Eco311 Optional Reading: Predicting Turning Point in Covid Cases

(Jing Li, Miami University)

1. Recall that a quadratic regression model is

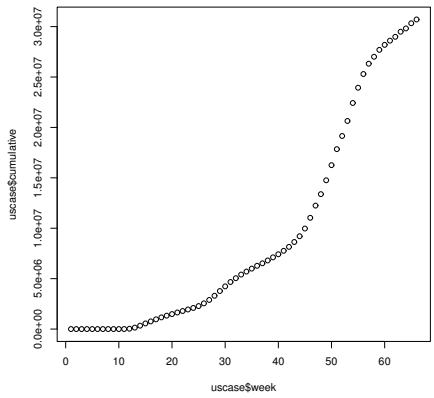
$$y = \beta_0 + \beta_1 x + \beta_2 x^2 + u \tag{1}$$

   If $\beta_2 < 0$, the maximum (turning point) is located at

$$x^{turningpoint} = \frac{-\beta_1}{2\beta_2} \tag{2}$$

2. This note provides an application of the quadratic model, and we try to model the cumulative Covid case in US in 2020 using the index for the week. The data look like

```
> setwd("/Users/lij14/Dropbox")
> data = read.csv("datacovid.csv", header=T, sep=",")
> usdata = data[data$country=="United States",]
> uscase = usdata[usdata$indicator=="cases",]
> uscase$week = seq(1,length(uscase$cumulative))
> plot(uscase$week,uscase$cumulative)
```



   We see that the growth rate of cumulative case is decreasing, which implies an incoming turning point. This finding motivates the quadratic model.

3. We use data from week 20 to week 50 to fit the quadratic model. The y variable is log cumulative case. The results are

```
> uscase2050 = uscase[uscase$week>=20&uscase$week<=50,]
> attach(uscase2050)
> qm = lm(log(cumulative)~poly(week,2,raw=T))
> summary(qm)$coef
                              Estimate   Std. Error   t value     Pr(>|t|)
(Intercept)             11.7677363503 0.2391056116 49.215643 9.733178e-29
poly(week, 2, raw = T)1  0.1417518016 0.0142666263  9.935902 1.109074e-10
poly(week, 2, raw = T)2 -0.0009609556 0.0002024949 -4.745578 5.559941e-05
```

We see $\beta_2 = -0.0009609556 < 0$, implying a parabola facing downward that has a maximum. The t value -4.745578 exceeds 1.96 in absolute value. So the squared term is significant, and the quadratic model is justified. Next we apply formula (2) to compute the turning point as

```
> cat("predicted turning point (week) is", -0.1417518016/(2*-0.0009609556), "\n")
predicted turning point (week) is 73.75565
```

The cumulative case is predicted to reach its turning point between week 73 and 74. This predict can help policy-maker make decision such as the duration of lockdown.

4. We can visualize the data and quadratic model with the graph below

```
> plot(log(cumulative)~week)
> curve(predict(qm,newdata=data.frame(week=x)),add=T)
```