Multivariate vs. Univariate Approach

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Set Up

```
x1 = c(5, 0 , 0)
x2 = c(3, 4, 0)
y = c(3, 2, 4)
```

Plot

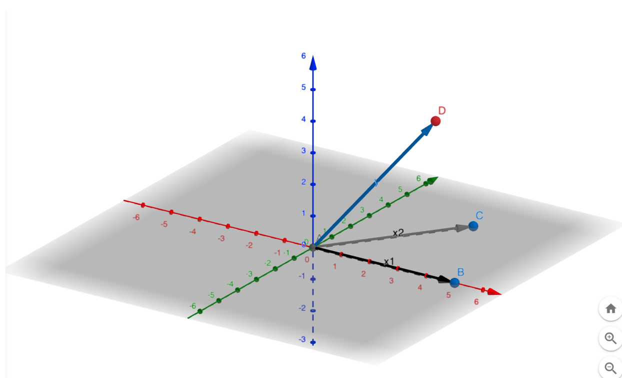

Figure 1: Vectors y (D), x1 (B), and x2 (C)

I created this plot in https://www.geogebra.org/3d?lang=en

Multivariate Regression

```
fit <- lm(y ~ x1 + x2)
summ <- summary(fit)
summ
```

```
##
## Call:
## lm(formula = y ~ x1 + x2)
##
## Residuals:
## ALL 3 residuals are 0: no residual degrees of freedom!
```

```
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)      4.0         NA      NA       NA
## x1               0.1         NA      NA       NA
## x2              -0.5         NA      NA       NA
##
## Residual standard error: NaN on 0 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:    NaN
## F-statistic:   NaN on 2 and 0 DF,  p-value: NA
```

We see the Beta2 is **-0.5**

Univariate Regression to obtain Beta2

```
fit1 <- lm(y ~ x1)
summ1 <- summary(fit1)
summ1
```

Step 1: Regress y onto x1 to obtain epsilon_y ~ x1

```
##
## Call:
## lm(formula = y ~ x1)
##
## Residuals:
##         1         2         3
##  1.11e-16 -1.00e+00  1.00e+00
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 3.000e+00  1.000e+00       3    0.205
## x1          1.088e-16  3.464e-01       0    1.000
##
## Residual standard error: 1.414 on 1 degrees of freedom
## Multiple R-squared:      0,  Adjusted R-squared:     -1
## F-statistic:     0 on 1 and 1 DF,  p-value: 1
```

```
EpsilonY_x1 <- summ1$residuals
```

```
fit2 <- lm(x2 ~ x1)
summ2 <- summary(fit2)
summ2
```

Step 2: Regress x2 onto x1 to obtain epsilon_x2 ~ x1

```
##
## Call:
## lm(formula = x2 ~ x1)
##
## Residuals:
##         1         2         3
## -2.22e-16  2.00e+00 -2.00e+00
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.0000     2.0000   1.000    0.500
## x1            0.2000     0.6928   0.289    0.821
##
## Residual standard error: 2.828 on 1 degrees of freedom
## Multiple R-squared:  0.07692,    Adjusted R-squared:  -0.8462
## F-statistic: 0.08333 on 1 and 1 DF,  p-value: 0.8211
```

```r
Epsilonx2_x1 <- summ2$residuals
```

```r
fit3 <- lm(EpsilonY_x1 ~ Epsilonx2_x1)
summ3 <- summary(fit3)
summ3$coefficients
```

Step 3: Regress [epsilon_y ~ x1] onto [epsilon_x2 ~ x1] to obtain Beta2

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)       0.0          0     NaN      NaN
## Epsilonx2_x1     -0.5          0    -Inf        0
```

Univariate regression also gives us **-0.5**