In [1]:

```
# import datetime
import os
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from datlib.FRED import *
from datlib.plots import *
import pandas_datareader.data as web

%matplotlib inline

# Import Statsmodels

from statsmodels.tsa.api import VAR
from statsmodels.tsa.stattools import adfuller
from statsmodels.tools.eval_measures import rmse, aic
```

In [2]:

```python
#FRED.py
#. . .
def bil_to_mil(series):
    return series* 10**3
# . . .
#fedProject.py
# . . .
data_codes  = {# Assets
               "Balance Sheet: Total Assets ($ Mil)": "WALCL",
               "Balance Sheet Securities, Prem-Disc, Repos, and Loans ($ Mil)": '
               "Balance Sheet: Securities Held Outright ($ Mil)": "WSHOSHO",
               ### breakdown of securities holdings ###
               "Balance Sheet: U.S. Treasuries Held Outright ($ Mil)":"WSHOTSL",
               "Balance Sheet: Federal Agency Debt Securities ($ Mil)" : "WSHOFAD
               "Balance Sheet: Mortgage-Backed Securities ($ Mil)": "WSHOMCB",
               # other forms of lending
               "Balance Sheet: Repos ($ Mil)": "WORAL",
               "Balance Sheet: Central Bank Liquidity Swaps ($ Mil)" : "SWPT",
               "Balance Sheet: Direct Lending ($ Mil)" : "WLCFLL",
               # unamortized value of securities held (due to changes in interest
               "Balance Sheet: Unamortized Security Premiums ($ Mil)": "WUPSHO",
               # Liabilities
               "Balance Sheet: Total Liabilities ($ Mil)" : "WLTLECL",
               "Balance Sheet: Federal Reserve Notes Outstanding ($ Mil)" : "WLFN
               "Balance Sheet: Reverse Repos ($ Mil)": "WLRRAL",
               ### Major share of deposits
               "Balance Sheet: Deposits from Dep. Institutions ($ Mil)":"WLODLL",
               "Balance Sheet: U.S. Treasury General Account ($ Mil)": "WDTGAL",
               "Balance Sheet: Other Deposits ($ Mil)": "WOTHLB",
               "Balance Sheet: All Deposits ($ Mil)": "WLDLCL",
               # Capital
               "Balance Sheet: Total Capital": "WCTCL",
               # Interest Rates
               "Unemployment Rate": "UNRATE",
               "Nominal GDP ($ Bil)":"GDP",
               "Real GDP ($ Bil)":"GDPC1",
               "GDP Deflator":"GDPDEF",
               "CPI":"CPIAUCSL",
               "Core PCE":"PCEPILFE",
               "Private Investment":"GPDI",
               "Base: Total ($ Mil)": "BOGMBASE",
               "Base: Currency in Circulation ($ Bil)": "WCURCIR",
               "1 Month Treasury Rate (%)": "DGS1MO",
               "3 Month Treasury Rate (%)": "DGS3MO",
               "1 Year Treasury Rate (%)": "DGS1",
               "2 Year Treasury Rate (%)": "DGS2",
               "10 Year Treasury Rate (%)": "DGS10",
               "30 Year Treasury Rate (%)": "DGS30",
               "Effective Federal Funds Rate (%)": "DFF",
               "Federal Funds Target Rate (Pre-crisis)":"DFEDTAR",
               "Federal Funds Upper Target":"DFEDTARU",
               "Federal Funds Lower Target":"DFEDTARL",
               "Interest on Reserves (%)": "IOER",
               "VIX": "VIXCLS",
                "5 Year Forward Rate": "T5YIFR"
               }
```

```python
inflation_target = 2

unemployment_target = 4
# Select start and end dates
start = datetime.datetime(2000, 1, 1)
end = datetime.datetime.today()

## year variable automatically adjusts the numper of periods
#   per year in light of data frequency
annual_div = {"Q":4,
              "W":52,
              "M":12}
### choose frequency
freq = "M"
### set periods per year
year = annual_div[freq]
```

In [3]:
```python
data=pd.read_csv("data up.csv")
data
```

Out[3]:

	Date	VIX	Log Total Assets	Log Currency in Circulation ($ Bil)	Effective Federal Funds Rate (%)	Loss Function
0	12/31/2002	28.210476	13.495030	6.516891	1.238387	-4.053360
1	1/31/2003	27.424286	13.493538	6.521227	1.235161	-3.288373
2	2/28/2003	32.218421	13.488846	6.521846	1.262143	-3.684400
3	3/31/2003	30.634286	13.492065	6.527099	1.252903	-3.663571
4	4/30/2003	23.991905	13.510243	6.532415	1.258000	-4.161742
...	...	...	...	...	...	...
220	4/30/2021	17.416190	15.866549	7.675462	0.069000	-2.827729
221	5/31/2021	19.760500	15.878174	7.681530	0.058065	-1.116398
222	6/30/2021	16.956818	15.898266	7.686549	0.078000	-1.093716
223	7/31/2021	17.603333	15.918468	7.689882	0.098065	0.611392
224	8/31/2021	17.472727	15.930789	7.690558	0.092258	1.117317

225 rows × 6 columns

In [4]:
```python
data = data.set_index('Date')
```

In [5]:
```
data
```

Out[5]:

Date	VIX	Log Total Assets	Log Currency in Circulation ($ Bil)	Effective Federal Funds Rate (%)	Loss Function
12/31/2002	28.210476	13.495030	6.516891	1.238387	-4.053360
1/31/2003	27.424286	13.493538	6.521227	1.235161	-3.288373
2/28/2003	32.218421	13.488846	6.521846	1.262143	-3.684400
3/31/2003	30.634286	13.492065	6.527099	1.252903	-3.663571
4/30/2003	23.991905	13.510243	6.532415	1.258000	-4.161742
...	...	...	...	...	...
4/30/2021	17.416190	15.866549	7.675462	0.069000	-2.827729
5/31/2021	19.760500	15.878174	7.681530	0.058065	-1.116398
6/30/2021	16.956818	15.898266	7.686549	0.078000	-1.093716
7/31/2021	17.603333	15.918468	7.689882	0.098065	0.611392
8/31/2021	17.472727	15.930789	7.690558	0.092258	1.117317

225 rows × 5 columns

In [6]:
```
data_diff = data.diff(year).dropna()
data_diff
```

Out[6]:

Date	VIX	Log Total Assets	Log Currency in Circulation ($ Bil)	Effective Federal Funds Rate (%)	Loss Function
12/31/2003	-11.384113	0.045793	0.057056	-0.254194	1.032640
1/31/2004	-11.323286	0.047454	0.049309	-0.238065	0.368954
2/29/2004	-16.220000	0.043829	0.047986	-0.254901	1.102860
3/31/2004	-12.946894	0.043121	0.043676	-0.251290	0.404229
4/30/2004	-8.293333	0.033697	0.042352	-0.254000	1.601901
...	...	...	...	...	...
4/30/2021	-24.037619	0.210753	0.132517	0.020000	112.839893
5/31/2021	-11.136500	0.124273	0.116395	0.008065	84.519025
6/30/2021	-14.162727	0.118755	0.108215	0.000333	48.659408
7/31/2021	-9.237121	0.162716	0.099906	0.005484	39.538836
8/31/2021	-5.416797	0.172818	0.087397	-0.002903	20.729400

213 rows × 5 columns

In [7]:
```
data_new = data_diff.diff(year).dropna()
```

In [8]:
```
data_new
```

Out[8]:

Date	VIX	Log Total Assets	Log Currency in Circulation ($ Bil)	Effective Federal Funds Rate (%)	Loss Function
12/31/2004	7.017294	0.016904	-0.006413	1.426129	0.032383
1/31/2005	8.660286	0.012750	0.000492	1.520323	0.889740
2/28/2005	11.930526	0.016558	0.002776	1.749446	-0.450845
3/31/2005	8.385867	0.017146	0.008396	1.878710	1.480530
4/30/2005	7.053810	0.019289	0.007823	2.035000	-0.470287
...	...	...	...	...	...
4/30/2021	-52.542381	-0.260106	0.043371	2.394667	228.571523
5/31/2021	-25.311682	-0.460421	0.008424	2.349032	170.165523
6/30/2021	-29.446273	-0.499225	-0.009767	2.300333	98.492688
7/31/2021	-22.771667	-0.441530	-0.024475	2.315806	78.485753
8/31/2021	-9.327229	-0.441747	-0.048900	2.027742	40.409641

201 rows × 5 columns

In [11]:
```python
column_names = {'VIX':'P',
                'Log Total Assets': 'Q',
                'Log Currency in Circulation ($ Bil)':'X',
                'Effective Federal Funds Rate (%)':'Y',
                'Loss Function':'Z'}

# rename columns
df = df.rename(columns = column_names)
```

In [12]:
```python
df
```

Out[12]:

Date	P	Q	X	Y	Z
12/31/2004	7.017294	0.016904	-0.006413	1.426129	0.032383
1/31/2005	8.660286	0.012750	0.000492	1.520323	0.889740
2/28/2005	11.930526	0.016558	0.002776	1.749446	-0.450845
3/31/2005	8.385867	0.017146	0.008396	1.878710	1.480530
4/30/2005	7.053810	0.019289	0.007823	2.035000	-0.470287
...	...	...	...	...	...
4/30/2021	-52.542381	-0.260106	0.043371	2.394667	228.571523
5/31/2021	-25.311682	-0.460421	0.008424	2.349032	170.165523
6/30/2021	-29.446273	-0.499225	-0.009767	2.300333	98.492688
7/31/2021	-22.771667	-0.441530	-0.024475	2.315806	78.485753
8/31/2021	-9.327229	-0.441747	-0.048900	2.027742	40.409641

201 rows × 5 columns

In [14]:
```python
## Partial Correlation

import statsmodels.api as sm

residuals = {}
for y_var in df.keys():
    X_vars = list(df.keys())
    X_vars.remove(y_var)
    X = df[X_vars]
    # Initial estimate should include constant
    #   This won't be the case we regress the errors
    X["Constant"] = 1
    # pass y_var as list for consistent structure
    y = df[[y_var]]
    model = sm.OLS(y, X)
    results = model.fit()
    residuals[y_var] = results.resid
residuals = pd.DataFrame(residuals)
```

In [15]:
```python
residuals
```

Out[15]:

Date	P	Q	X	Y	Z
12/31/2004	9.849021	0.112525	-0.014792	1.754966	-4.395330
1/31/2005	13.077744	0.065692	-0.007423	1.773681	-4.903426
2/28/2005	17.384859	0.051942	-0.005322	2.052677	-7.202058
3/31/2005	15.139816	0.041784	-0.001625	2.030169	-6.030974
4/30/2005	14.196069	0.057093	-0.003338	2.185788	-8.155989
...	...	...	...	...	...
4/30/2021	-34.986555	0.230718	0.019126	-1.142877	208.280595
5/31/2021	-5.785034	0.030449	0.018060	-0.366177	144.187619
6/30/2021	-10.050999	-0.014380	0.008812	0.078302	73.532742
7/31/2021	-7.182427	0.072184	-0.007770	0.681436	57.155418
8/31/2021	2.183128	0.085653	-0.023287	1.199790	21.874820

201 rows × 5 columns

In [17]:
```python
residuals.corr()[residuals.corr().abs() < 1].mul(-1).fillna(1).round(2)
```

Out[17]:

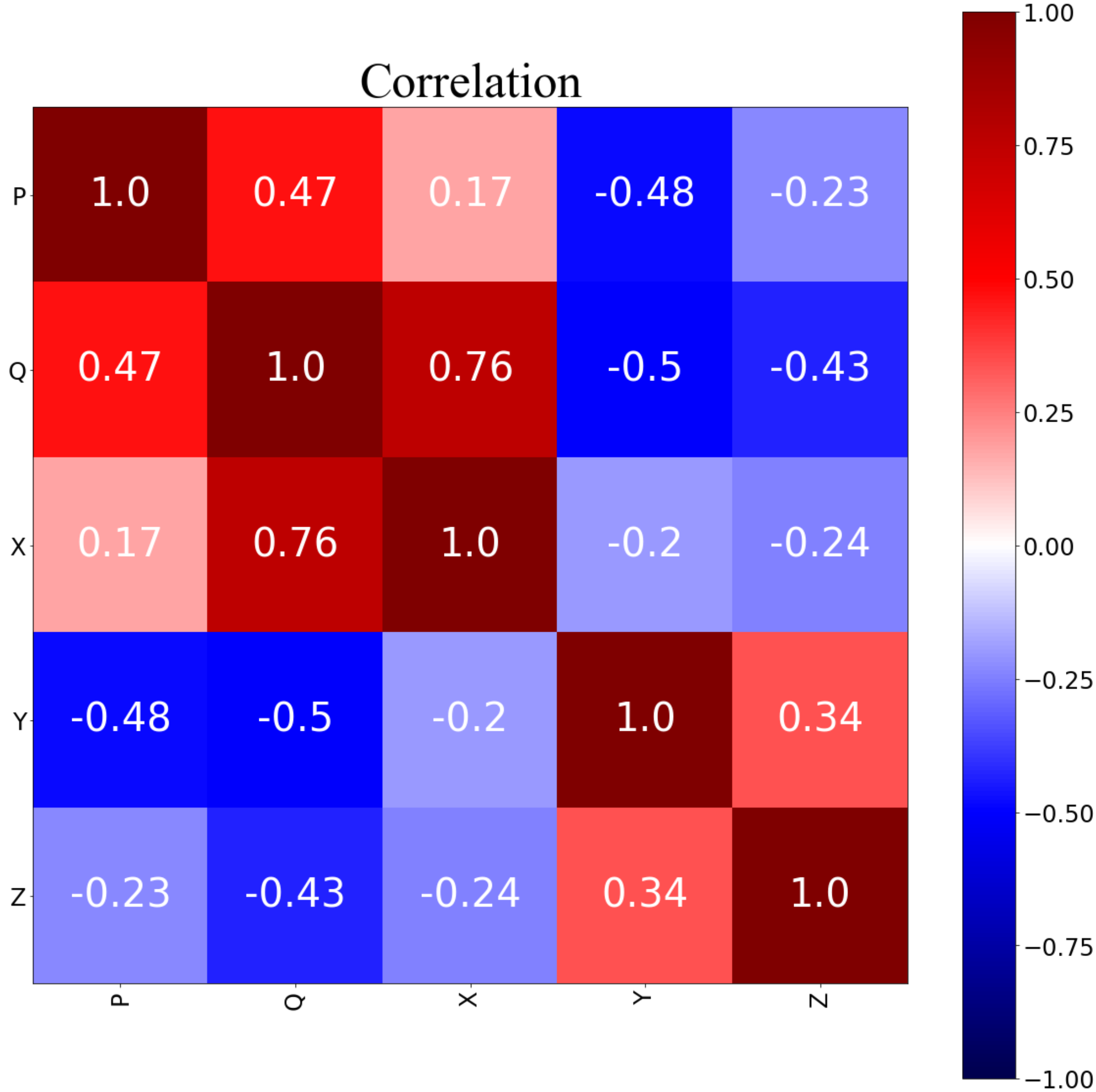
	P	Q	X	Y	Z
P	1.00	0.36	-0.23	-0.25	0.04
Q	0.36	1.00	0.78	-0.36	-0.27
X	-0.23	0.78	1.00	0.24	0.10
Y	-0.25	-0.36	0.24	1.00	0.13
Z	0.04	-0.27	0.10	0.13	1.00

In [18]:
```python
# !pip install pingouin
import pingouin
df.pcorr().round(2)
```

Out[18]:

	P	Q	X	Y	Z
P	1.00	0.36	-0.23	-0.25	0.04
Q	0.36	1.00	0.78	-0.36	-0.27
X	-0.23	0.78	1.00	0.24	0.10
Y	-0.25	-0.36	0.24	1.00	0.13
Z	0.04	-0.27	0.10	0.13	1.00

In [20]:
```python
from datlib.plots import *
corr_matrix_heatmap(df.corr(),
                    save_fig = False,
                    pp = None)
corr_matrix_heatmap(df.pcorr(), save_fig = False, pp = None, title = "Partial Cor
```




```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
~\AppData\Local\Temp/ipykernel_10084/2713408390.py in <module>
      3                     save_fig = False,
      4                     pp = None)
----> 5 corr_matrix_heatmap(df.pcorr(), save_fig = False, pp = None, title = "P
artial Correlation")

TypeError: corr_matrix_heatmap() got an unexpected keyword argument 'title'
```

In [21]:
```
residuals
```

Out[21]:

Date	P	Q	X	Y	Z
12/31/2004	9.849021	0.112525	-0.014792	1.754966	-4.395330
1/31/2005	13.077744	0.065692	-0.007423	1.773681	-4.903426
2/28/2005	17.384859	0.051942	-0.005322	2.052677	-7.202058
3/31/2005	15.139816	0.041784	-0.001625	2.030169	-6.030974
4/30/2005	14.196069	0.057093	-0.003338	2.185788	-8.155989
...	...	...	...	...	...
4/30/2021	-34.986555	0.230718	0.019126	-1.142877	208.280595
5/31/2021	-5.785034	0.030449	0.018060	-0.366177	144.187619
6/30/2021	-10.050999	-0.014380	0.008812	0.078302	73.532742
7/31/2021	-7.182427	0.072184	-0.007770	0.681436	57.155418
8/31/2021	2.183128	0.085653	-0.023287	1.199790	21.874820

201 rows × 5 columns

In [22]:
```
pcorr_pvalues = {}
for y, Y in residuals.items():
    pcorr_pvalues[y] = {}
    for x, X in residuals.items():
        if x != y:
            pcorr_pvalues[y][x] = sm.OLS(Y,X).fit().pvalues[x]

        else:
            pcorr_pvalues[y][x] = np.NaN
pd.DataFrame(pcorr_pvalues).round(2)
```

Out[22]:

	P	Q	X	Y	Z
P	NaN	0.0	0.00	0.00	0.56
Q	0.00	NaN	0.00	0.00	0.00
X	0.00	0.0	NaN	0.00	0.15
Y	0.00	0.0	0.00	NaN	0.07
Z	0.56	0.0	0.15	0.07	NaN

In [23]:
```python
undirected_graph = {key:[] for key in df.keys()}
for x in undirected_graph:
    remaining_vars = [y for y in df.keys() if y != x]
    for y in remaining_vars:
        undirected_graph[x].append(y)

undirected_graph
```

Out[23]:
```
{'P': ['Q', 'X', 'Y', 'Z'],
 'Q': ['P', 'X', 'Y', 'Z'],
 'X': ['P', 'Q', 'Y', 'Z'],
 'Y': ['P', 'Q', 'X', 'Z'],
 'Z': ['P', 'Q', 'X', 'Y']}
```

In [24]:

