

```

In[1]:= SetDirectory[NotebookDirectory[]];

In[2]:= Solve[(1 + ctplusone / 100)^(t + 1) == (1 + rtplusone / 100) * (1 + ct / 100)^t, rtplusone];
Simplify[%];
rtplusone[ctplusone_, ct_, t_] = rtplusone /. %[[1, 1]]

Out[4]= (100 + ct)^-t (ctplusone (100 + ctplusone)^t - 100 ((100 + ct)^t - (100 + ctplusone)^t))

In[5]:= data = Flatten[Import["TIAApre1987annual.txt", "Table"]]

Out[5]= {5.66, 5.75, 5.85, 5.94, 6.04, 6.14, 6.25, 6.36, 6.47, 6.58, 6.69,
6.81, 6.93, 7.06, 7.2, 7.35, 7.51, 8.33, 8.43, 8.53, 8.64, 8.73, 8.83,
8.96, 9.1, 9.26, 10.6, 10.92, 11.19, 12.28, 11.94, 11.74, 11.4, 10.29}

In[6]:= f[{first_, second_}, {third_}] := {first, second, third}
MapIndexed[f, MapThread[{#1, #2} &, {Most[data], Most[RotateLeft[data]]}]];
Map[Apply[{#1, #2, 34 - #3} &], %];
returnsFromAnnual = Map[Apply[rtplusone, #] &, %];
returnsFromAnnual = AppendTo[returnsFromAnnual, Last[data]]

Out[10]= {2.73258, 2.5994, 3.0976, 2.98345, 3.18063, 3.10581, 3.32262, 3.53955, 3.75659,
3.97376, 3.96691, 4.2038, 4.23617, 4.29808, 4.38949, 4.51038, -5.51761,
6.74249, 6.94101, 7.00164, 7.47676, 7.53714, 7.4102, 7.56984, 7.6705,
-0.891763, 8.3857, 9.31371, 5.89668, 13.6504, 12.5422, 12.4231, 12.5212, 10.29}

In[11]:= Solve[(1 + 11.40 / 100)^2 == (1 + r / 100) * (1 + 10.29 / 100), r] (* check *)

Out[11]= {{r -> 12.5212}}

In[12]:= Solve[(1 + 5.66 / 100)^34 == (1 + r / 100) * (1 + 5.75 / 100)^33, r] (* check *)

Out[12]= {{r -> 2.73258}}

In[13]:= Length[returnsFromAnnual]

Out[13]= 34

(* Now do the returns from cumulative. *)
(*
https://www.sec.gov/Archives/edgar/data/826037/0000950131-95-003006.txt
CTR: cumulative total return
FV: future value
IV: initial value
CTR = (FV-IV)*100/IV
FV_2 = FV_1 * (1+r), find r.
*)

In[14]:= rtplusone[ctplusone_, ct_, t_] = 100 * ((ctplusone + 100) / (ct + 100) - 1)

Out[14]= 100 \left( -1 + \frac{100 + ctplusone}{100 + ct} \right)

```

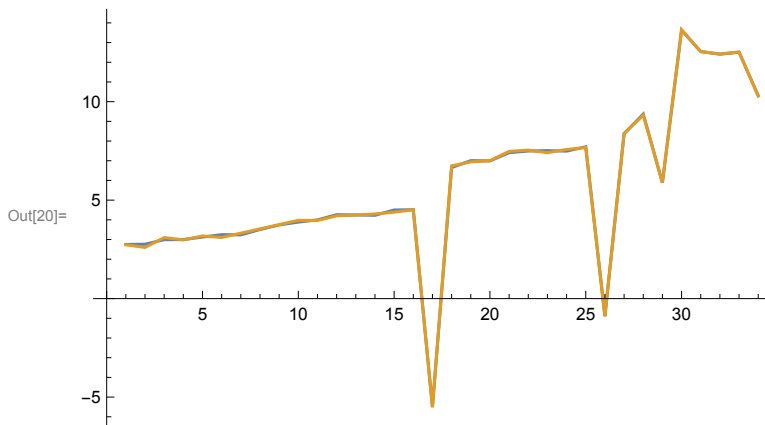
```
In[15]= data = Flatten[Import["TIAApre1987cumulative.txt", "Table"]]
```

```
Out[15]= {550.3, 532.9, 515.9, 498., 480.6, 463., 445.3, 428.2, 410.3, 391.9, 373.5,
  355.3, 336.7, 318.9, 301.9, 284.6, 268., 289.4, 265.1, 241.2, 218.9, 196.9,
  176.2, 156.9, 139., 121.9, 123.9, 106.6, 88.9, 78.4, 57., 39.5, 24.1, 10.3}
```

