Asset Return Computations

1 Simple net returns

Assume we observe the price of an asset at the end of a period where the period could be days, months, or years, etc. We could then say that at the end of period $t$, the asset price is $P_t$ and at the end of the previous period, $t-1$, the price was $P_{t-1}$. We define the simple net return as the percentage change in the price:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1 = \%\Delta P_t$$

(R <- diff(intc.x)/lag(intc.x))

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>2013-01-31</td>
<td>NA</td>
</tr>
<tr>
<td>2013-02-28</td>
<td>0.002938</td>
</tr>
<tr>
<td>2013-03-31</td>
<td>0.046387</td>
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<td>2013-08-31</td>
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2 Log returns

If we let $R_t$ denote the simple net return, then we can define the continuously compounded return, $r_t$ as:

$$r_t = \ln(1 + R_t) = \ln \left( \frac{P_t}{P_{t-1}} \right)$$

where $\ln(\cdot)$ is the natural log function. We call this the continuously compounded return because we can manipulate the above equation into:

$$P_t = P_{t-1} e^{r_t}$$

so that $r_t$ is the continuously compounded growth rate in prices between periods $t-1$ and $t$ whereas $R_t$ is the simple growth rate in prices between periods $t-1$ and $t$ without any compounding. Note that the continuously compounded return is often referred to as the log return.

```r
r <- diff(log(intc.x))
head(r, 3)
## [,1]
## 2013-01-31 NA
## 2013-02-28 0.002934
## 2013-03-31 0.045343

plot(r, main = "Intel Log Returns")
```

**Intel Log Returns**

![Graph of Intel Log Returns](image)

Jan 2013  Apr 2013  Jul 2013
3 Annualized returns and annualized volatility

We can annualize continuously compounded returns and return volatility (the standard deviation of returns) using the following formulas:

\[
\begin{align*}
    r_A &= 100 \cdot T \cdot \text{mean}(r_t) \\
    \sigma_A &= 100 \cdot \sqrt{T} \cdot \text{sd}(r_t)
\end{align*}
\]

where:

- \( r_A \) = annualized continuously compounded return
- \( \sigma_A \) = annualized volatility
- \( T \) = number of time periods per year
- \( r_t \) = continuously compounded return series