Actualizacion de ecuaciones univariada

2022-07-25

```
#La base de datos freeny tiene la siguiente estructura:
head(freeny)
```

```
##              y lag.quarterly.revenue price.index income.level market
## 1962.25 8.792                 8.796       4.710        5.821
## 1962.5  8.791                 8.792       4.702        5.826
## 1962.75 8.815                 8.791       4.689        5.831
## 1963    8.813                 8.815       4.686        5.840
## 1963.25 8.908                 8.813       4.640        5.850
## 1963.5  8.937                 8.908       4.626        5.865
```

```
#m19 <- c(-2.3, 2.3, -0.7)
#G20 <- matrix(c(1.001, 0, 0, 0, 1, 0, 0, 0, 1), ncol=3)
```

```
#A. Posterior en t=19
m19 <- c(1.5, 1.8, -0.7)
C19 <- matrix(c(0.00002, 0.00001, -0.00002, 0.00001, 0.00003, -0.00001
                -0.00001, 0.00002), ncol = 3)

#Valores conocidos de G20 y W20
G20 <- matrix(c(1.001, 0, 0, 0, 1, 0, 0, 0, 1), ncol=3)
W20 <- matrix(c(0.00001, 0, 0, 0, 0.00001, -0.00001, 0, -0.00001, 0.000

#B. Priori de parámetros en t=20
a20 <- G20 %*% m19
R20 <- G20 %*% C19 %*% t(G20) + W20
a20
```

```
##        [,1]
## [1,]  1.501
## [2,]  1.800
## [3,] -0.700
```

```
R20
```

```
##              [,1]        [,2]        [,3]
## [1,]  3.004e-05  1.001e-05 -2.002e-05
## [2,]  1.001e-05  4.000e-05 -2.000e-05
## [3,] -2.002e-05 -2.000e-05  7.000e-05
```

```
freeny[20,]
```

```
##          y lag.quarterly.revenue price.index income.level market.pot
## 1967 9.314                 9.284        4.51        6.061
```

```
F20 <- c(1, 6.06093, 4.51018) #Variables explicativas en t=20. El 1 es
                              #agregar el intercepto
V20 <- 0.00005

#C. Pronóstico a un periodo.
f20 <- t(F20) %*% a20
Q20 <- t(F20) %*% R20 %*% F20 + V20
f20
```

```
##        [,1]
## [1,] 9.254
```

```
Q20
```

```
##           [,1]
## [1,] 0.001821
```

```
c(qnorm(0.025, mean = f20, sd = sqrt(Q20)), qnorm(0.975, mean = f20,
```

```
## [1] 9.170 9.338
```

```
#Valor observado de Y20:
Y20 <- 9.31378
#D. Posterior en t=20
A20 <- R20 %*% F20 %*% solve(Q20)
e20 <- Y20-f20
m20 <- a20 + A20 %*% e20
C20 <- R20 - A20 %*% Q20 %*% t(A20)
m20
```

```
##          [,1]
## [1,]  1.5015
## [2,]  1.8053
## [3,] -0.6943
```

```
C20
```

```
##             [,1]       [,2]       [,3]
## [1,]  3.004e-05  9.973e-06 -2.006e-05
## [2,]  9.973e-06  2.554e-05 -3.555e-05
## [3,] -2.006e-05 -3.555e-05  5.328e-05
```

Funcion para actualizar mas de un periodo

```
datos_ej <- freeny %>%
  mutate(intercept = 1) %>%
  slice(20:n()) %>%
  dplyr::select(y, intercept, income.level, price.index)

#Se asume que Gt, Vt y Wt son ctes conocidas para toda t.
actualizacion <- function(datos, m0, C0, G, W, V){
  mt_menos_1 <- m0
  Ct_menos_1 <- C0
  lista_at <- list()
  lista_Rt <- list()
  lista_ft <- list()
  lista_Qt <- list()
  lista_mt <- list()
  lista_Ct <- list()
  lista_CI <- list()
  lista_CI_inf <- list()
  lista_CI_sup <- list()
  for(t in 1:length(datos$y)){

    at <- G %*% mt_menos_1
    Rt <- G %*% Ct_menos_1 %*% t(G) + W
    Ft <- as.numeric(datos[t, 2:4])
    ft <- t(Ft) %*% at
    Qt <- t(Ft) %*% Rt %*% Ft + V
    CI <- c(qnorm(0.025, mean = ft, sd = sqrt(Qt)), qnorm(0.975, mean =
                                                            sd = sqr

    CI_inf <- CI[1]
    CI_sup <- CI[2]
    Yt <- datos[t,1]
    At <- Rt %*% Ft %*% solve(Qt)
    et <- Yt-ft
    mt <- at + At %*% et
    Ct <- Rt - At %*% Qt %*% t(At)
```

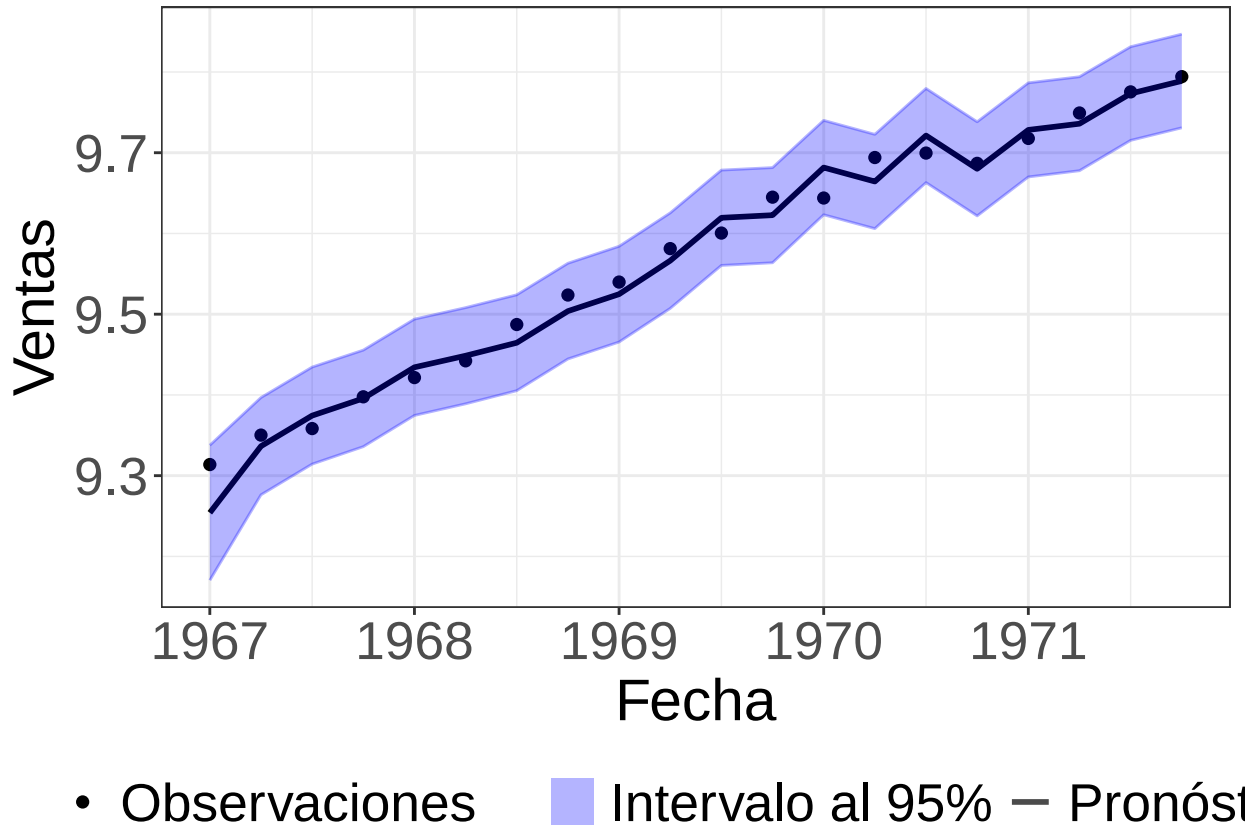
```
    lista_at[[t]] <- at
    lista_Rt[[t]] <- Rt
    lista_ft[[t]] <- ft
    lista_Qt[[t]] <- Qt
    lista_CI[[t]] <- CI
    lista_CI_inf[[t]] <- CI_inf
    lista_CI_sup[[t]] <- CI_sup
    lista_mt[[t]] <- mt
    lista_Ct[[t]] <- Ct
    mt_menos_1 <- mt
    Ct_menos_1 <- Ct
  }
  return(list("at" = lista_at, "Rt" = lista_Rt, "ft" = lista_ft,
              "Qt" = lista_Qt, "CI" = lista_CI, "CI_inf" = lista_CI_in
              "CI_sup" = lista_CI_sup, "mt" = lista_mt, "Ct" = lista_C
}
```

```
res_dlm <- actualizacion(datos_ej, m19, C19, G20, W20, V20)
```

```
df_graficas <- data.frame("fecha" = datos_ej %>% row.names(), "y_real"
            "y_pronostico" = res_dlm$ft %>% unlist(), "CI_inf" = res_dl
            "CI_sup" = res_dlm$CI_sup %>% unlist()) %>%
  mutate(fecha = as.numeric(fecha))
```

```
ggplot(data = df_graficas, aes(x = fecha)) +
  geom_point(aes(y = y_real, shape = "Observaciones"), size = 2) +
  geom_line(aes(y = y_pronostico, color = 'Pronósticos'), size = 1) +
  geom_line(aes(y = CI_inf), color = "blue", alpha = 0.3) +
  geom_line(aes(y = CI_sup), color = "blue", alpha = 0.3) +
  geom_ribbon(aes(ymax = CI_sup, ymin = CI_inf, fill = 'Intervalo al 9
  theme_bw() +
  scale_colour_manual(
    name = "", values = c("Intervalo al 95%" = "transparent",
                          "Pronósticos" = "black")) +
  scale_fill_manual(
    name = "",  values = c("Intervalo al 95%" = "blue",
                           "Pronósticos" = "transparent")) +
  theme(legend.position = "bottom") +
  labs(shape = "") +
  ylab('Ventas') +
  xlab('Fecha') +
  theme(axis.text.x = element_text(size = 20),
        axis.text.y = element_text(size = 20),
```

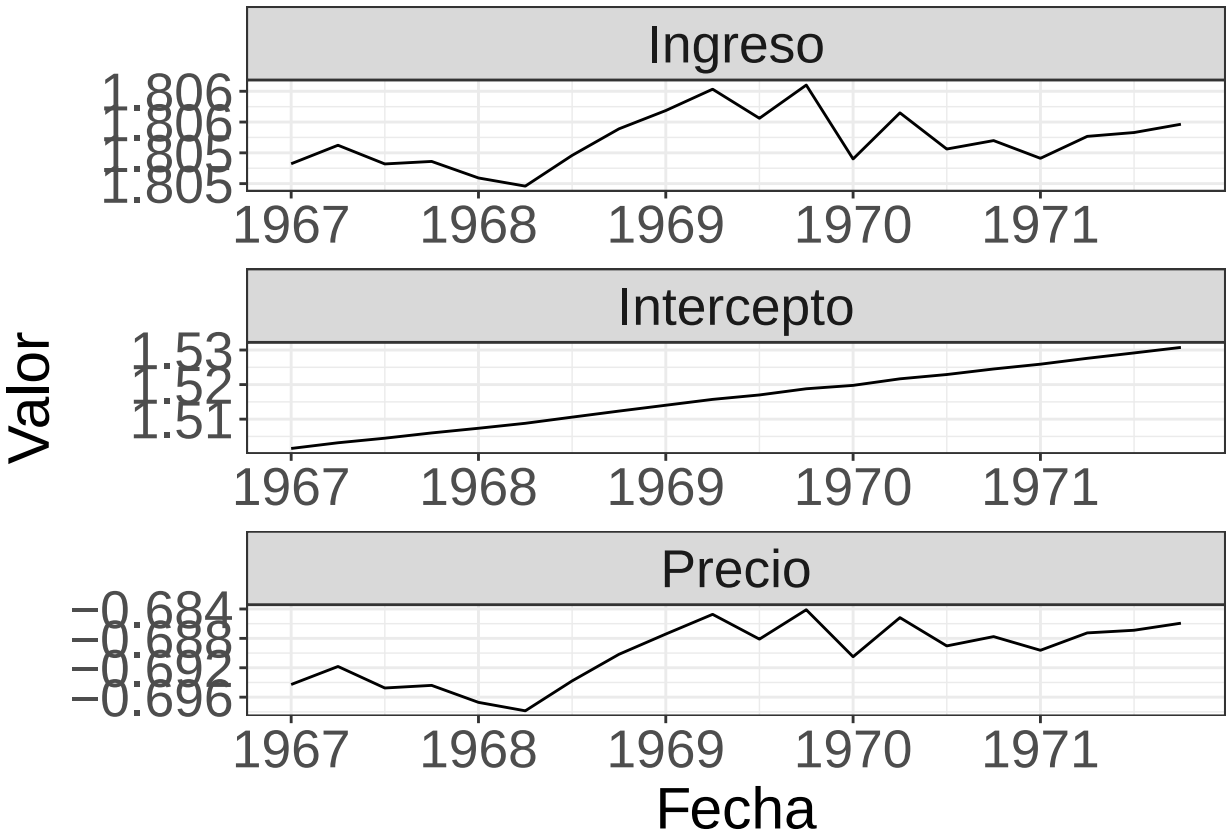
```
        axis.title = element_text(size = 22),
        legend.text = element_text(size=20))
```




```
ggsave(filename = "graphs/teoria/actualizacion/actualizacion.png", widt
```

```
df_params <- data.frame(reduce(res_dlm$mt, cbind) %>% t(), fecha = df_g
  rename(Intercepto = X1, Ingreso = X2, Precio = X3) %>%
  pivot_longer(names_to = "parametro", values_to = "valor",
               cols = c(Intercepto, Ingreso, Precio))
```

```
ggplot(df_params, aes(x=fecha, y = valor)) +
  geom_line() +
  facet_wrap(~parametro, nrow = 3, scales = "free") +
  theme_bw()  +
  ylab("Valor") +
  xlab("Fecha") +
  theme(axis.text.x = element_text(size = 20),
        axis.text.y = element_text(size = 20),
        axis.title = element_text(size = 22),
        strip.text = element_text(size=20))
```




```
ggsave(filename = "graphs/teoria/actualizacion/parametros.png", width =
```

Pronosticos

```
freeny[21,]
```

```
##             y lag.quarterly.revenue price.index income.level market.p
## 1967.25 9.35                   9.314       4.504        6.071
```

```
#Valores iniciales.
#m20 y C20 se definieron en el ejemplo pasado
a20_0 <- m20
R20_0 <- C20

#k = 1
#Valores conocidos de F21, G21, V21 y W21
F21 <- c(1, 6.07103, 4.50352)
G21 <- matrix(c(1.001, 0, 0, 0, 1, 0, 0, 0, 1), ncol=3)
V21 <- 0.00005
W21 <- matrix(c(0.00001, 0, 0, 0, 0.00001, -0.00001, 0, -0.00001, 0.000
```

```r
#Distribución de estados en t=21
a20_1 <- G21 %*% a20_0
R20_1 <- G21 %*% R20_0 %*% t(G21) + W21

#Distribución de pronóstico de Y21
f20_1 <- t(F21) %*% a20_1
Q20_1 <- t(F21) %*% R20_1 %*% F21 + V21
f20_1
```

```
##       [,1]
## [1,] 9.336
```

```r
Q20_1
```

```
##            [,1]
## [1,] 0.0009445
```

```r
freeny[22,]
```

```
##             y lag.quarterly.revenue price.index income.level market.p
## 1967.5 9.358                  9.35       4.494         6.08
```

```r
#k = 2
#Valores conocidos de F22, G22, V22 y W22
F22 <- c(1, 6.08018, 4.4936)
G22 <- matrix(c(1.001, 0, 0, 0, 1, 0, 0, 0, 1), ncol=3)
V22 <- 0.00005
W22 <- matrix(c(0.00001, 0, 0, 0, 0.00001, -0.00001, 0, -0.00001, 0.000

#Distribución de estados en t=22
a20_2 <- G22 %*% a20_1
R20_2 <- G22 %*% R20_1 %*% t(G22) + W22

#Distribución de pronóstico de Y22
f20_2 <- t(F22) %*% a20_2
Q20_2 <- t(F22) %*% R20_2 %*% F22 + V22
f20_2
```

```
##       [,1]
## [1,] 9.361
```

```
Q20_2
```

```
##           [,1]
## [1,] 0.001784
```

```
#Covarianzas
C20_1_1 <- R20_1
C20_2_1 <- G22 %*% C20_1_1 #Covarianza entre theta22 y theta 21
cov_Y22_Y21 <- t(F22) %*% C20_2_1 %*% F21
cov_Y22_Y21
```

```
##           [,1]
## [1,] 0.000893
```

```
a20_1
```

```
##         [,1]
## [1,]  1.5030
## [2,]  1.8053
## [3,] -0.6943
```

```
R20_1
```

```
##             [,1]       [,2]       [,3]
## [1,]  4.010e-05  9.983e-06 -2.008e-05
## [2,]  9.983e-06  3.554e-05 -4.555e-05
## [3,] -2.008e-05 -4.555e-05  1.033e-04
```

```
a20_2
```

```
##         [,1]
## [1,]  1.5045
## [2,]  1.8053
## [3,] -0.6943
```

```
R20_2
```

```
##             [,1]       [,2]       [,3]
## [1,]  5.018e-05  9.993e-06 -2.010e-05
## [2,]  9.993e-06  4.554e-05 -5.555e-05
## [3,] -2.010e-05 -5.555e-05  1.533e-04
```

```r
pronosticos <- function(datos, at_0, Rt_0, G, W, V){
  at_k<- at_0
  Rt_k <- Rt_0
  lista_at_k <- list()
  lista_Rt_k <- list()
  lista_ft_k <- list()
  lista_Qt_k <- list()
  lista_CI_inf <- list()
  lista_CI_sup <- list()
  for(k in 1:length(datos$y)){
    browser()
    at_k <- G %*% at_k
    Rt_k <- G %*% Rt_k %*% t(G) + W
    Ft <- as.numeric(datos[k+1, 2:4])
    ft_k <- t(Ft) %*% at_k
    Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
    CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_k)),
            qnorm(0.975, mean = ft_k,  sd = sqrt(Qt_k)))
    CI_inf <- CI[1]
    CI_sup <- CI[2]
    lista_at_k[[k]] <- at_k
    lista_Rt_k[[k]] <- Rt_k
    lista_ft_k[[k]] <- ft_k
    lista_Qt_k[[k]] <- Qt_k
    lista_CI_inf[[k]] <- CI_inf
    lista_CI_sup[[k]] <- CI_sup

  }
  return(list("at_k" = lista_at_k, "Rt_k" = lista_Rt_k, "ft_k" = lista_
              "Qt_k" = lista_Qt_k, "CI_inf" = lista_CI_inf, "CI_sup" =
}
```

```r
pronos_dlm <- pronosticos(datos_ej, m20, C20, G20, W20, V20)
```

```
## Called from: pronosticos(datos_ej, m20, C20, G20, W20, V20)
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_k
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
```

```
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
```

```
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
```

```
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
```

```
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
```

```
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
```

```
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
```

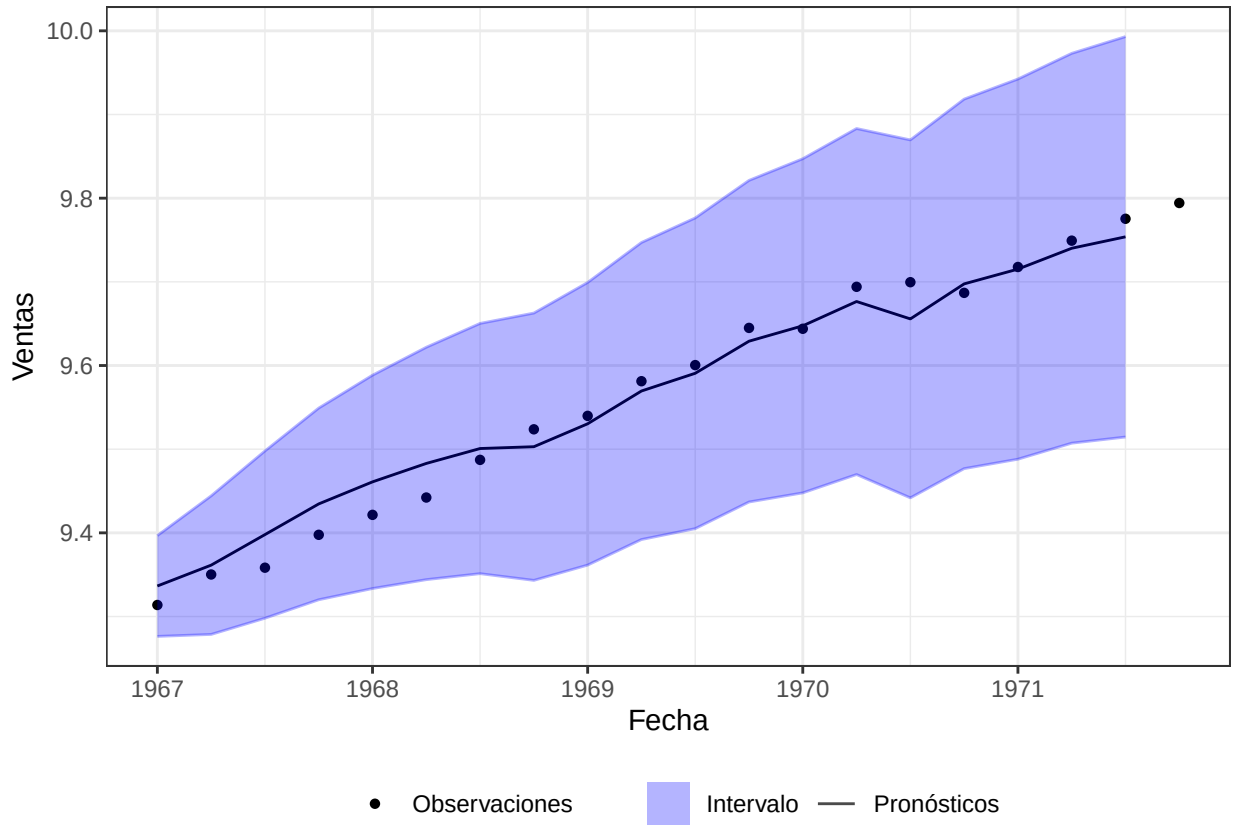
```
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
## debug at <text>#11: browser()
## debug at <text>#12: at_k <- G %*% at_k
## debug at <text>#13: Rt_k <- G %*% Rt_k %*% t(G) + W
## debug at <text>#14: Ft <- as.numeric(datos[k + 1, 2:4])
## debug at <text>#15: ft_k <- t(Ft) %*% at_k
## debug at <text>#16: Qt_k <- t(Ft) %*% Rt_k %*% Ft + V
```

```
## debug at <text>#17: CI <- c(qnorm(0.025, mean = ft_k, sd = sqrt(Qt_
##     mean = ft_k, sd = sqrt(Qt_k)))
## debug at <text>#19: CI_inf <- CI[1]
## debug at <text>#20: CI_sup <- CI[2]
## debug at <text>#21: lista_at_k[[k]] <- at_k
## debug at <text>#22: lista_Rt_k[[k]] <- Rt_k
## debug at <text>#23: lista_ft_k[[k]] <- ft_k
## debug at <text>#24: lista_Qt_k[[k]] <- Qt_k
## debug at <text>#25: lista_CI_inf[[k]] <- CI_inf
## debug at <text>#26: lista_CI_sup[[k]] <- CI_sup
```

```
df_pronos <- data.frame("fecha" = datos_ej %>% row.names(), "y_real" =
           "y_pronostico" = pronos_dlm$ft_k %>% unlist(),
           "CI_inf" = pronos_dlm$CI_inf %>% unlist(),
           "CI_sup" = pronos_dlm$CI_sup %>% unlist()) %>%
  mutate(fecha = as.numeric(fecha))
```

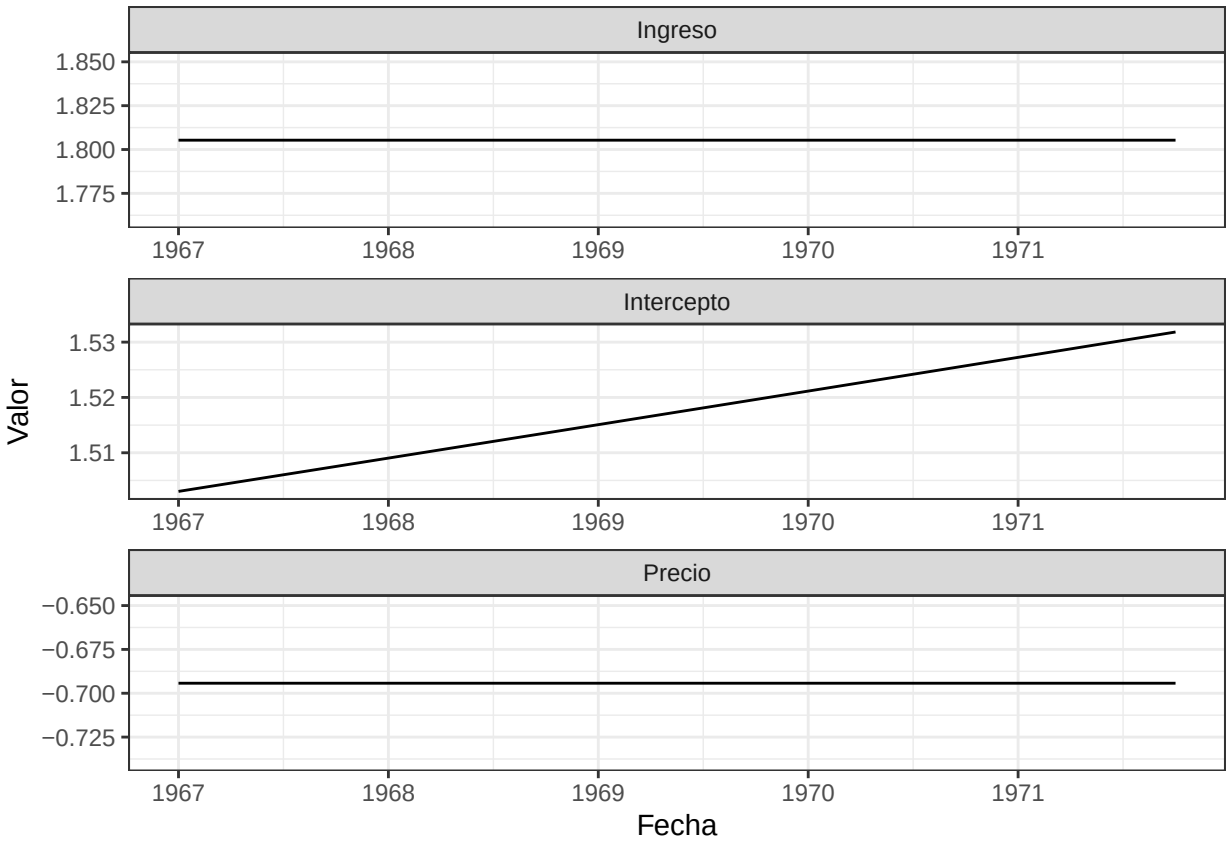
```
ggplot(data = df_pronos, aes(x = fecha)) +
  geom_point(aes(y = y_real, shape = "Observaciones")) +
  geom_line(aes(y = y_pronostico, color = 'Pronósticos')) +
  geom_line(aes(y = CI_inf), color = "blue", alpha = 0.3) +
  geom_line(aes(y = CI_sup), color = "blue", alpha = 0.3) +
  geom_ribbon(aes(ymax = CI_sup, ymin = CI_inf, fill = 'Intervalo'), a
  theme_bw() +
  scale_colour_manual(
    name = "", values = c("Intervalo" = "transparent",
                          "Pronósticos" = "black")) +
  scale_fill_manual(
    name = "",  values = c("Intervalo" = "blue",
                           "Pronósticos" = "transparent")) +
  theme(legend.position = "bottom") +
  labs(shape = "") +
  ylab('Ventas') +
  xlab('Fecha')
```

```
## Warning: Removed 1 row(s) containing missing values (geom_path).
## Removed 1 row(s) containing missing values (geom_path).
## Removed 1 row(s) containing missing values (geom_path).
```




```
df_params_pronos <- data.frame(reduce(pronos_dlm$at_k, cbind) %>% t(),
  rename(Intercepto = X1, Ingreso = X2, Precio = X3) %>%
  pivot_longer(names_to = "parametro", values_to = "valor",
               cols = c(Intercepto, Ingreso, Precio))
```

```
ggplot(df_params_pronos, aes(x=fecha, y = valor)) +
  geom_line() +
  facet_wrap(~parametro, nrow = 3, scales = "free") +
  theme_bw()  +
  ylab("Valor") +
  xlab("Fecha")
```


Ingreso
1.850
1.825
1.800
1.775
1967
1968
1969
1970
1971
Intercepto
1.53
1.52
1.51
Valor
Precio
−0.650
−0.675
−0.700
−0.725
Fecha