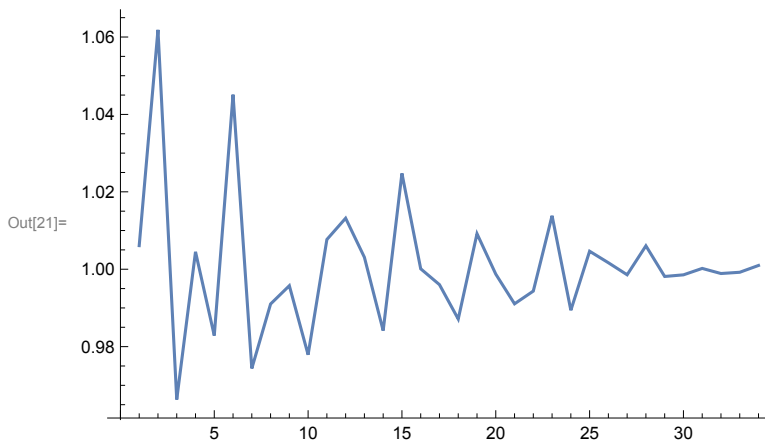
```
In[16]= MapIndexed[f, MapThread[{-#1, #2} &, {Most[data], Most[RotateLeft[data]}]];
Map[Apply[{-#1, #2, 34 - #3} &], %];
returnsFromCumulative = Map[Apply[rtplusone, #] &, %];
returnsFromCumulative = AppendTo[returnsFromCumulative, Last[data]]
```

```
Out[19]= {2.74925, 2.76019, 2.99331, 2.9969, 3.12611, 3.24592, 3.23741, 3.50774, 3.7406,
  3.88596, 3.99736, 4.25922, 4.24922, 4.22991, 4.49818, 4.51087, -5.49563,
  6.65571, 7.00469, 6.99279, 7.4099, 7.49457, 7.51265, 7.48954, 7.70617,
  -0.893256, 8.37367, 9.37004, 5.88565, 13.6306, 12.5448, 12.4093, 12.5113, 10.3}
```

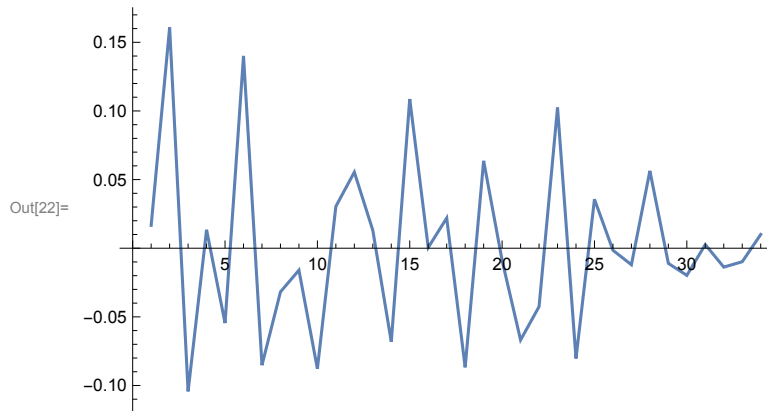
```
In[20]= ListLinePlot[{returnsFromCumulative, returnsFromAnnual}]
```



```
In[21]= ListLinePlot[returnsFromCumulative / returnsFromAnnual]
```



```
In[22]:= ListLinePlot[returnsFromCumulative - returnsFromAnnual]
```



```
In[23]:= {Table[1952 + i, {i, 1, Length[returnsFromCumulative]}],
returnsFromCumulative, returnsFromAnnual} // Transpose // TableForm
```