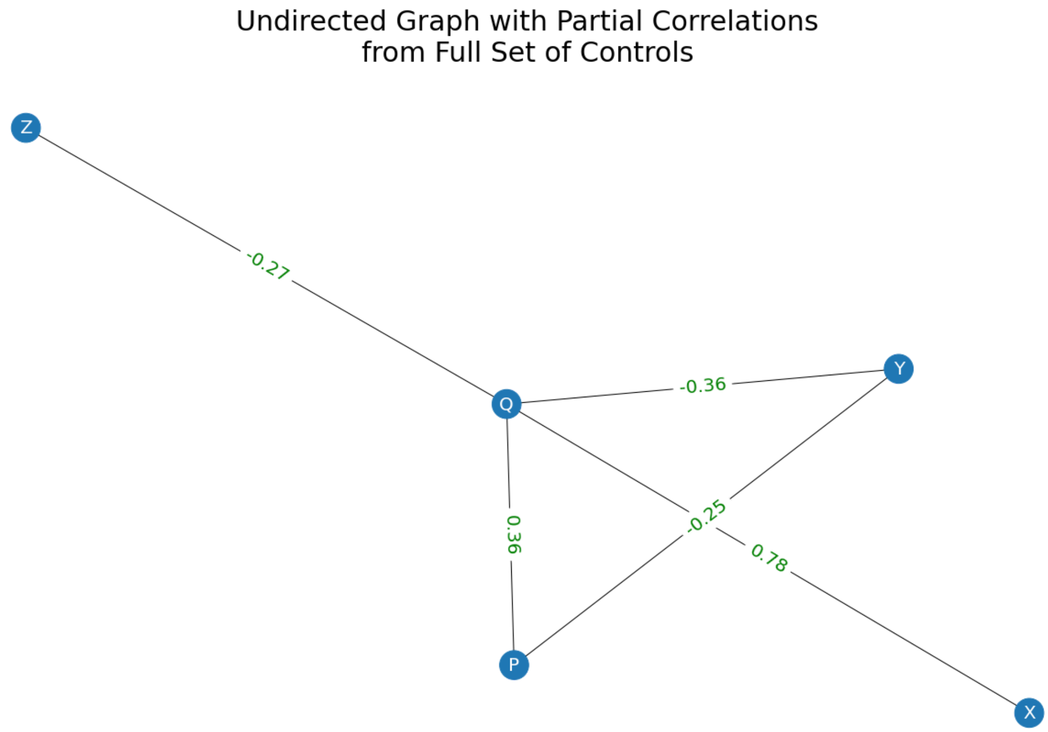
```python
import copy
p_val = .01
def build_skeleton(df, undirected_graph):
    def check_remaining_controls(control_vars, undirected_graph, x, y, controls_u
        for c_var in control_vars:
            # set c_used every time use cycle through a new control
            #  the program will then iterate through remaining controls
            #  until statistical significance is broken
            c_used = copy.copy(controls_used)
            if y in undirected_graph[x]:

                c_used.append(c_var)
                test = df.partial_corr(x = x, y = y, covar=c_used,
                                      method = "pearson")
                if test["p-val"].values[0] > p_val:

                    undirected_graph[x].remove(y)
                    #breakout of the for
                    break
                else:
                    remaining_controls = copy.copy(control_vars)
                    remaining_controls.remove(c_var)
                    # recursive function that iterates through remaining variable
                    #  uses them as controls statistical significance holds witho
                    #  otherwise break
                    check_remaining_controls(remaining_controls, undirected_graph

    for x in df.keys():
        ys = undirected_graph[x]
        for y in df.keys():
            if x != y:
            # first check for correlation with no controls
                test = df.partial_corr(x = x,
                                       y = y,
                                       covar = None,
                                       method = "pearson")
                if test["p-val"].values[0] > p_val:
                    undirected_graph[x].remove(y)
            # if correlated check for deseparation controlling for other variable
                else:
                    control_vars = [z for z in df.keys() if z != y and z != x]
                    check_remaining_controls(control_vars, undirected_graph, x, y
    return undirected_graph

undirected_graph = build_skeleton(df, undirected_graph)
undirected_graph
```

Out[24]:

```
{'P': ['Q', 'Y'],
 'Q': ['P', 'X', 'Y', 'Z'],
 'X': ['Q'],
 'Y': ['P', 'Q'],
 'Z': ['Q']}
```

In [25]:
```python
import matplotlib.pyplot as plt
import networkx as nx
def graph_DAG(undirected_graph, df, title = "DAG Structure"):

    # generate partial correlation matrix to draw values from
    # for graph edges
    pcorr_matrix = df.pcorr()
    graph = nx.Graph()
    edges = []
    edge_labels = {}
    for key in undirected_graph:
        for key2 in undirected_graph[key]:
            if (key2, key) not in edges:
                edge = (key.replace(" ","\n"), key2[0].replace(" ","\n"))
                edges.append(edge)
                # edge label is partial correlation between
                # key and key2
                edge_labels[edge] = str(round(pcorr_matrix.loc[key][key2],2))

    # edge format: ("i", "j") --> from node i to node j
    graph.add_edges_from(edges)
    color_map = ["C0" for g in graph]

    fig, ax = plt.subplots(figsize = (20,12))
    graph.nodes()
    plt.tight_layout()
    pos = nx.spring_layout(graph)#, k = 5/(len(sig_corr.keys())**.5))

    plt.title(title, fontsize = 30)
    nx.draw_networkx(graph, pos, node_color=color_map,
                     node_size = 1000,
                     with_labels=True,  arrows=False,
                     font_size = 20, alpha = 1,
                     font_color = "white",
                     ax = ax)
    nx.draw_networkx_edge_labels(graph,pos,
                                 edge_labels=edge_labels,
                                 font_color='green',
                                 font_size=20)
    plt.axis("off")
    plt.savefig("g1.png", format="PNG")
    plt.show()
```

In [26]:
```
graph_DAG(undirected_graph, df, title = "Undirected Graph with Partial Correlatic
```



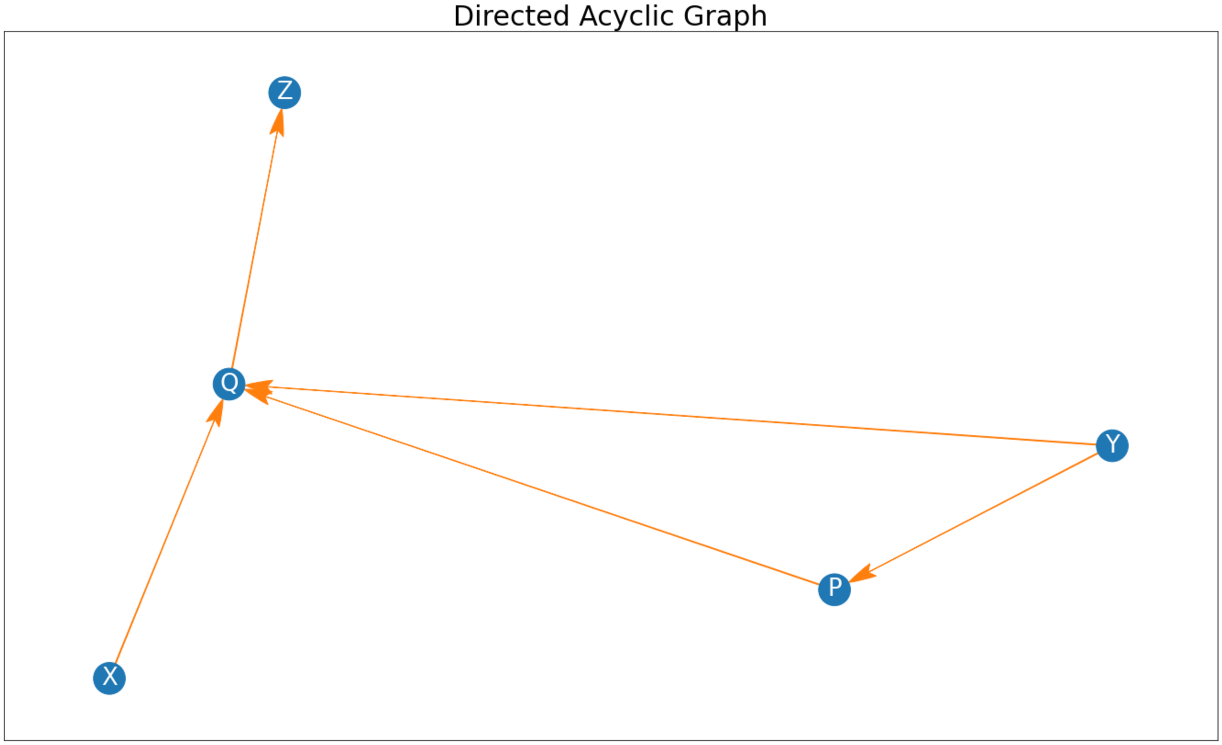
In [27]:
```
## Estimating a Directed Acyclic Graph

from pgmpy.estimators import PC
c = PC(df)
max_cond_vars = len(df.keys()) - 2


model = c.estimate(return_type = "dag",variant= "parallel",#"orig", "stable"
                   significance_level = p_val,
                   max_cond_vars = max_cond_vars, ci_test = "pearsonr")
edges = model.edges()
```

```
  0%|          | 0/3 [00:00<?, ?it/s]
```

In [28]:
```python
from matplotlib.patches import ArrowStyle

def graph_DAG(edges, df, title = ""):
    graph = nx.DiGraph()
    graph.add_edges_from(edges)
    color_map = ["C0" for g in graph]

    fig, ax = plt.subplots(figsize = (20,12))
    graph.nodes()
    plt.tight_layout()
    pos = nx.spring_layout(graph)#, k = 5/(len(sig_corr.keys())**.5))

    plt.title(title, fontsize = 30)
    nx.draw_networkx(graph, pos, node_color=color_map, node_size = 1200,
                     with_labels=True,  arrows=True,
                     font_color = "white",
                     font_size = 26, alpha = 1,
                     width = 1, edge_color = "C1",
                     arrowstyle=ArrowStyle("Fancy, head_length=3, head_width=1.5,

graph_DAG(edges, df, title = "Directed Acyclic Graph")
edges
```

Out[28]:
```
OutEdgeView([('Y', 'Q'), ('Y', 'P'), ('Q', 'Z'), ('X', 'Q'), ('P', 'Q')])
```

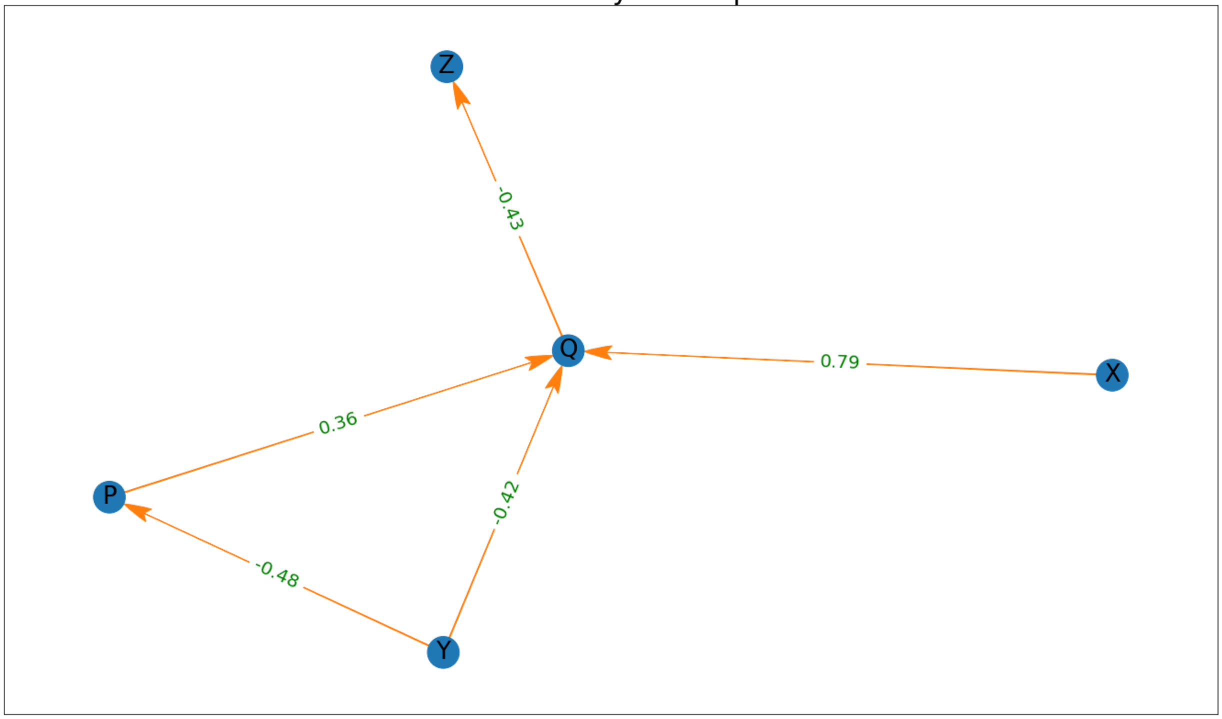
Directed Acyclic Graph



```
In [29]: ## D-separation

def graph_DAG(edges, df, title = ""):
    graph = nx.DiGraph()
    edge_labels = {}
    ############ Add ############
    for edge in edges:
        controls = [key for key in df.keys() if key not in edge]
        controls = list(set(controls))
        keep_controls = []
        for control in controls:
            control_edges = [ctrl_edge for ctrl_edge in edges if control == ctrl_
            if (control, edge[1]) in control_edges:
                print("keep control:", control)
                keep_controls.append(control)
        print(edge, keep_controls)
        pcorr = df[[edge[0], edge[1]]+keep_controls].pcorr()
#         corr_matrix_heatmap(pcorr, save_fig = False, pp = None, title = "Partic
        edge_labels[edge] = str(round(pcorr[edge[0]].loc[edge[1]],2))
    graph.add_edges_from(edges)
    color_map = ["C0" for g in graph]

    fig, ax = plt.subplots(figsize = (20,12))
    graph.nodes()
    plt.tight_layout()
    pos = nx.spring_layout(graph)#, k = 5/(len(sig_corr.keys())**.5))

    plt.title(title, fontsize = 30)
    nx.draw_networkx(graph, pos, node_color=color_map, node_size = 1200,
                     with_labels=True,  arrows=True,
                     # turn text black for larger variable names in homework
                     font_color = "k",
                     font_size = 26, alpha = 1,
                     width = 1, edge_color = "C1",
                     arrowstyle=ArrowStyle("Fancy, head_length=3, head_width=1.5,
    ############ Add ############
    nx.draw_networkx_edge_labels(graph,pos,
                                 edge_labels=edge_labels,
                                 font_color='green',
                                 font_size=20)

graph_DAG(edges, df, title = "Directed Acyclic Graph")
```

```
keep control: X
keep control: P
('Y', 'Q') ['X', 'P']
('Y', 'P') []
('Q', 'Z') []
keep control: Y
keep control: P
('X', 'Q') ['Y', 'P']
keep control: Y
keep control: X
('P', 'Q') ['Y', 'X']
```

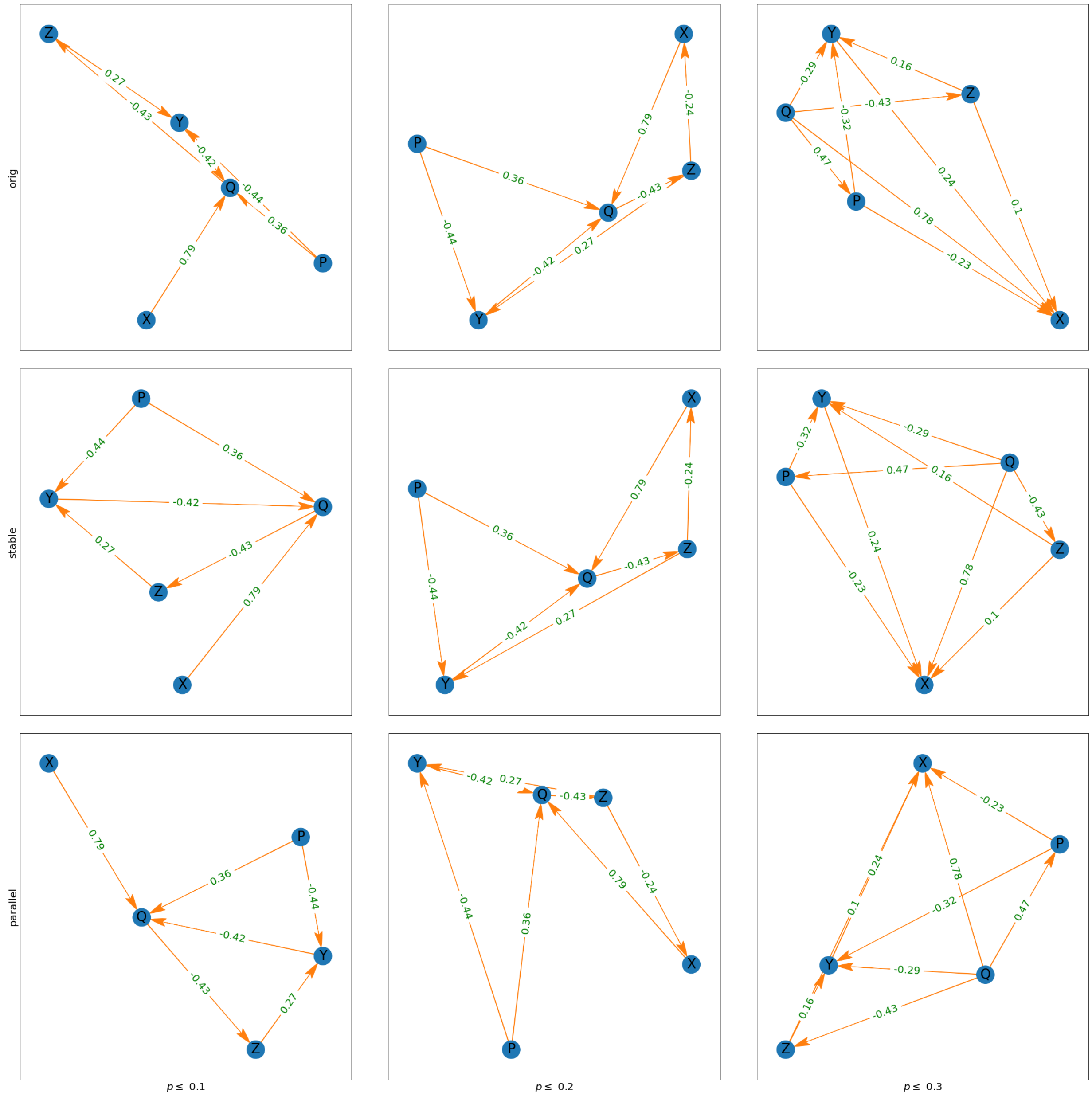
Directed Acyclic Graph



In [30]:
```
def graph_DAG(edges, df, title = "", fig = False, ax = False):
    graph = nx.DiGraph()
    edge_labels = {}
    for edge in edges:
        controls = [key for key in df.keys() if key not in edge]
        controls = list(set(controls))
        keep_controls = []
        for control in controls:
            control_edges = [ctrl_edge for ctrl_edge in edges if control == ctrl_
            if (control, edge[1]) in control_edges:
                keep_controls.append(control)
        pcorr = df[[edge[0], edge[1]]+keep_controls].pcorr()
        edge_labels[edge] = str(round(pcorr[edge[0]].loc[edge[1]],2))
    graph.add_edges_from(edges)
    color_map = ["C0" for g in graph]

    # add fig and ax if none passed to function
    if not fig and not ax:
        fig, ax = plt.subplots(figsize = (20,12))
    graph.nodes()
    plt.tight_layout()
    pos = nx.spring_layout(graph)

    # use ax.set_title to access subplot when setting title
    ax.set_title(title, fontsize = 30)
    nx.draw_networkx(graph, pos, node_color=color_map, node_size = 1200,
                     with_labels=True,  arrows=True,
                     font_color = "k",
                     font_size = 26, alpha = 1,
                     width = 1, edge_color = "C1",
                     arrowstyle = ArrowStyle("Fancy, head_length=3, head_width=1.
                     ax = ax) # reference ax for specific subplot since that is p
                            # just using plt.title will only add title to very la
    nx.draw_networkx_edge_labels(graph,pos,
                                 edge_labels=edge_labels,
                                 font_color='green',
                                 font_size=20,
                                 ax = ax)

algorithms = ["orig", "stable", "parallel"]
p_vals = [0.1, 0.2, 0.3]
i,j = 0,0
fig, ax = plt.subplots(len(algorithms), len(p_vals), figsize = (30,30))

# use i in range(len(algorithm)) instead of algorithm in algorithms for ax refere
for i in range(len(algorithms)):
    for j in range(len(p_vals)):
        a = ax[i]
        algorithm = algorithms[i]
        p_val = p_vals[j]
        c = PC(df)
        max_cond_vars = len(df.keys()) - 2
        model = c.estimate(return_type = "dag",
                           variant = algorithm,
                           significance_level = p_val,
                           max_cond_vars = max_cond_vars,
```

```
                              ci_test = "pearsonr")
        edges = model.edges()
        a = ax[i][j]
        graph_DAG(edges, df, fig = fig, ax = a)

        if j == 0:
            a.set_ylabel(algorithm, fontsize = 20)
        if i == len(algorithms) - 1:
            a.set_xlabel("$p \leq$ "+ str(p_val), fontsize = 20)
        if i == 3:
            break

import pingouin as pg
import matplotlib.pyplot as plt
import networkx as nx
from pgmpy.estimators import PC
from matplotlib.patches import ArrowStyle
```

```
  0%|          | 0/3 [00:00<?, ?it/s]

C:\Users\HP\anaconda3\lib\site-packages\pgmpy\base\DAG.py:1187: UserWarning: PD
AG has no faithful extension (= no oriented DAG with the same v-structures as P
DAG). Remaining undirected PDAG edges oriented arbitrarily.
  warn(

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]

  0%|          | 0/3 [00:00<?, ?it/s]
```



In [ ]: