test

Here we are

```
# check if 'librarian' is installed and if not, install it
if (! "librarian" %in% rownames(installed.packages()) ){
  install.packages("librarian")
}

# load packages if not already loaded
librarian::shelf(
viridis, ggplot2, patchwork, showtext, extrafont
)
```

```
  The 'cran_repo' argument in shelf() was not set, so it will use
  cran_repo = 'https://cran.r-project.org' by default.

  To avoid this message, set the 'cran_repo' argument to a CRAN
  mirror URL (see https://cran.r-project.org/mirrors.html) or set
  'quiet = TRUE'.
```

```
set.seed(8740); T = 20
a <- 1 + rnorm(n = T)
b <- a + 4 + rnorm(n = T, sd = 2)

# calculate using difference equation
cov_diff <-
  1:(T-1) |> purrr::map_vec(
    (\(k){ ((dplyr::lead(a,k) - a) * (dplyr::lead(b,k) - b)) |> sum(na.rm=TRUE) })
  ) |> sum(na.rm=TRUE) / (T*T)

# summarize results
```

Covariances

T=20

pop_cov	smpl_cov	calc_cov	cov_diff
0.9179426	0.9662554	0.9662554	0.9179426

```
tibble::tibble(x = a, y = b) |>
  dplyr::mutate(x = x - mean(x), y = y - mean(y), prod = x*y) |>
  dplyr::summarize(pop_cov = mean(prod), smpl_cov = sum(prod)/(dplyr::n()-1) ) |>
  tibble::add_column(
    calc_cov = cov(a,b) # built in covariance
    , cov_diff = cov_diff
  ) |>
  gt::gt() |>
  gt::tab_header(title = "Covariances", subtitle = stringr::str_glue("T={T}")) |>
  gt::tab_options(table.width = gt::pct(75), table.align = "center") |>
  gtExtras::gt_theme_espn() # |> gt::as_latex()
```