EX1

In [14]:

```
import pandas as pd
import matplotlib.pyplot as plt
```

1. Import Data1.csv file to python. 2. Set first column as the index.

In [15]:

```
df=pd.read_csv('Data1.csv',index_col=0,parse_dates=True)
```

In [16]:

```
df.head()
```

Out[16]:

	theta_1	theta_2	theta_3	theta_4	theta_5	theta_6
2017-01-01	0.756936	-1.467790	0.096136	-0.115306	-0.447908	0.902579
2017-01-02	0.767089	0.185797	-1.428536	-0.086443	-0.954288	1.930909
2017-01-03	0.404544	1.415887	0.443466	0.000200	-0.892351	2.449691
2017-01-04	1.313957	-1.804471	-0.836986	0.011785	-1.012518	1.182085
2017-01-05	0.209862	1.315868	0.140993	-0.046473	-1.417092	1.742433

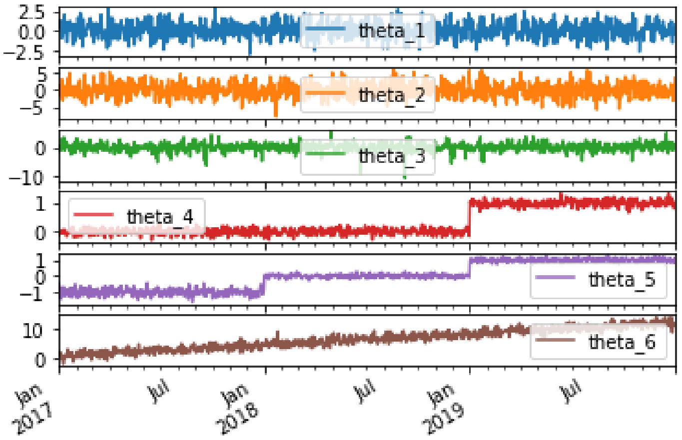
3. Plot all columns as time series.

In [17]:

```
df.plot(subplots=True)
```

Out[17]:

```
array([<AxesSubplot:>, <AxesSubplot:>, <AxesSubplot:>, <AxesSubplot:>,
       <AxesSubplot:>, <AxesSubplot:>], dtype=object)
```



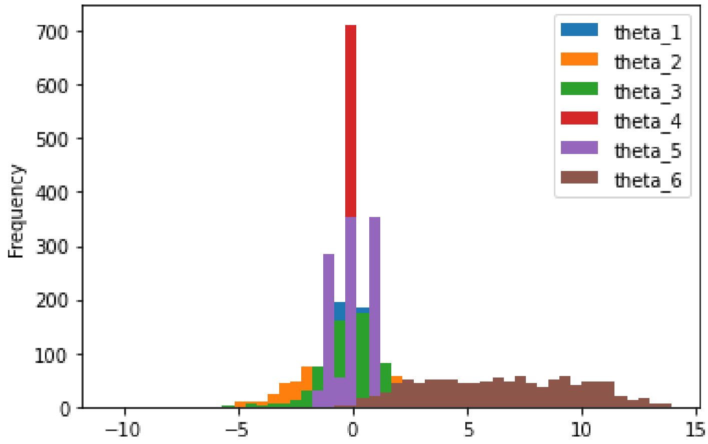
4. Plot histograms of all columns, verify bin size. Plot all on a single, faceted plot.

In [18]:

```
df.plot.hist(bins=50)
```

Out[18]:

```
<AxesSubplot:ylabel='Frequency'>
```



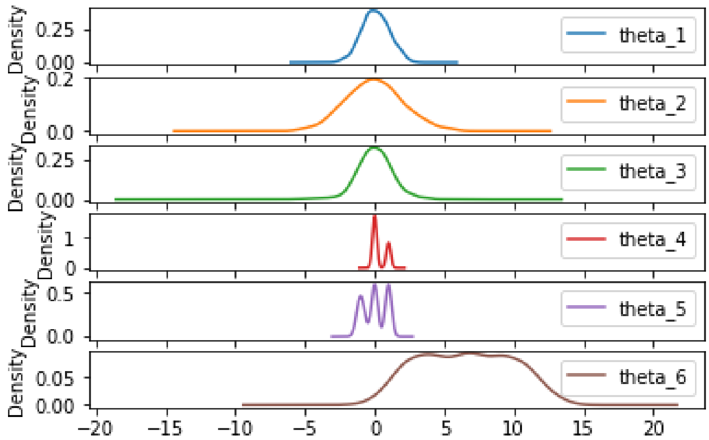
5. Plot KDE-s (Kernel Denisty Estimators) for all columns.

In [19]:

```
df.plot.density(subplots=True)
```

Out[19]:

```
array([<AxesSubplot:ylabel='Density'>, <AxesSubplot:ylabel='Density'>,
       <AxesSubplot:ylabel='Density'>, <AxesSubplot:ylabel='Density'>,
       <AxesSubplot:ylabel='Density'>, <AxesSubplot:ylabel='Density'>],
      dtype=object)
```



6. Repeat analysis for columns
θ_1-
θ_4 **in 2018.**

In [20]:

```
df2018=df.loc["2018"]
```

In [21]:

```
df2018.head()
```

Out[21]:

	theta_1	theta_2	theta_3	theta_4	theta_5	theta_6
2018-01-01	0.682693	-3.091767	-0.475717	-0.238530	0.036404	4.551359
2018-01-02	-0.283107	-0.979955	1.233933	0.158031	-0.097014	4.623086
2018-01-03	1.572221	-2.033528	2.196317	0.041347	0.009982	4.330249
2018-01-04	-1.042981	0.651530	1.060125	0.064832	0.036592	6.617830
2018-01-05	-1.392614	-2.570905	-0.600063	-0.015025	0.124576	5.577570

In [22]:

```
df2018=df2018.drop(columns=['theta_5', 'theta_6'])
```

In [23]:

```
df2018.head()
```

Out[23]:

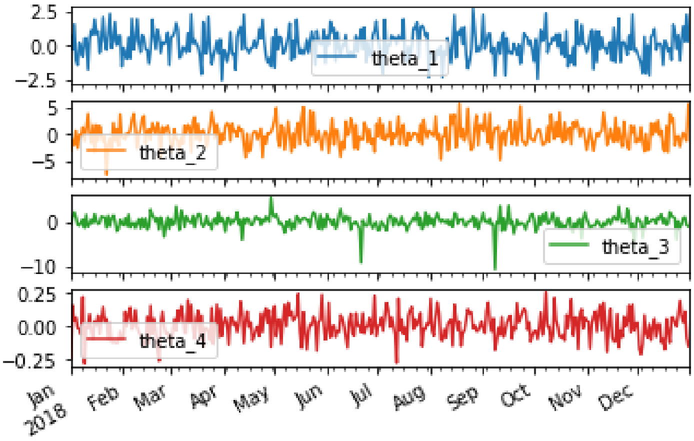
	theta_1	theta_2	theta_3	theta_4
2018-01-01	0.682693	-3.091767	-0.475717	-0.238530
2018-01-02	-0.283107	-0.979955	1.233933	0.158031
2018-01-03	1.572221	-2.033528	2.196317	0.041347
2018-01-04	-1.042981	0.651530	1.060125	0.064832
2018-01-05	-1.392614	-2.570905	-0.600063	-0.015025

In [24]:

```
df2018.plot(subplots=True)
```

Out[24]:

```
array([<AxesSubplot:>, <AxesSubplot:>, <AxesSubplot:>, <AxesSubplot:>],
      dtype=object)
```

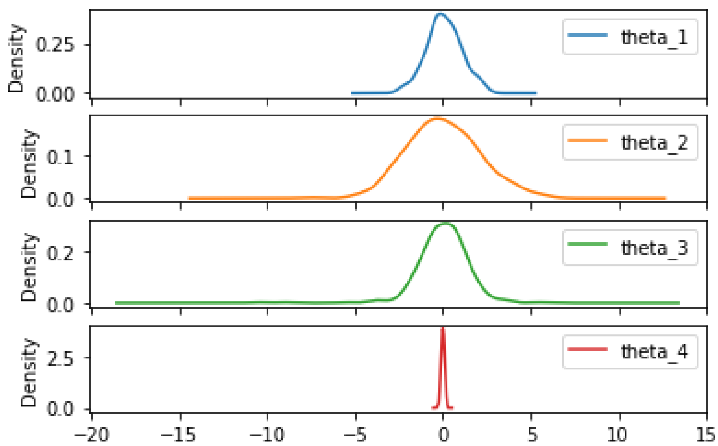


In [25]:

```
df2018.plot.density(subplots=True)
```

Out[25]:

```
array([<AxesSubplot:ylabel='Density'>, <AxesSubplot:ylabel='Density'>,
       <AxesSubplot:ylabel='Density'>, <AxesSubplot:ylabel='Density'>],
      dtype=object)
```

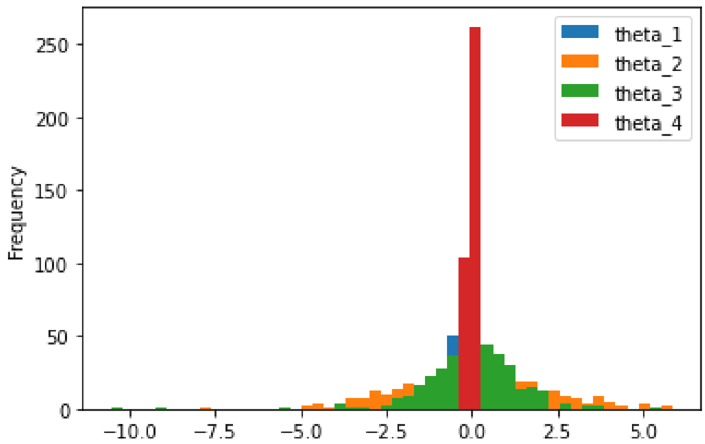


In [27]:

```
df2018.plot.hist(bins=50)
```

Out[27]:

```
<AxesSubplot:ylabel='Frequency'>
```



EX2

1. Install `cmdstanpy` package 2. Install cmdstan

In [29]:

```
import cmdstanpy
```

3. Create a cmdstanpy model from `bern_1.stan` code provided.

In [30]:

```
b_model=cmdstanpy.CmdStanModel(stan_file='bern_1.stan')
```

```
INFO:cmdstanpy:found newer exe file, not recompiling
INFO:cmdstanpy:compiled model file: C:/Users/Studia/LAB1-P~1/bern_1.exe
```

2. Create a dataset (as a dictionary) of F+L binary samples with F zeros and L ones, with F=number of letters in first name, L=number of letters in last name. Dictionary needs to consist of N=F+L, and y = list of samples.

In [31]:

```
im=len("Michal")
na=len("Druciak")

b_data={"N":im+na,
     "y": [0,1,0,0,1,1,1,0,0,1,1,0,1]}
```

4. Sample from the model using the dataset and `.sample()` method

In [32]:

```
bern_fit=b_model.sample(data=b_data,output_dir='sample'#,show_progress=true,,show_progres
s='notebook'
                              )
```

```
INFO:cmdstanpy:start chain 1
INFO:cmdstanpy:start chain 2
INFO:cmdstanpy:finish chain 1
INFO:cmdstanpy:start chain 3
INFO:cmdstanpy:finish chain 2
INFO:cmdstanpy:start chain 4
INFO:cmdstanpy:finish chain 3
INFO:cmdstanpy:finish chain 4
```

5. Extract θ variable and create its histogram.

In [33]:

```
draws_theta=bern_fit.stan_variable(name='theta')
```

In [34]:

```
type(draws_theta)
```

Out[34]:

```
numpy.ndarray
```

6. Using `.summary()` method get mean, median and 5% and 95% quantiles of theta, and mark them on the histogram.

In [35]:

```
basic_stats=bern_fit.summary()
basic_stats
```

Out[35]:

name	Mean	MCSE	StdDev	5%	50%	95%	N_Eff	N_Eff/s	R_hat
lp__	-11.00	0.0190	0.69	-12.00	-11.00	-10.00	1400.0	11000.0	1.0
theta	0.54	0.0033	0.12	0.34	0.54	0.75	1400.0	11000.0	1.0

In [36]:

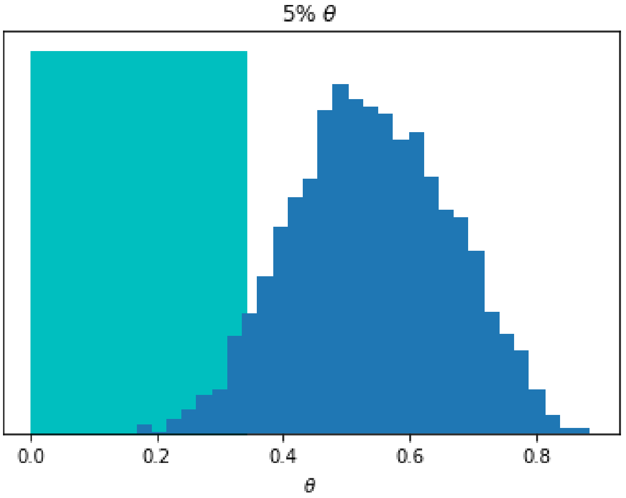
```
type(basic_stats)
```

Out[36]:

```
pandas.core.frame.DataFrame
```

In [64]:

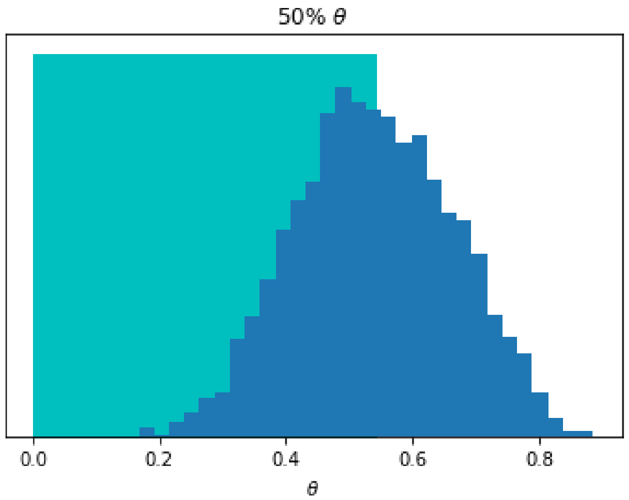
```
fix,ax=plt.subplots(1,1)
ax.hist(draws_theta,bins=30,density=True)
ax.fill_betweenx([0, 3.4], 0, 0.34, color='c')
ax.set_yticks([])
ax.set_xlabel('$\\theta$')
plt.title('5% $\\theta$')
plt.show()
```



In [65]:

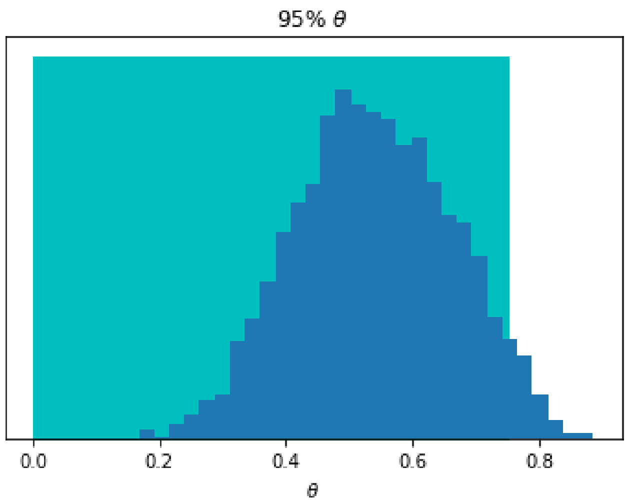
```
fix,ax=plt.subplots(1,1)
```

```
fix,ax=plt.subplots(1,1)
ax.hist(draws_theta,bins=30,density=True)
ax.fill_betweenx([0, 3.4], 0, 0.54, color='c')
ax.set_yticks([])
ax.set_xlabel('$\\theta$')
plt.title('50% $\\theta$')

plt.show()
```



In [66]:

```
fix,ax=plt.subplots(1,1)
ax.hist(draws_theta,bins=30,density=True)
ax.fill_betweenx([0, 3.4], 0, 0.75, color='c')
ax.set_yticks([])
ax.set_xlabel('$\\theta$')
plt.title('95% $\\theta$')

plt.show()
```



In [ ]: