generation 0 of 1
Model Number: 18 with model AverageValueNaive in generation 0 of 1
Model Number: 19 with model GLS in generation 0 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 19: GLS
Model Number: 20 with model SeasonalNaive in generation 0 of 1
Model Number: 21 with model SeasonalityMotif in generation 0 of 1
Model Number: 22 with model SeasonalNaive in generation 0 of 1
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'quadratic', 'transformations': {'0': 'Cl
ipOutliers', '1': 'AnomalyRemoval', '2': 'PowerTransformer', '3': 'ClipOutliers', '4': 'AlignLastValue', '5': 'RollingMean100thN'}, 'transf
ormation_params': {'0': {'method': 'clip', 'std_threshold': 3.5, 'fillna': None}, '1': {'method': 'rolling_zscore', 'transform_dict': {'tra
nsformations': {'0': 'DatepartRegression'}, 'transformation_params': {'0': {'datepart_method': 'simple_3', 'regression_model': {'model': 'F
astRidge', 'model_params': {}}}}}, 'method_params': {'distribution': 'norm', 'alpha': 0.05, 'rolling_periods': 300, 'center': False}, 'fill
na': 'ffill'}, '2': {}, '3': {'method': 'clip', 'std_threshold': 2, 'fillna': None}, '4': {'rows': 1, 'lag': 1, 'method': 'additive', 'stre
ngth': 1.0, 'first_value_only': False}, '5': {}}}. fail_on_forecast_nan=True") in model 22: SeasonalNaive
C:\Users\Lollo\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site-packages\sk
learn\linear_model\_ridge.py:212: LinAlgWarning: Ill-conditioned matrix (rcond=1.02516e-25): result may not be accurate.
  return linalg.solve(A, Xy, assume_a="pos", overwrite_a=True).T
```

```
Model Number: 23 with model ConstantNaive in generation 0 of 1
Model Number: 24 with model AverageValueNaive in generation 0 of 1
Model Number: 25 with model ConstantNaive in generation 0 of 1
Model Number: 26 with model SeasonalNaive in generation 0 of 1
Model Number: 27 with model AverageValueNaive in generation 0 of 1
Model Number: 28 with model GLS in generation 0 of 1
Model Number: 29 with model AverageValueNaive in generation 0 of 1
Model Number: 30 with model GLS in generation 0 of 1
Model Number: 31 with model SeasonalityMotif in generation 0 of 1
Model Number: 32 with model SeasonalNaive in generation 0 of 1
Model Number: 33 with model SeasonalityMotif in generation 0 of 1
Model Number: 34 with model ConstantNaive in generation 0 of 1
Model Number: 35 with model AverageValueNaive in generation 0 of 1
Model Number: 36 with model AverageValueNaive in generation 0 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 36: AverageValueNaive
Model Number: 37 with model ConstantNaive in generation 0 of 1
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'ffill_mean_biased', 'transformations':
{'0': 'RollingMeanTransformer', '1': 'Round', '2': 'ClipOutliers', '3': 'RobustScaler', '4': 'AlignLastValue', '5': 'AlignLastValue'}, 'tra
nsformation_params': {'0': {'fixed': True, 'window': 3}, '1': {'decimals': 0, 'on_transform': True, 'on_inverse': True}, '2': {'method': 'c
lip', 'std_threshold': 3, 'fillna': None}, '3': {}, '4': {'rows': 1, 'lag': 1, 'method': 'additive', 'strength': 1.0, 'first_value_only': F
alse}, '5': {'rows': 7, 'lag': 1, 'method': 'multiplicative', 'strength': 0.7, 'first_value_only': False}}}. fail_on_forecast_nan=True") in
model 37: ConstantNaive
Model Number: 38 with model SeasonalNaive in generation 0 of 1
Model Number: 39 with model SeasonalityMotif in generation 0 of 1
Model Number: 40 with model SeasonalNaive in generation 0 of 1
Model Number: 41 with model LastValueNaive in generation 0 of 1
Model Number: 42 with model GLS in generation 0 of 1
Model Number: 43 with model ConstantNaive in generation 0 of 1
Model Number: 44 with model LastValueNaive in generation 0 of 1
Model Number: 45 with model GLS in generation 0 of 1
New Generation: 1 of 1
Model Number: 46 with model AverageValueNaive in generation 1 of 1
Model Number: 47 with model AverageValueNaive in generation 1 of 1
Model Number: 48 with model LastValueNaive in generation 1 of 1
Model Number: 49 with model ConstantNaive in generation 1 of 1
Model Number: 50 with model ConstantNaive in generation 1 of 1
Model Number: 51 with model SeasonalNaive in generation 1 of 1
Model Number: 52 with model SeasonalityMotif in generation 1 of 1
Model Number: 53 with model GLS in generation 1 of 1
Model Number: 54 with model SeasonalNaive in generation 1 of 1
Model Number: 55 with model GLS in generation 1 of 1
Model Number: 56 with model SeasonalityMotif in generation 1 of 1
Model Number: 57 with model LastValueNaive in generation 1 of 1
Model Number: 58 with model LastValueNaive in generation 1 of 1
Model Number: 59 with model LastValueNaive in generation 1 of 1
Model Number: 60 with model AverageValueNaive in generation 1 of 1
```

```
Model Number: 61 with model ConstantNaive in generation 1 of 1
Model Number: 62 with model SeasonalNaive in generation 1 of 1
Model Number: 63 with model ConstantNaive in generation 1 of 1
Model Number: 64 with model SeasonalNaive in generation 1 of 1
Model Number: 65 with model ConstantNaive in generation 1 of 1
Model Number: 66 with model AverageValueNaive in generation 1 of 1
Model Number: 67 with model GLS in generation 1 of 1
Model Number: 68 with model AverageValueNaive in generation 1 of 1
Model Number: 69 with model SeasonalityMotif in generation 1 of 1
Model Number: 70 with model SeasonalNaive in generation 1 of 1
Model Number: 71 with model LastValueNaive in generation 1 of 1
Model Number: 72 with model SeasonalNaive in generation 1 of 1
Model Number: 73 with model AverageValueNaive in generation 1 of 1
Model Number: 74 with model ConstantNaive in generation 1 of 1
Model Number: 75 with model SeasonalNaive in generation 1 of 1
Validation Round: 1
Model Number: 1 of 12 with model LastValueNaive for Validation 1
📈 1 - LastValueNaive with avg smape 80.21:
Model Number: 2 of 12 with model LastValueNaive for Validation 1
2 - LastValueNaive with avg smape 80.21:
Model Number: 3 of 12 with model GLS for Validation 1
3 - GLS with avg smape 80.21:
Model Number: 4 of 12 with model ConstantNaive for Validation 1
📈 4 - ConstantNaive with avg smape 80.2:
Model Number: 5 of 12 with model ConstantNaive for Validation 1
5 - ConstantNaive with avg smape 80.2:
Model Number: 6 of 12 with model LastValueNaive for Validation 1
6 - LastValueNaive with avg smape 80.2:
Model Number: 7 of 12 with model AverageValueNaive for Validation 1
7 - AverageValueNaive with avg smape 80.2:
Model Number: 8 of 12 with model AverageValueNaive for Validation 1
8 - AverageValueNaive with avg smape 80.2:
Model Number: 9 of 12 with model GLS for Validation 1
9 - GLS with avg smape 80.2:
Model Number: 10 of 12 with model SeasonalNaive for Validation 1
10 - SeasonalNaive with avg smape 80.2:
Model Number: 11 of 12 with model AverageValueNaive for Validation 1
11 - AverageValueNaive with avg smape 80.2:
Model Number: 12 of 12 with model SeasonalNaive for Validation 1
12 - SeasonalNaive with avg smape 80.92:
Validation Round: 2
Model Number: 1 of 12 with model LastValueNaive for Validation 2
📈 1 - LastValueNaive with avg smape 65.14:
Model Number: 2 of 12 with model LastValueNaive for Validation 2
2 - LastValueNaive with avg smape 65.14:
Model Number: 3 of 12 with model GLS for Validation 2
```

```
3 - GLS with avg smape 65.17:
Model Number: 4 of 12 with model ConstantNaive for Validation 2
4 - ConstantNaive with avg smape 65.22:
Model Number: 5 of 12 with model ConstantNaive for Validation 2
5 - ConstantNaive with avg smape 65.22:
Model Number: 6 of 12 with model LastValueNaive for Validation 2
6 - LastValueNaive with avg smape 65.22:
Model Number: 7 of 12 with model AverageValueNaive for Validation 2
7 - AverageValueNaive with avg smape 65.22:
Model Number: 8 of 12 with model AverageValueNaive for Validation 2
8 - AverageValueNaive with avg smape 65.22:
Model Number: 9 of 12 with model GLS for Validation 2
9 - GLS with avg smape 65.22:
Model Number: 10 of 12 with model SeasonalNaive for Validation 2
10 - SeasonalNaive with avg smape 65.22:
Model Number: 11 of 12 with model AverageValueNaive for Validation 2
11 - AverageValueNaive with avg smape 65.22:
Model Number: 12 of 12 with model SeasonalNaive for Validation 2
📈 12 - SeasonalNaive with avg smape 65.1:
Model Number: 1 with model Ensemble in generation 0 of Horizontal Ensembles
```

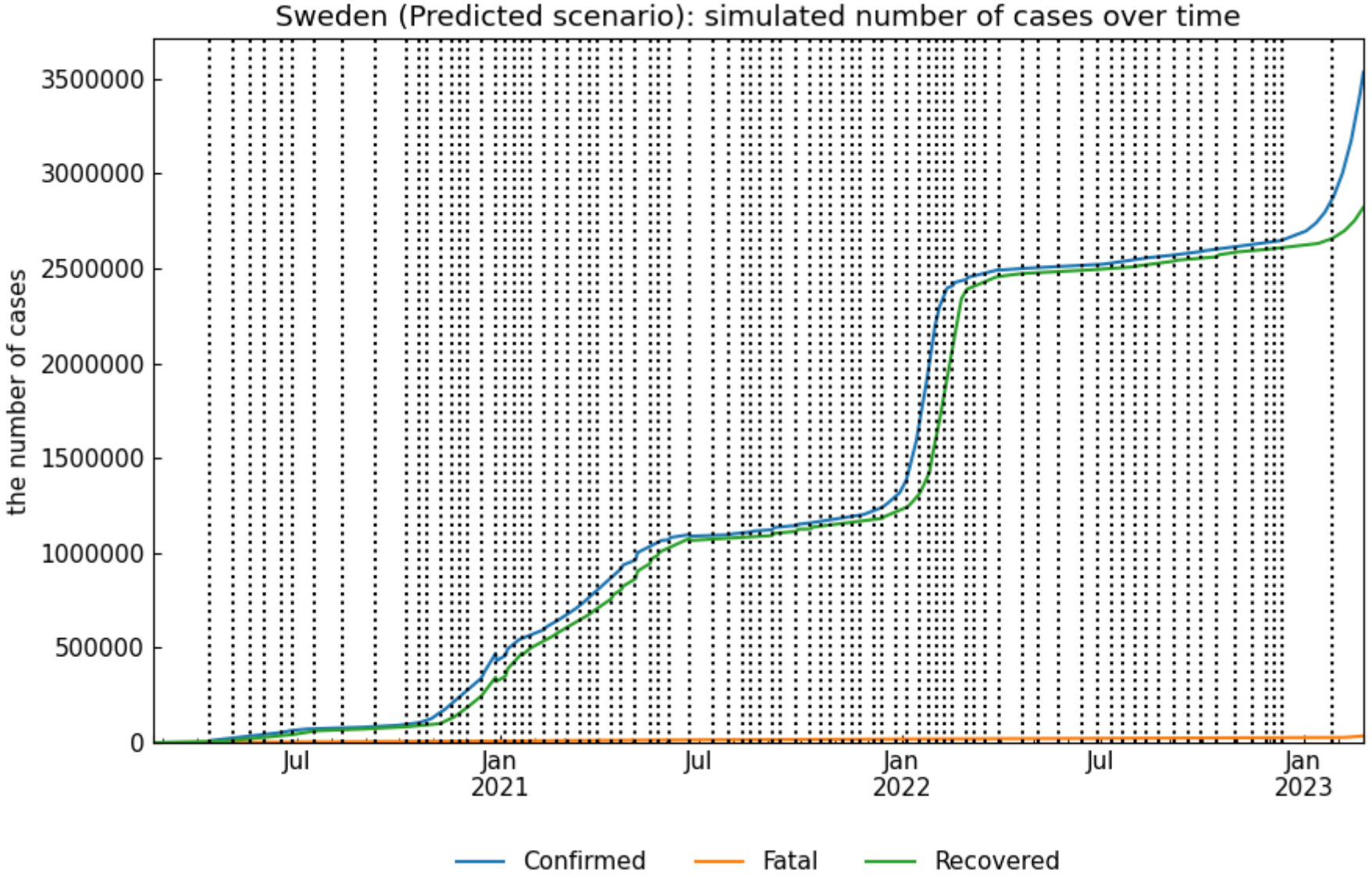
Out[ ]:
```
<covsirphy.science.ode_scenario.ODEScenario at 0x20e44c430a0>
```

In [ ]:
```
df = scenario.append().summary()
df.loc[df["Start"] >= future_start_date]
```

Out[ ]:

Scenario	Phase	Start	End	Rt	theta	kappa	rho	sigma	alpha1 [-]	1/alpha2 [day]	1/beta [day]	1/gamma [day]	ODE	tau
Predicted	**82nd**	2023-01-27	2023-02-24	5.81	0.013153	0.000178	0.090586	0.015222	0.013	5632	11	66	SIR-F Model	1440

In [ ]:
```
scenario.simulate(name="Predicted")
```


Sweden (Predicted scenario): simulated number of cases over time
the number of cases
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
Jul
Jan
2021
Jul
Jan
2022
Jul
Jan
2023
Confirmed
Fatal
Recovered

Out[ ]:

Date	Confirmed	Fatal	Recovered
2020-02-21	1	0.0	1.0
2020-02-22	1	0.0	1.0
2020-02-23	1	0.0	1.0
2020-02-24	1	0.0	1.0
2020-02-25	1	0.0	1.0
...	...	...	...
2023-02-20	3384053	33175.0	2783169.0
2023-02-21	3419055	33738.0	2792004.0
2023-02-22	3455437	34324.0	2801236.0
2023-02-23	3493233	34934.0	2810880.0
2023-02-24	3532474	35568.0	2820950.0

1100 rows × 3 columns

Predict for 300 days

In [ ]:
```
scenario.build_with_template(name="Predicted", template="Baseline")
```

Out[ ]:
```
<covsirphy.science.ode_scenario.ODEScenario at 0x20e44c430a0>
```

In [ ]:
```
scenario.predict(days=300, name="Predicted")
```

```
Using 3 cpus for n_jobs.
Model Number: 1 with model AverageValueNaive in generation 0 of 1
Model Number: 2 with model AverageValueNaive in generation 0 of 1
Model Number: 3 with model AverageValueNaive in generation 0 of 1
Model Number: 4 with model GLS in generation 0 of 1
Model Number: 5 with model GLS in generation 0 of 1
Model Number: 6 with model LastValueNaive in generation 0 of 1
Model Number: 7 with model LastValueNaive in generation 0 of 1
Model Number: 8 with model LastValueNaive in generation 0 of 1
Model Number: 9 with model LastValueNaive in generation 0 of 1
Model Number: 10 with model SeasonalNaive in generation 0 of 1
Model Number: 11 with model SeasonalNaive in generation 0 of 1
Model Number: 12 with model SeasonalNaive in generation 0 of 1
Model Number: 13 with model ConstantNaive in generation 0 of 1
Model Number: 14 with model SeasonalNaive in generation 0 of 1
Model Number: 15 with model SeasonalNaive in generation 0 of 1
Model Number: 16 with model ConstantNaive in generation 0 of 1
Model Number: 17 with model LastValueNaive in generation 0 of 1
Model Number: 18 with model AverageValueNaive in generation 0 of 1
Model Number: 19 with model GLS in generation 0 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 19: GLS
Model Number: 20 with model SeasonalNaive in generation 0 of 1
Model Number: 21 with model SeasonalityMotif in generation 0 of 1
Model Number: 22 with model SeasonalNaive in generation 0 of 1
C:\Users\Lollo\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.9_qbz5n2kfra8p0\LocalCache\local-packages\Python39\site-packages\sklearn\linear_model\_ridge.py:212: LinAlgWarning: Ill-conditioned matrix (rcond=1.33412e-25): result may not be accurate.
  return linalg.solve(A, Xy, assume_a="pos", overwrite_a=True).T
```

```
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'quadratic', 'transformations': {'0': 'Cl
ipOutliers', '1': 'AnomalyRemoval', '2': 'PowerTransformer', '3': 'ClipOutliers', '4': 'AlignLastValue', '5': 'RollingMean100thN'}, 'transf
ormation_params': {'0': {'method': 'clip', 'std_threshold': 3.5, 'fillna': None}, '1': {'method': 'rolling_zscore', 'transform_dict': {'tra
nsformations': {'0': 'DatepartRegression'}, 'transformation_params': {'0': {'datepart_method': 'simple_3', 'regression_model': {'model': 'F
astRidge', 'model_params': {}}}}}, 'method_params': {'distribution': 'norm', 'alpha': 0.05, 'rolling_periods': 300, 'center': False}, 'fill
na': 'ffill'}, '2': {}, '3': {'method': 'clip', 'std_threshold': 2, 'fillna': None}, '4': {'rows': 1, 'lag': 1, 'method': 'additive', 'stre
ngth': 1.0, 'first_value_only': False}, '5': {}}}. fail_on_forecast_nan=True") in model 22: SeasonalNaive
Model Number: 23 with model ConstantNaive in generation 0 of 1
Model Number: 24 with model AverageValueNaive in generation 0 of 1
Model Number: 25 with model ConstantNaive in generation 0 of 1
Model Number: 26 with model SeasonalNaive in generation 0 of 1
Model Number: 27 with model AverageValueNaive in generation 0 of 1
Model Number: 28 with model GLS in generation 0 of 1
Model Number: 29 with model AverageValueNaive in generation 0 of 1
Model Number: 30 with model GLS in generation 0 of 1
Model Number: 31 with model SeasonalityMotif in generation 0 of 1
Model Number: 32 with model SeasonalNaive in generation 0 of 1
Model Number: 33 with model SeasonalityMotif in generation 0 of 1
Model Number: 34 with model ConstantNaive in generation 0 of 1
Model Number: 35 with model AverageValueNaive in generation 0 of 1
Model Number: 36 with model AverageValueNaive in generation 0 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 36: AverageValueNaive
Model Number: 37 with model ConstantNaive in generation 0 of 1
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'ffill_mean_biased', 'transformations':
{'0': 'RollingMeanTransformer', '1': 'Round', '2': 'ClipOutliers', '3': 'RobustScaler', '4': 'AlignLastValue', '5': 'AlignLastValue'}, 'tra
nsformation_params': {'0': {'fixed': True, 'window': 3}, '1': {'decimals': 0, 'on_transform': True, 'on_inverse': True}, '2': {'method': 'c
lip', 'std_threshold': 3, 'fillna': None}, '3': {}, '4': {'rows': 1, 'lag': 1, 'method': 'additive', 'strength': 1.0, 'first_value_only': F
alse}, '5': {'rows': 7, 'lag': 1, 'method': 'multiplicative', 'strength': 0.7, 'first_value_only': False}}}. fail_on_forecast_nan=True") in
model 37: ConstantNaive
Model Number: 38 with model SeasonalNaive in generation 0 of 1
Model Number: 39 with model SeasonalityMotif in generation 0 of 1
Model Number: 40 with model SeasonalNaive in generation 0 of 1
Model Number: 41 with model LastValueNaive in generation 0 of 1
Model Number: 42 with model GLS in generation 0 of 1
Model Number: 43 with model ConstantNaive in generation 0 of 1
Model Number: 44 with model LastValueNaive in generation 0 of 1
Model Number: 45 with model GLS in generation 0 of 1
New Generation: 1 of 1
Model Number: 46 with model SeasonalityMotif in generation 1 of 1
Model Number: 47 with model AverageValueNaive in generation 1 of 1
Model Number: 48 with model AverageValueNaive in generation 1 of 1
Model Number: 49 with model SeasonalityMotif in generation 1 of 1
Model Number: 50 with model LastValueNaive in generation 1 of 1
Model Number: 51 with model GLS in generation 1 of 1
Model Number: 52 with model SeasonalityMotif in generation 1 of 1
Model Number: 53 with model GLS in generation 1 of 1
```

```
Model Number: 54 with model AverageValueNaive in generation 1 of 1
Model Number: 55 with model AverageValueNaive in generation 1 of 1
Model Number: 56 with model SeasonalNaive in generation 1 of 1
Template Eval Error: ValueError("Model returned NaN due to a preprocessing transformer {'fillna': 'fake_date', 'transformations': {'0': 'Al
ignLastValue', '1': 'bkfilter', '2': 'Round', '3': 'AlignLastValue', '4': 'Detrend'}, 'transformation_params': {'0': {'rows': 1, 'lag': 1,
'method': 'multiplicative', 'strength': 1.0, 'first_value_only': False}, '1': {}, '2': {'decimals': 0, 'on_transform': False, 'on_inverse':
True}, '3': {'rows': 1, 'lag': 1, 'method': 'additive', 'strength': 1.0, 'first_value_only': False}, '4': {'model': 'Poisson', 'phi': 1, 'w
indow': None, 'transform_dict': {'fillna': None, 'transformations': {'0': 'ScipyFilter'}, 'transformation_params': {'0': {'method': 'savgol
_filter', 'method_args': {'window_length': 31, 'polyorder': 3, 'deriv': 0, 'mode': 'interp'}}}}}}. fail_on_forecast_nan=True") in model 5
6: SeasonalNaive
Model Number: 57 with model LastValueNaive in generation 1 of 1
Model Number: 58 with model SeasonalityMotif in generation 1 of 1
Model Number: 59 with model AverageValueNaive in generation 1 of 1
Model Number: 60 with model AverageValueNaive in generation 1 of 1
Model Number: 61 with model SeasonalNaive in generation 1 of 1
Model Number: 62 with model ConstantNaive in generation 1 of 1
Model Number: 63 with model GLS in generation 1 of 1
No anomalies detected.
Model Number: 64 with model ConstantNaive in generation 1 of 1
Model Number: 65 with model LastValueNaive in generation 1 of 1
Model Number: 66 with model SeasonalNaive in generation 1 of 1
Template Eval Error: Exception('Transformer Detrend failed on fit') in model 66: SeasonalNaive
Model Number: 67 with model GLS in generation 1 of 1
Model Number: 68 with model SeasonalityMotif in generation 1 of 1
Model Number: 69 with model LastValueNaive in generation 1 of 1
Model Number: 70 with model SeasonalityMotif in generation 1 of 1
Model Number: 71 with model LastValueNaive in generation 1 of 1
Model Number: 72 with model SeasonalityMotif in generation 1 of 1
Model Number: 73 with model AverageValueNaive in generation 1 of 1
Model Number: 74 with model LastValueNaive in generation 1 of 1
Model Number: 75 with model LastValueNaive in generation 1 of 1
Validation Round: 1
Model Number: 1 of 13 with model GLS for Validation 1
📈 1 - GLS with avg smape 97.13:
Model Number: 2 of 13 with model GLS for Validation 1
2 - GLS with avg smape 97.13:
Model Number: 3 of 13 with model GLS for Validation 1
3 - GLS with avg smape 103.18:
Model Number: 4 of 13 with model SeasonalNaive for Validation 1
📈 4 - SeasonalNaive with avg smape 90.72:
Model Number: 5 of 13 with model AverageValueNaive for Validation 1
📈 5 - AverageValueNaive with avg smape 90.45:
Model Number: 6 of 13 with model SeasonalityMotif for Validation 1
6 - SeasonalityMotif with avg smape 110.19:
Model Number: 7 of 13 with model SeasonalNaive for Validation 1
7 - SeasonalNaive with avg smape 151.97:
```

```
Model Number: 8 of 13 with model LastValueNaive for Validation 1
8 - LastValueNaive with avg smape 101.19:
Model Number: 9 of 13 with model LastValueNaive for Validation 1
9 - LastValueNaive with avg smape 98.76:
Model Number: 10 of 13 with model AverageValueNaive for Validation 1
10 - AverageValueNaive with avg smape 93.41:
Model Number: 11 of 13 with model LastValueNaive for Validation 1
11 - LastValueNaive with avg smape 119.44:
Model Number: 12 of 13 with model SeasonalityMotif for Validation 1
12 - SeasonalityMotif with avg smape 95.4:
Model Number: 13 of 13 with model AverageValueNaive for Validation 1
13 - AverageValueNaive with avg smape 106.46:
Validation Round: 2
Model Number: 1 of 13 with model GLS for Validation 2
No anomalies detected.
Template Eval Error: Exception('Transformer HolidayTransformer failed on fit') in model 1: GLS
Model Number: 2 of 13 with model GLS for Validation 2
No anomalies detected.
Template Eval Error: Exception('Transformer HolidayTransformer failed on fit') in model 2: GLS
Model Number: 3 of 13 with model GLS for Validation 2
📈 3 - GLS with avg smape 84.26:
Model Number: 4 of 13 with model SeasonalNaive for Validation 2
4 - SeasonalNaive with avg smape 100.45:
Model Number: 5 of 13 with model AverageValueNaive for Validation 2
5 - AverageValueNaive with avg smape 93.89:
Model Number: 6 of 13 with model SeasonalityMotif for Validation 2
6 - SeasonalityMotif with avg smape 93.67:
Model Number: 7 of 13 with model SeasonalNaive for Validation 2
7 - SeasonalNaive with avg smape 155.29:
Model Number: 8 of 13 with model LastValueNaive for Validation 2
8 - LastValueNaive with avg smape 90.53:
Model Number: 9 of 13 with model LastValueNaive for Validation 2
📈 9 - LastValueNaive with avg smape 83.47:
Model Number: 10 of 13 with model AverageValueNaive for Validation 2
10 - AverageValueNaive with avg smape 98.32:
Model Number: 11 of 13 with model LastValueNaive for Validation 2
11 - LastValueNaive with avg smape 90.87:
Model Number: 12 of 13 with model SeasonalityMotif for Validation 2
12 - SeasonalityMotif with avg smape 91.33:
Model Number: 13 of 13 with model AverageValueNaive for Validation 2
13 - AverageValueNaive with avg smape 106.73:
Model Number: 1 with model Ensemble in generation 0 of Horizontal Ensembles
```

Out[ ]:
```
<covsirphy.science.ode_scenario.ODEScenario at 0x20e44c430a0>
```

In [ ]:
```
df = scenario.append().summary()
```

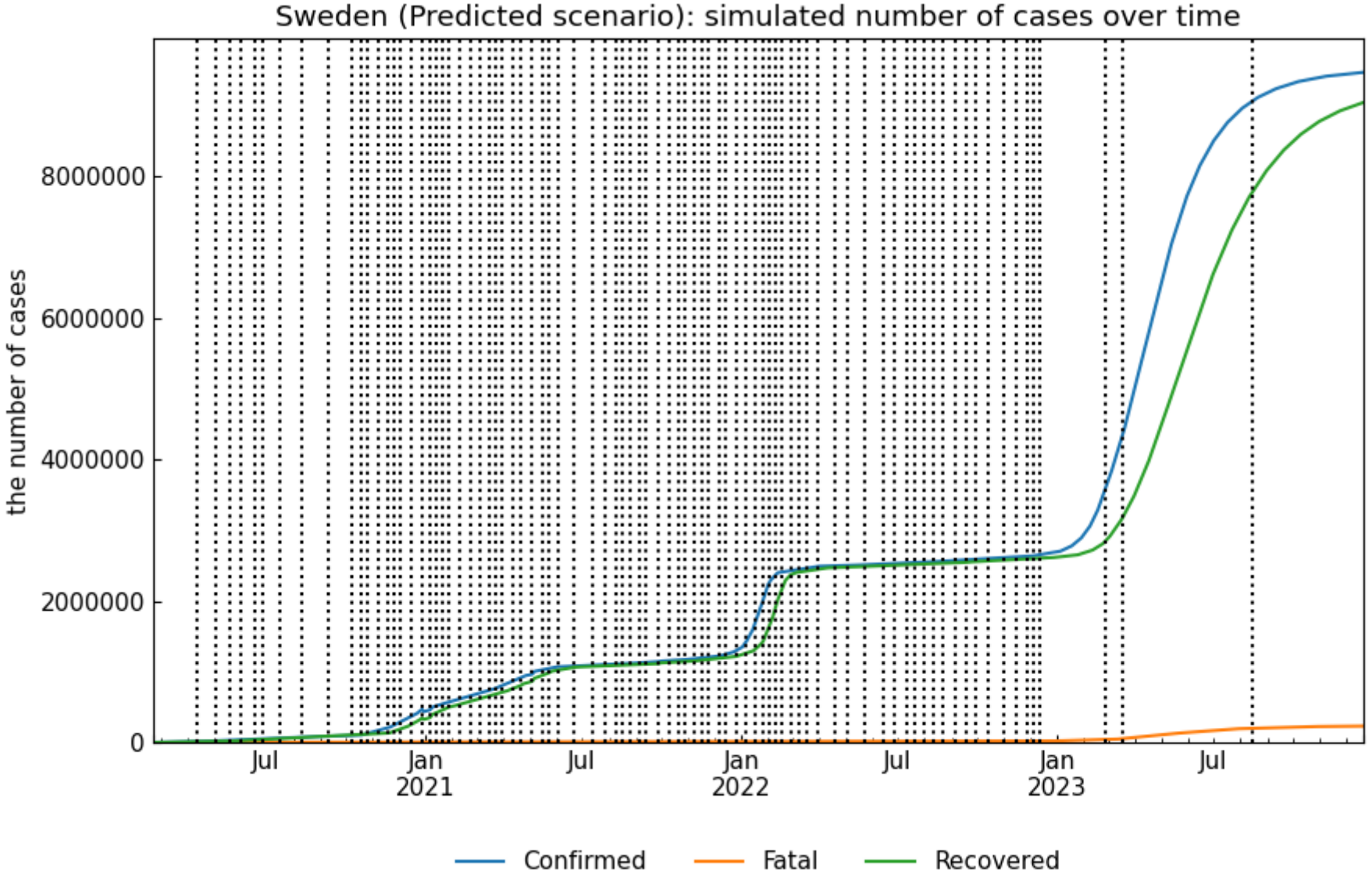
```
df.loc[df["Start"] >= future_start_date]
```

Out[ ]:

Scenario	Phase	Start	End	Rt	theta	kappa	rho	sigma	alpha1 [-]	1/alpha2 [day]	1/beta [day]	1/gamma [day]	ODE	tau
Predicted	**82nd**	2023-02-25	2023-03-17	3.56	0.013502	0.000342	0.06765	0.01843	0.014	2925	15	54	SIR-F Model	1440
	83rd	2023-03-18	2023-08-14	3.55	0.013508	0.000344	0.06765	0.018481	0.014	2903	15	54	SIR-F Model	1440
	84th	2023-08-15	2023-12-21	3.54	0.013514	0.000347	0.06765	0.018524	0.014	2885	15	54	SIR-F Model	1440

In [ ]:

```
scenario.simulate(name="Predicted")
```


Sweden (Predicted scenario): simulated number of cases over time
the number of cases
8000000
6000000
4000000
2000000
0
Jul
Jan
2021
Jul
Jan
2022
Jul
Jan
2023
Jul
Confirmed
Fatal
Recovered

Out[ ]:

Date	Confirmed	Fatal	Recovered
2020-02-21	1	0.0	1.0
2020-02-22	1	0.0	1.0
2020-02-23	1	0.0	1.0
2020-02-24	1	0.0	1.0
2020-02-25	1	0.0	1.0
...	...	...	...
2023-12-17	9465934	231376.0	9029247.0
2023-12-18	9466895	231460.0	9033023.0
2023-12-19	9467841	231542.0	9036746.0
2023-12-20	9468772	231624.0	9040416.0
2023-12-21	9469689	231704.0	9044034.0

1400 rows × 3 columns