Gas Stuff

Intro

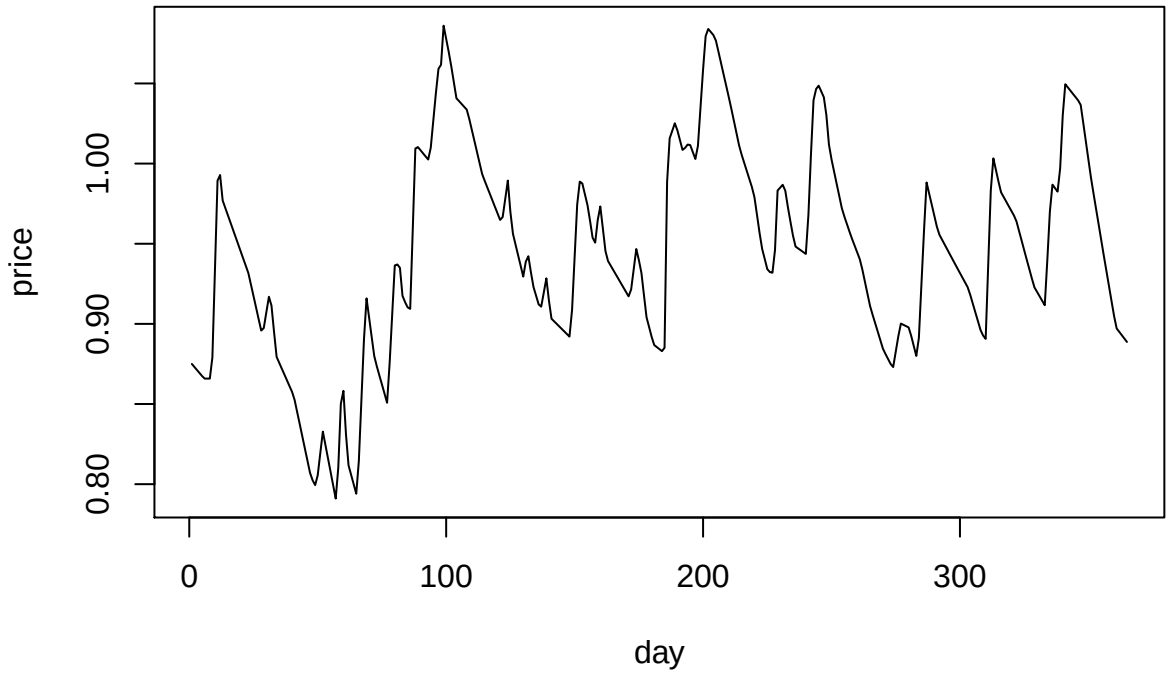
I want to use historical gas prices so that I can simulate customer behaviour and test what strategy leads to greatest savings.

Data

Found historical gas prices (CAN c/L) from the Edmonton (AB) area at edmontongasprices.com.

Digitized the 1-year chart (2016-09-25, 2017-09-25) using Plot Digitizer, 2.6.8. Used linear interpolation to get daily prices in CAN/L.

```
##       day          price      
##  Min.   :  1   Min.   :0.7910  
##  1st Qu.: 92   1st Qu.:0.9000  
##  Median :183   Median :0.9425  
##  Mean   :183   Mean   :0.9446  
##  3rd Qu.:274   3rd Qu.:0.9882  
##  Max.   :365   Max.   :1.0860
```



Strategies

Define some constants:

- Tank volume in L: `vol`
- Mileage in L/100km: `mil`
- Avg distance per day: `dis`

```
vol <- 60
mil <- 9.6
dis <- 50
LperD <- mil*dis/100 # average L/day
```

Scenario 1: Go until empty

Refill only when low gas indicator light comes on (we ignore the few litres there, but one can adjust tank volume accordingly)

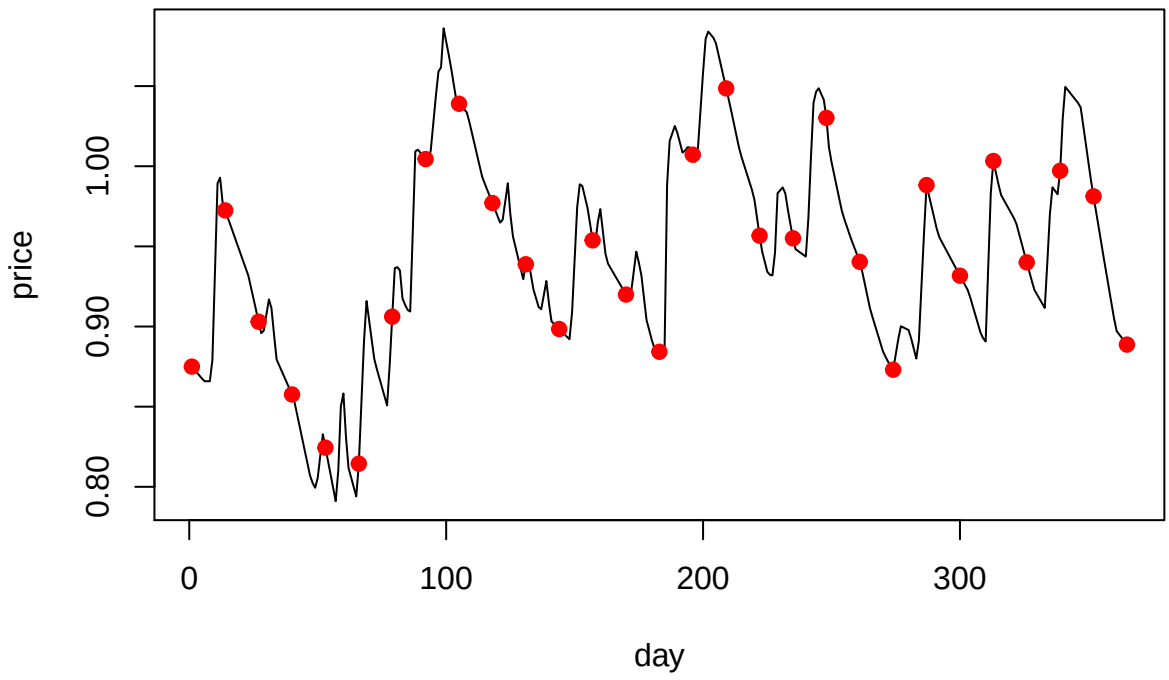
```
z1 <- z # copy for scenario 1
z1$refill <- FALSE # indicates decision to refill
z1$refill[1] <- TRUE
z1$distance <- 0
z1$level <- vol # gas in tank in L
z1$cost <- 0
for (i in 2:n) {
    z1$distance[i] <- z1$distance[i-1] + dis
    doRefill <- z1$level[i-1] - LperD < 0
    if (doRefill) { # refill
        z1$level[i] <- z1$level[i-1] - LperD
        z1$refill[i] <- TRUE
        z1$cost[i] <- ceiling(100 * z1$price[i] * (vol - z1$level[i]))/100
        z1$level[i] <- vol
        z1$distance[i] <- 0
    } else { # not
        z1$level[i] <- z1$level[i-1] - LperD
    }
}
summary(z1[,-(1:2)])
```

```
##    refill           distance         level            cost
##  Mode :logical   Min.   :  0.0   Min.   : 2.40   Min.   : 0.00
##  FALSE:336       1st Qu.:150.0   1st Qu.:16.80   1st Qu.: 0.00
##  TRUE :29        Median :300.0   Median :31.20   Median : 0.00
##  NA's :0         Mean   :299.2   Mean   :31.28   Mean   : 4.52
##                  3rd Qu.:450.0   3rd Qu.:45.60   3rd Qu.: 0.00
##                  Max.   :600.0   Max.   :60.00   Max.   :65.44
```

```
sum(z1$cost)
```

```
## [1] 1649.69
```

```
plot(z, type="l")
points(z1[z1$refill,1:2], col=2, pch=19)
```



In Scenario 1, we spent 1649.69 CAD in a year and stopped at the gas station 29 times. We will use this scenario as the baseline.

Scenario 2: Fill up when cheaper

Top up the tank if price is lower, keep driving until empty when price is higher.

```
z2 <- z # copy for scenario 2
z2$refill <- FALSE # indicates decision to refill
z2$refill[1] <- TRUE
z2$distance <- 0
z2$level <- vol # gas in tank in L
z2$cost <- 0
for (i in 2:n) {
    z2$distance[i] <- z2$distance[i-1] + dis
    doRefill1 <- z2$level[i-1] - LperD < 0
    doRefill2 <- z2$price[i-1] > z2$price[i]
    if (doRefill1 || doRefill2) { # refill
        z2$level[i] <- z2$level[i-1] - LperD
        z2$refill[i] <- TRUE
        z2$cost[i] <- ceiling(100 * z2$price[i] * (vol - z2$level[i]))/100
        z2$level[i] <- vol
        z2$distance[i] <- 0
    } else { # not
        z2$level[i] <- z2$level[i-1] - LperD
    }
```

```
}
summary(z2[,-(1:2)])
```

```
##    refill           distance          level            cost
##  Mode :logical   Min.   :  0.00   Min.   :31.20   Min.   : 0.000
##  FALSE:85        1st Qu.:  0.00   1st Qu.:60.00   1st Qu.: 3.860
##  TRUE :280       Median :  0.00   Median :60.00   Median : 4.410
##  NA's :0         Mean   : 28.63   Mean   :57.25   Mean   : 4.549
##                  3rd Qu.:  0.00   3rd Qu.:60.00   3rd Qu.: 4.680
##                  Max.   :300.00   Max.   :60.00   Max.   :36.220
```

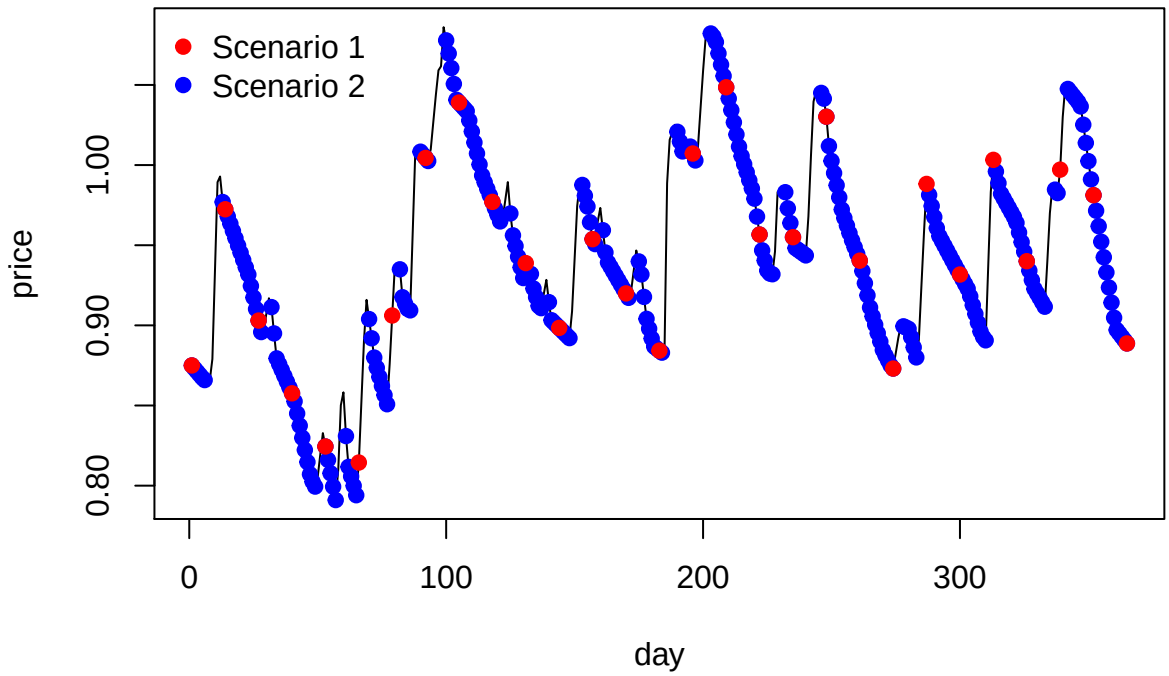
```
sum(z2$cost)
```

```
## [1] 1660.35
```

```
sum(z2$cost) - sum(z1$cost)
```

```
## [1] 10.66
```

```
plot(z, type="l")
points(z2[z2$refill,1:2], col=4, pch=19)
points(z1[z1$refill,1:2], col=2, pch=19)
legend("topleft", bty="n", pch=19, col=c(2,4),
    legend=paste("Scenario", 1:2))
```

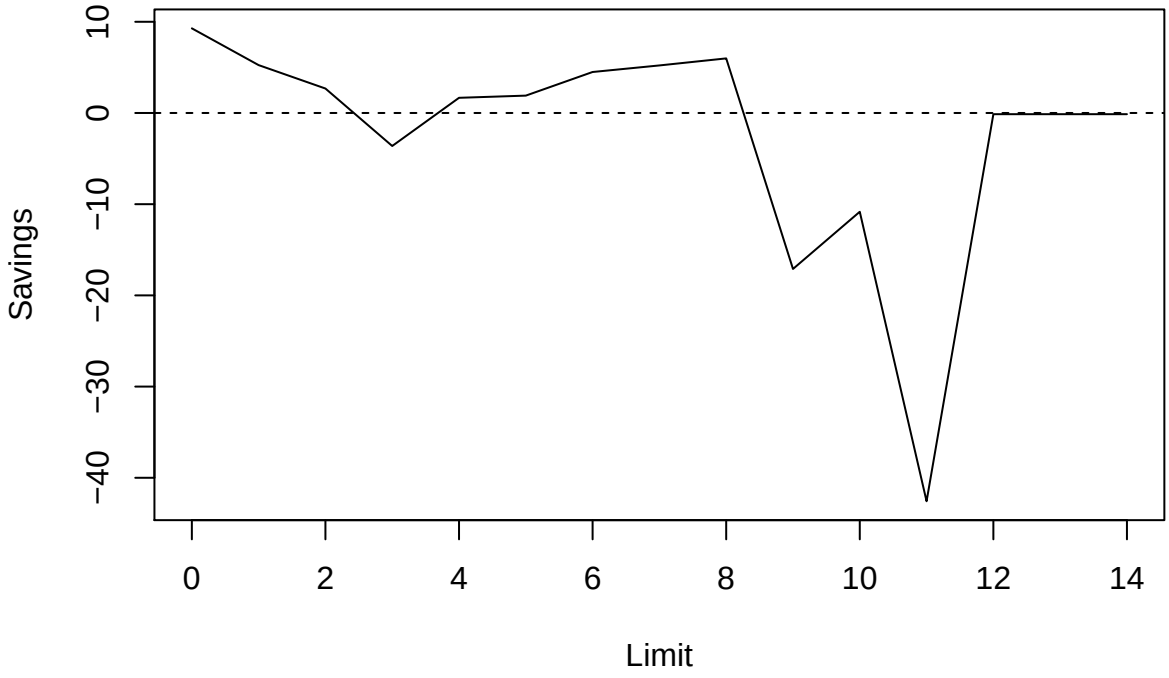


In Scenario 2, we spent 1660.35 CAD in a year, saved 10.66 CAD relative to Scenario 1. For this we had to stop at the gas station 280 times, which is 9.7 times more than under Scenario 1.

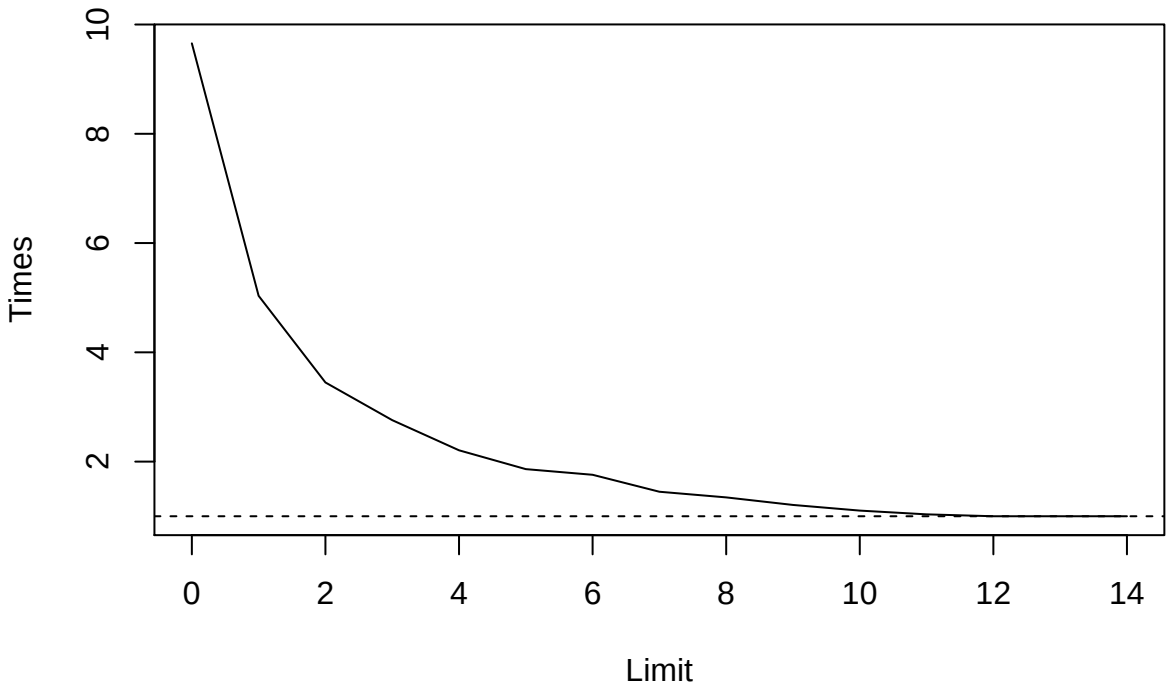
Scenario 3: Don't want to fill up every day

Micro fill-ups can save money, but it is boring to check the prices every day and stop at the gas station. Is there a threshold in terms of number of days since fill-up (which relates to amount of gas missing from the tank under average calculations)?

```
fun_limit <- function(Limit=1) {
    z$refill <- FALSE # indicates decision to refill
    z$refill[1] <- TRUE
    z$distance <- 0
    z$level <- vol # gas in tank in L
    z$cost <- 0
    z$dsf <- 0
    for (i in 2:n) {
        z$distance[i] <- z$distance[i-1] + dis
        doRefill1 <- z$level[i-1] - LperD < 0
        z$dsf[i] <- z$day[i] - z$day[rev(which(z$refill))[1]]
        doRefill2 <- z$price[i-1] > z$price[i] && z$dsf[i] > Limit
        if (doRefill1 || doRefill2) { # refill
            z$level[i] <- z$level[i-1] - LperD
            z$refill[i] <- TRUE
            z$cost[i] <- z$price[i] * (vol - z$level[i])
            z$level[i] <- vol
            z$distance[i] <- 0
        } else { # not
            z$level[i] <- z$level[i-1] - LperD
        }
    }
    z
}
Limit <- 0:14
res <- lapply(Limit, fun_limit)
Savings <- sapply(res, function(z) sum(z$cost) - sum(z1$cost))
Times <- sapply(res, function(z) sum(z$refill) / sum(z1$refill))
plot(Limit, Savings, type="l")
abline(h=0, lty=2)
```



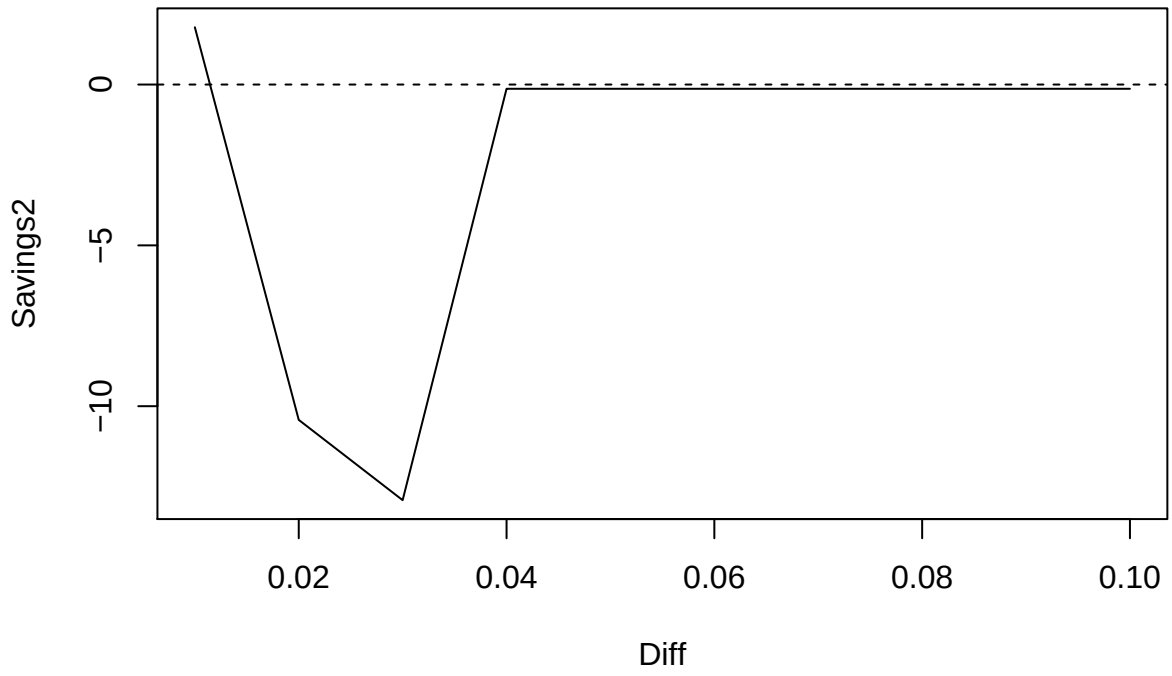

```
plot(Limit, Times, type="l")
abline(h=1, lty=2)
```



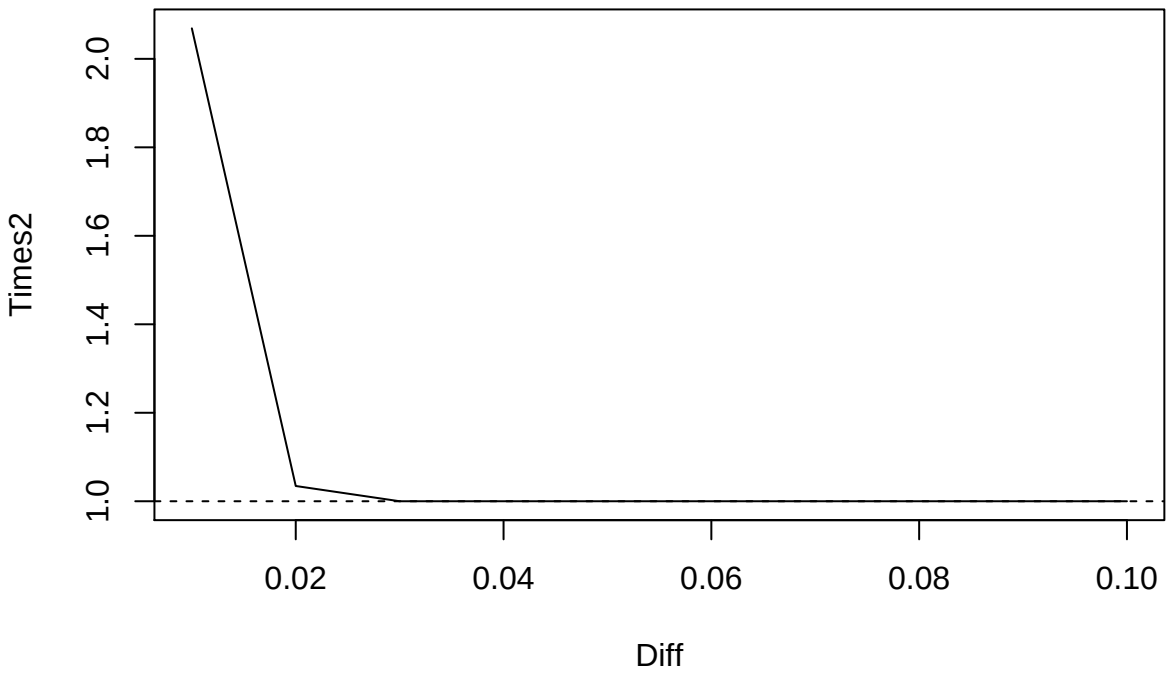
It looks like the micro-filling strategy pays off, whereas not sticking to the rule of **fill up when it's cheaper** leads to much smaller savings.

```
fun_prediff <- function(prediff=0.01) {
    z$refill <- FALSE # indicates decision to refill
    z$refill[1] <- TRUE
    z$distance <- 0
    z$level <- vol # gas in tank in L
    z$cost <- 0
    z$dsf <- 0
    for (i in 2:n) {
        z$distance[i] <- z$distance[i-1] + dis
        doRefill1 <- z$level[i-1] - LperD < 0
        z$dsf[i] <- z$day[i] - z$day[rev(which(z$refill))[1]]
        doRefill2 <- (1-prediff)*z$price[i-1] > z$price[i]
        if (doRefill1 || doRefill2) { # refill
            z$level[i] <- z$level[i-1] - LperD
            z$refill[i] <- TRUE
            z$cost[i] <- z$price[i] * (vol - z$level[i])
            z$level[i] <- vol
            z$distance[i] <- 0
        } else { # not
            z$level[i] <- z$level[i-1] - LperD
        }
    }
    z
}
```

```
Diff <- 1:10/100
res2 <- lapply(Diff, fun_pricediff)
Savings2 <- sapply(res2, function(z) sum(z$cost) - sum(z1$cost))
Times2 <- sapply(res2, function(z) sum(z$refill) / sum(z1$refill))
plot(Diff, Savings2, type="l")
abline(h=0, lty=2)
```




```
plot(Diff, Times2, type="l")
abline(h=1, lty=2)
```


Times2
1.0
1.2
1.4
1.6
1.8
2.0
0.02
0.04
0.06
0.08
0.10
Diff