Out[23]/TableForm=

1953	2.74925	2.73258
1954	2.76019	2.5994
1955	2.99331	3.0976
1956	2.9969	2.98345
1957	3.12611	3.18063
1958	3.24592	3.10581
1959	3.23741	3.32262
1960	3.50774	3.53955
1961	3.7406	3.75659
1962	3.88596	3.97376
1963	3.99736	3.96691
1964	4.25922	4.2038
1965	4.24922	4.23617
1966	4.22991	4.29808
1967	4.49818	4.38949
1968	4.51087	4.51038
1969	-5.49563	-5.51761
1970	6.65571	6.74249
1971	7.00469	6.94101
1972	6.99279	7.00164
1973	7.4099	7.47676
1974	7.49457	7.53714
1975	7.51265	7.4102
1976	7.48954	7.56984
1977	7.70617	7.6705
1978	-0.893256	-0.891763
1979	8.37367	8.3857
1980	9.37004	9.31371
1981	5.88565	5.89668
1982	13.6306	13.6504
1983	12.5448	12.5422
1984	12.4093	12.4231
1985	12.5113	12.5212
1986	10.3	10.29

```
In[24]= (* check of annual; should be 5.66% *)
```

```
In[25]= Solve[Apply[Times, Map[(1 + #1 / 100) &, returnsFromAnnual]] ==  
  (1 + r) ^ Length[returnsFromAnnual] && r > 0, r]  
  Solve[Apply[Times, Map[(1 + #1 / 100) &, returnsFromCumulative]] ==  
  (1 + r) ^ Length[returnsFromCumulative] && r > 0, r]
```

```
Out[25]= {{r -> 0.0566}}
```

```
Out[26]= {{r -> 0.056611}}
```

```
In[27]= (* check of cumulative; should be 550.3% *)
```

```
In[28]= (Apply[Times, Map[(1 + #1 / 100) &, returnsFromAnnual]] - 1) * 100  
  (Apply[Times, Map[(1 + #1 / 100) &, returnsFromCumulative]] - 1) * 100
```

```
Out[28]= 550.071
```

```
Out[29]= 550.3
```

```
In[30]:= {Table[1952 + i, {i, 1, Length[returnsFromCumulative]}],
          Round[returnsFromCumulative, 1 / 100] // N,
          Round[returnsFromAnnual, 1 / 100] // N} // Transpose // TableForm
Export["TIAA_returns.dat", %];
```

Out[30]/TableForm=

1953	2.75	2.73
1954	2.76	2.6
1955	2.99	3.1
1956	3.	2.98
1957	3.13	3.18
1958	3.25	3.11
1959	3.24	3.32
1960	3.51	3.54
1961	3.74	3.76
1962	3.89	3.97
1963	4.	3.97
1964	4.26	4.2
1965	4.25	4.24
1966	4.23	4.3
1967	4.5	4.39
1968	4.51	4.51
1969	-5.5	-5.52
1970	6.66	6.74
1971	7.	6.94
1972	6.99	7.
1973	7.41	7.48
1974	7.49	7.54
1975	7.51	7.41
1976	7.49	7.57
1977	7.71	7.67
1978	-0.89	-0.89
1979	8.37	8.39
1980	9.37	9.31
1981	5.89	5.9
1982	13.63	13.65
1983	12.54	12.54
1984	12.41	12.42
1985	12.51	12.52
1986	10.3	10.29