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

import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:
```
filepath = 'data/ppauto_pos.csv'
auto_df = pd.read_csv(filepath)
auto_df.head()
```

Out[2]:

	GRCODE	GRNAME	AccidentYear	DevelopmentYear	DevelopmentLag	IncurLoss_B	Cun
0	43	IDS Property Cas Ins Co	1988	1988	1	607	
1	43	IDS Property Cas Ins Co	1988	1989	2	647	
2	43	IDS Property Cas Ins Co	1988	1990	3	582	
3	43	IDS Property Cas Ins Co	1988	1991	4	598	
4	43	IDS Property Cas Ins Co	1988	1992	5	614	

Generating a loss triangle for IDS Property Cas Ins Co

In [3]:
```
IDS_df = auto_df[auto_df['GRNAME'] == 'IDS Property Cas Ins Co']
triangle = IDS_df.pivot(index='AccidentYear', columns = 'DevelopmentLag',
values='CumPaidLoss_B').sort_index().sort_index(axis=1)
```

In [4]:
```
development_factors = triangle.shift(-1, axis=1) / triangle
factors = development_factors.mean(skipna=True, axis=0)
```

In [5]:
```
print("Average Development Factors: ",factors)
```

```
Average Development Factors:  DevelopmentLag
1     2.174467
2     1.301747
3     1.140917
4     1.056834
5     1.032519
6     1.006120
7     1.006755
8     0.999751
9     1.000058
10         NaN
dtype: float64
```

Projecting Future Losses

In [6]:
```
projected = triangle.copy()

for col in range(1, projected.shape[1]):
    for row in range(projected.shape[0]):
        if pd.isna(projected.iloc[row, col]):
            if row + col < projected.shape[1]:
                projected.iloc[row, col] = projected.iloc[row, col - 1] *
factors[col - 1]
```

In [7]:
```
ultimate = projected.max(axis=1)
ibnr = ultimate - triangle.max(axis=1)
print("Estimated IBNR by Accident Year:")
print(ibnr)
```

```
Estimated IBNR by Accident Year:
AccidentYear
1988    0
1989    0
1990    0
1991    0
1992    0
1993    0
1994    0
1995    0
1996    0
1997    0
dtype: int64
```

> Projected Incurred but not reported values are zero meaning there is nothing left to project What if our valuation year was 1994 instead?

In [8]:
```
valuation_year = 1994
early_report_df = IDS_df[IDS_df['DevelopmentYear'] <= valuation_year]
early_report_df.head()
```

Out[8]:

	GRCODE	GRNAME	AccidentYear	DevelopmentYear	DevelopmentLag	IncurLoss_B	Cun
0	43	IDS Property Cas Ins Co	1988	1988	1	607	
1	43	IDS Property Cas Ins Co	1988	1989	2	647	
2	43	IDS Property Cas Ins Co	1988	1990	3	582	
3	43	IDS Property Cas Ins Co	1988	1991	4	598	
4	43	IDS Property Cas Ins Co	1988	1992	5	614	

In [9]:
```
triangle = early_report_df.pivot(index='AccidentYear', columns = 'DevelopmentLag',
values='CumPaidLoss_B').sort_index().sort_index(axis=1)
triangle[:10]
```

Out[9]:

DevelopmentLag	1	2	3	4	5	6	7
AccidentYear							
1988	133.0	333.0	431.0	570.0	615.0	615.0	615.0
1989	934.0	1746.0	2365.0	2579.0	2763.0	2966.0	NaN
1990	2030.0	4864.0	6880.0	8087.0	8595.0	NaN	NaN
1991	4537.0	11527.0	15123.0	16656.0	NaN	NaN	NaN
1992	7564.0	16061.0	22465.0	NaN	NaN	NaN	NaN
1993	8343.0	19900.0	NaN	NaN	NaN	NaN	NaN
1994	12565.0	NaN	NaN	NaN	NaN	NaN	NaN

In [10]:
```
factors = (triangle.shift(-1,axis=1) / triangle).mean(skipna=True)
# factors
# redo Projected
projected = triangle.copy()
for col in range(1, projected.shape[1]):
    for row in range(projected.shape[0]):
        if pd.isna(projected.iloc[row, col]):
```

```
            if not pd.isna(projected.iloc[row, col - 1]):
                projected.iloc[row, col] = projected.iloc[row, col - 1] *
factors.iloc[col - 1]
```

In [11]:
```
projected
```

Out[11]:

DevelopmentLag	1	2	3	4	5	
AccidentYear						
1988	133.0	333.000000	431.000000	570.000000	615.000000	615.0
1989	934.0	1746.000000	2365.000000	2579.000000	2763.000000	2966.0
1990	2030.0	4864.000000	6880.000000	8087.000000	8595.000000	8910.7
1991	4537.0	11527.000000	15123.000000	16656.000000	17839.185153	18494.5
1992	7564.0	16061.000000	22465.000000	26339.071733	28210.109113	29246.4
1993	8343.0	19900.000000	26960.462949	31609.773761	33855.223749	35098.9
1994	12565.0	28938.124244	39205.287763	45966.209067	49231.491013	51040.0

In [12]:
```
ultimate = projected.max(axis=1)
ibnr = ultimate - triangle.max(axis=1)
print("Estimated IBNR by Accident Year:")
print(ibnr)
```

```
Estimated IBNR by Accident Year:
AccidentYear
1988        0.000000
1989        0.000000
1990      315.741042
1991     1838.515335
1992     6781.419673
1993    15198.910036
1994    38475.031128
dtype: float64
```

In [ ]:

In [ ]: