Introduction to Linear Regression with R

Econ 440 - Introduction to Econometrics

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Rmarkdown themes

The overall theme of your notebook is controlled by the option `theme` in the `yaml` preamble. Supported themes include `cerulean`, `cosmo`, `flatly`, `journal`, `lumen`, `paper`, `readable`, `sandstone`, `simplex`, `spacelab`, `united`, and `yeti`.

The highlighting theme is controlled by the option `highlight`, usually placed immediately below the theme. Supported styles include `default`, `tango`, `pygments`, `kate`, `monochrome`, `espresso`, `zenburn`, `haddock`, `breezedark`, and `textmate`.

See this gallery for examples. For more themes, you can use the extension package prettydoc. And you can also modify existing styles, or even create your own style from scratch, with `css` modifiers. See immediately below the `yaml` preamble of the source `Rmd` file for a simple example.

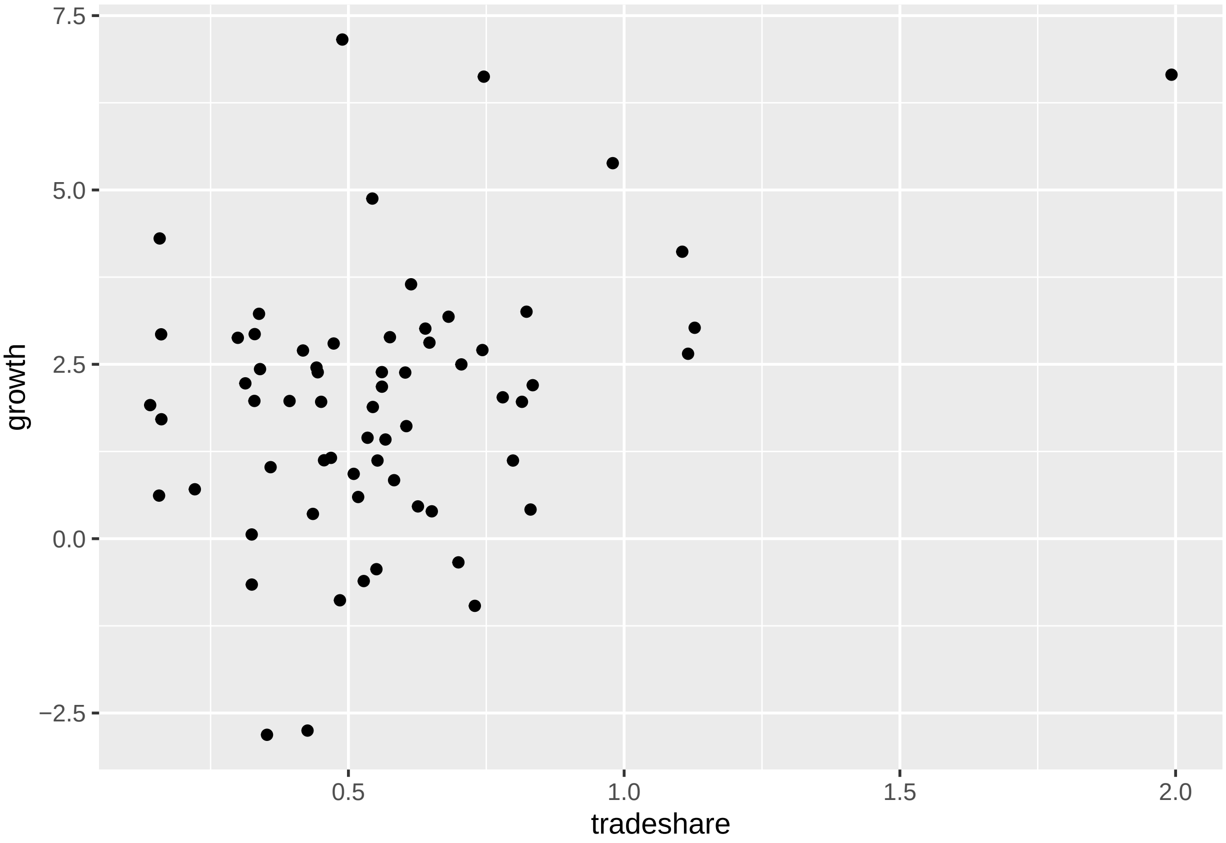
Load dataset

```
library(readxl)
df <- read_xlsx("Growth.xlsx", trim_ws=TRUE)
head(df)
```

```
## # A tibble: 6 x 8
##   country_name  growth   oil rgdp60 tradeshare yearsschool rev_coups
##   <chr>          <dbl> <dbl>  <dbl>      <dbl>       <dbl>     <dbl>
## 1 India          1.92      0   766.      0.141       1.45      0.133
## 2 Argentina      0.618     0  4462.      0.157       4.99      0.933
## 3 Japan          4.30      0  2954.      0.158       6.71      0
## 4 Brazil         2.93      0  1784.      0.160       2.89      0.100
## 5 United States  1.71      0  9895.      0.161       8.66      0
## 6 Bangladesh     0.708     0   952.      0.221       0.790     0.306
## # ... with 1 more variable: assasinations <dbl>
```

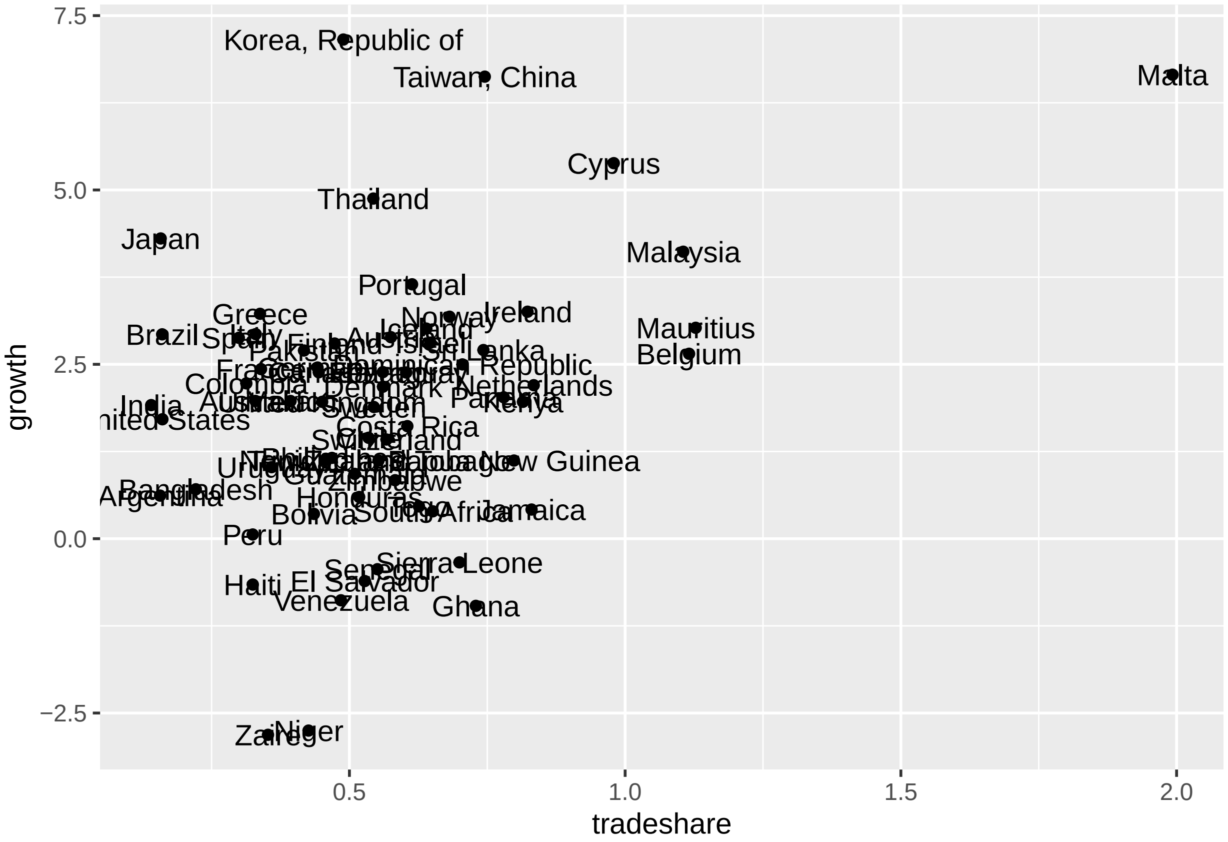
Make a scatterplot of average annual growth rate and average trade share:

```
library(ggplot2)
df$country <- as.factor(df$country_name)
ggplot(data=df, aes(x=tradeshare, y=growth)) + geom_point()
```



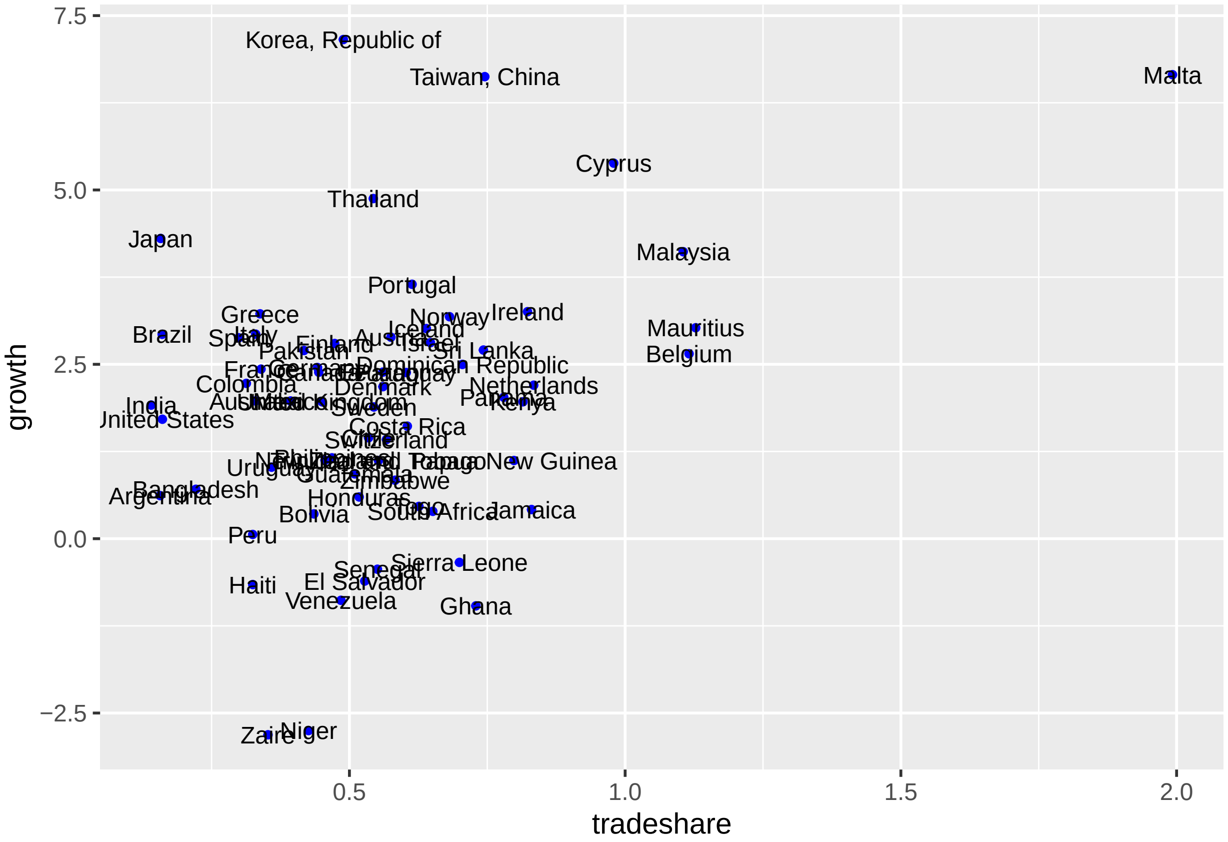
Detect the outlier: Print the country name

```
ggplot(data=df, aes(x=tradeshare, y=growth, label=country)) +
    geom_point() +
    geom_text()
```



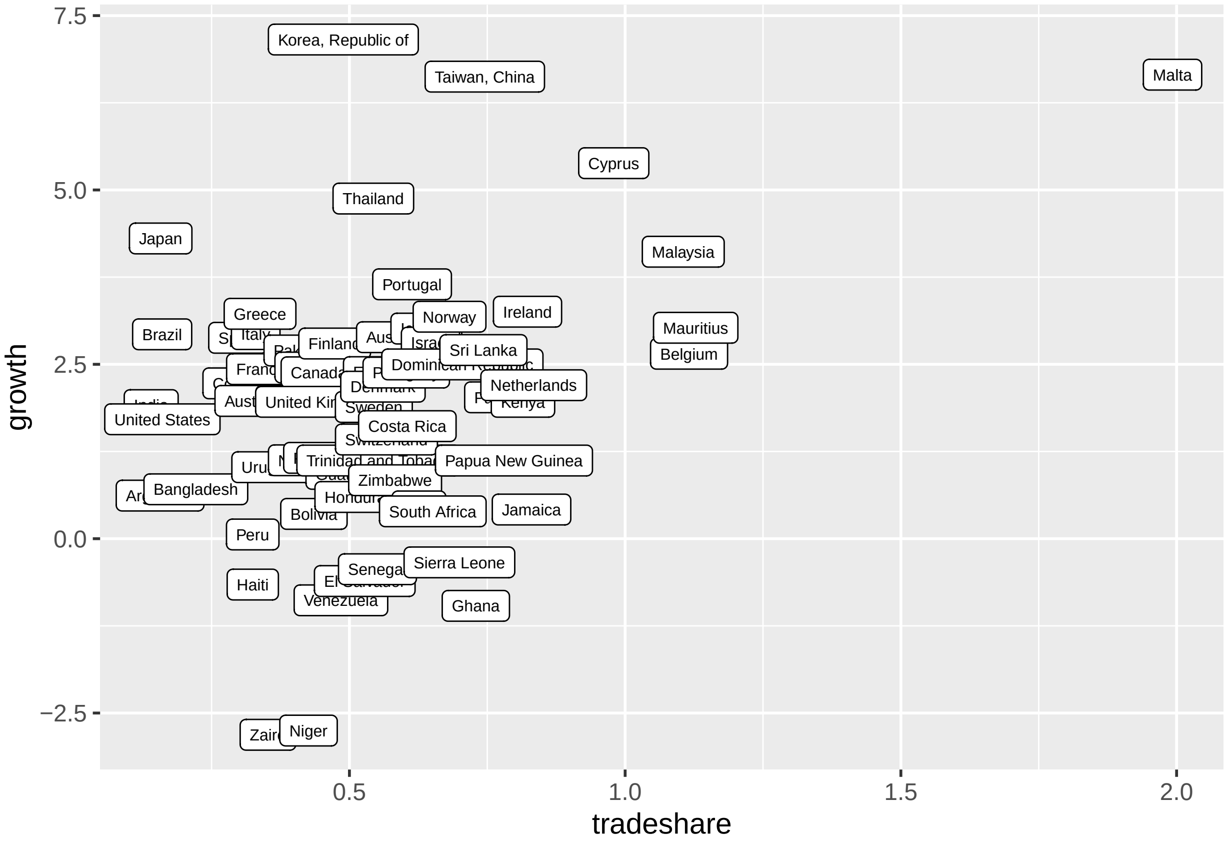
Detect the outlier: Print the country name + Tweak

```
ggplot(data=df, aes(x=tradeshare, y=growth, label=country)) +
    geom_point(col='blue', size=1) +
    geom_text(size=3)
```



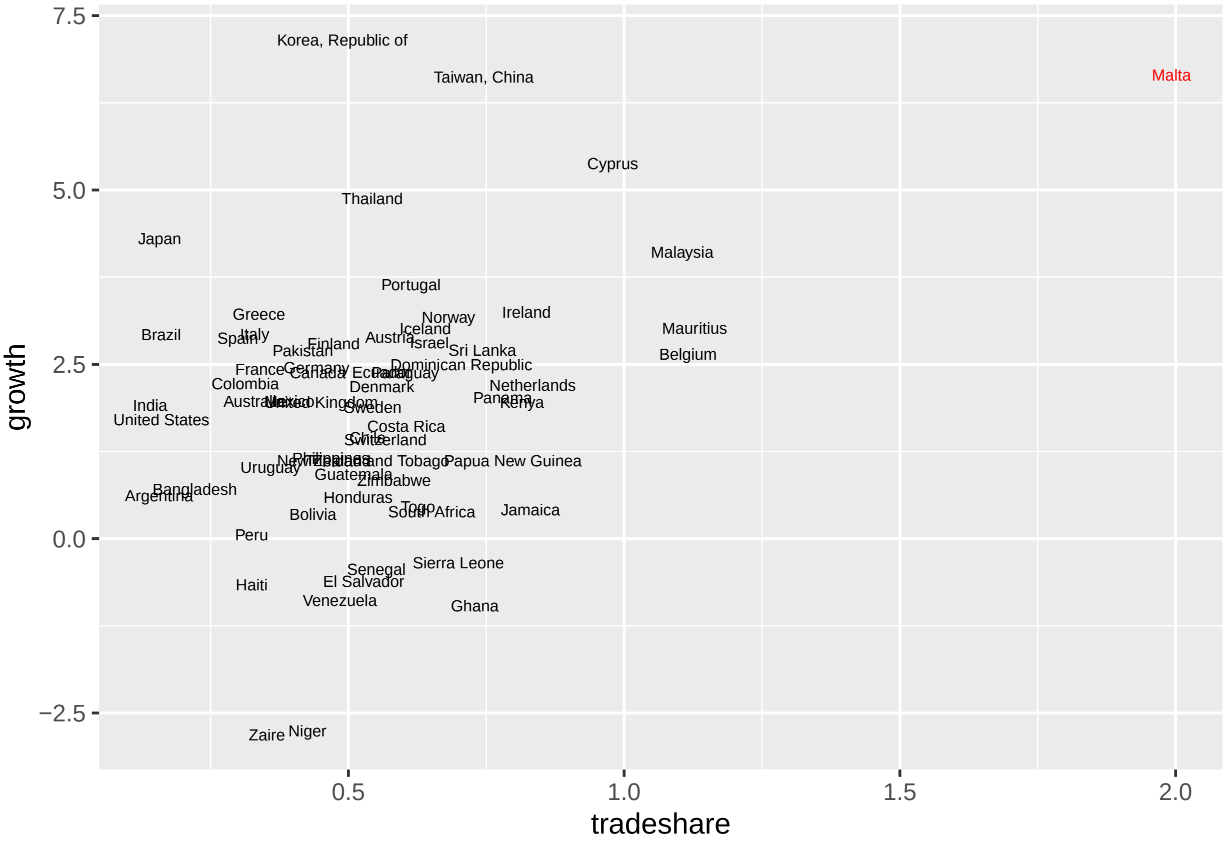
Detect the outlier: Use labels instead of plaint text

```
ggplot(data=df, aes(x=tradeshare, y=growth, label=country)) +
    geom_label(size=2)
```



Detect the outlier: Highlight the variable name

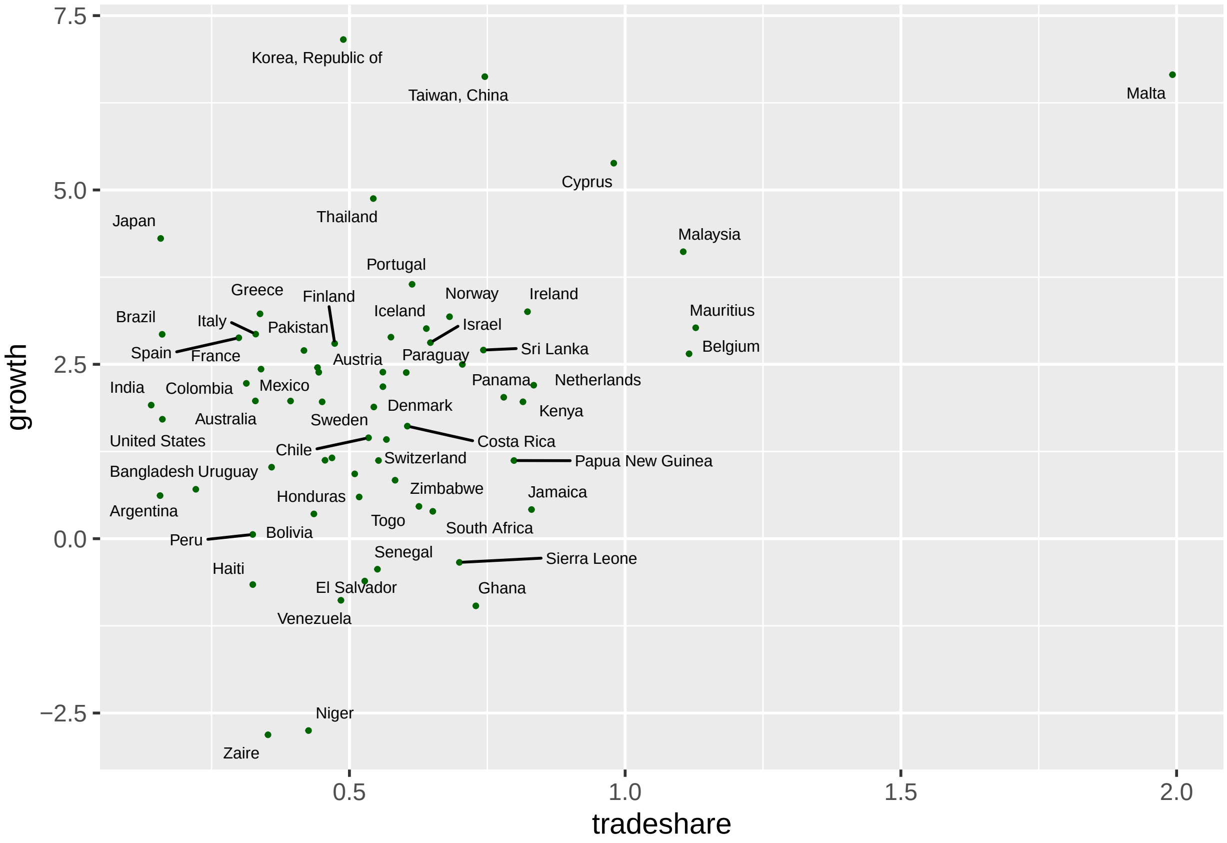
```
ggplot(data=df, aes(x=tradeshare, y=growth, label=country)) +
    geom_text(size=2, aes(colour = I(ifelse(country == "Malta", "red", "black"))))
```



Detect the outlier: Avoid overlapping labels

```
library(ggrepel)
ggplot(data=df, aes(x=tradeshare, y=growth, label=country)) +
    geom_point(col="darkgreen", size=0.5) +
    geom_text_repel(aes(label=country), size=2)
```

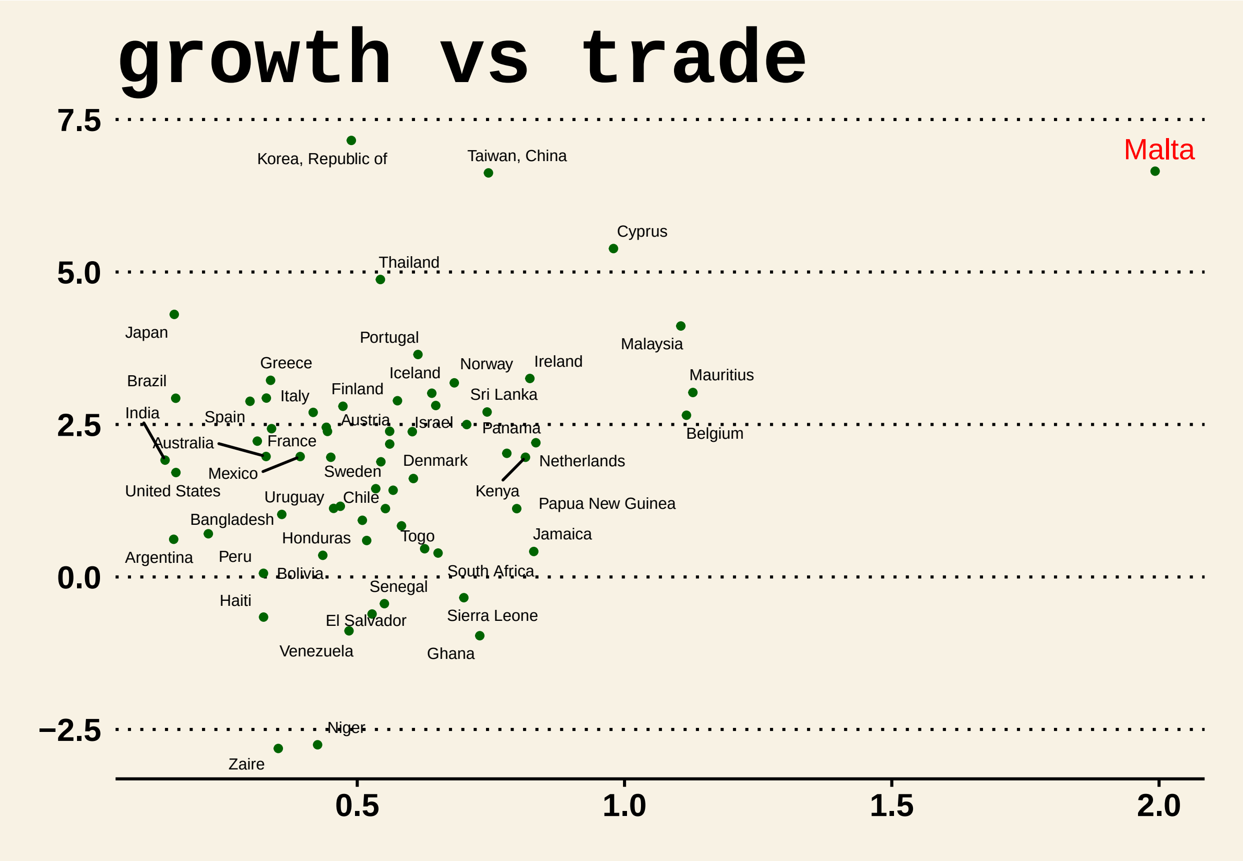
```
## Warning: ggrepel: 9 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



Detect the outlier: Add a theme!

```
ggplot(data=df, aes(x=tradeshare, y=growth, label=country)) +
    geom_point(col="darkgreen", size=1) +
    geom_text_repel(aes(label=country), colour=I(ifelse(df$country == "Malta", "red", "black")), size=I
    ggtitle("growth vs trade") +
    theme_wsj()
```

```
## Warning: ggrepel: 15 unlabeled data points (too many overlaps). Consider
## increasing max.overlaps
```



Investigate correlation:

```
cor.test(df$growth, df$tradeshare)
```

```
##
##  Pearson's product-moment correlation
##
## data:  df$growth and df$tradeshare
## t = 2.98, df = 63, p-value = 0.0041
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.11790 0.54853
## sample estimates:
##     cor
## 0.35168
```

Investigate linear regression:

```
ols <- lm(growth ~ tradeshare, data=df)
summary(ols)
```

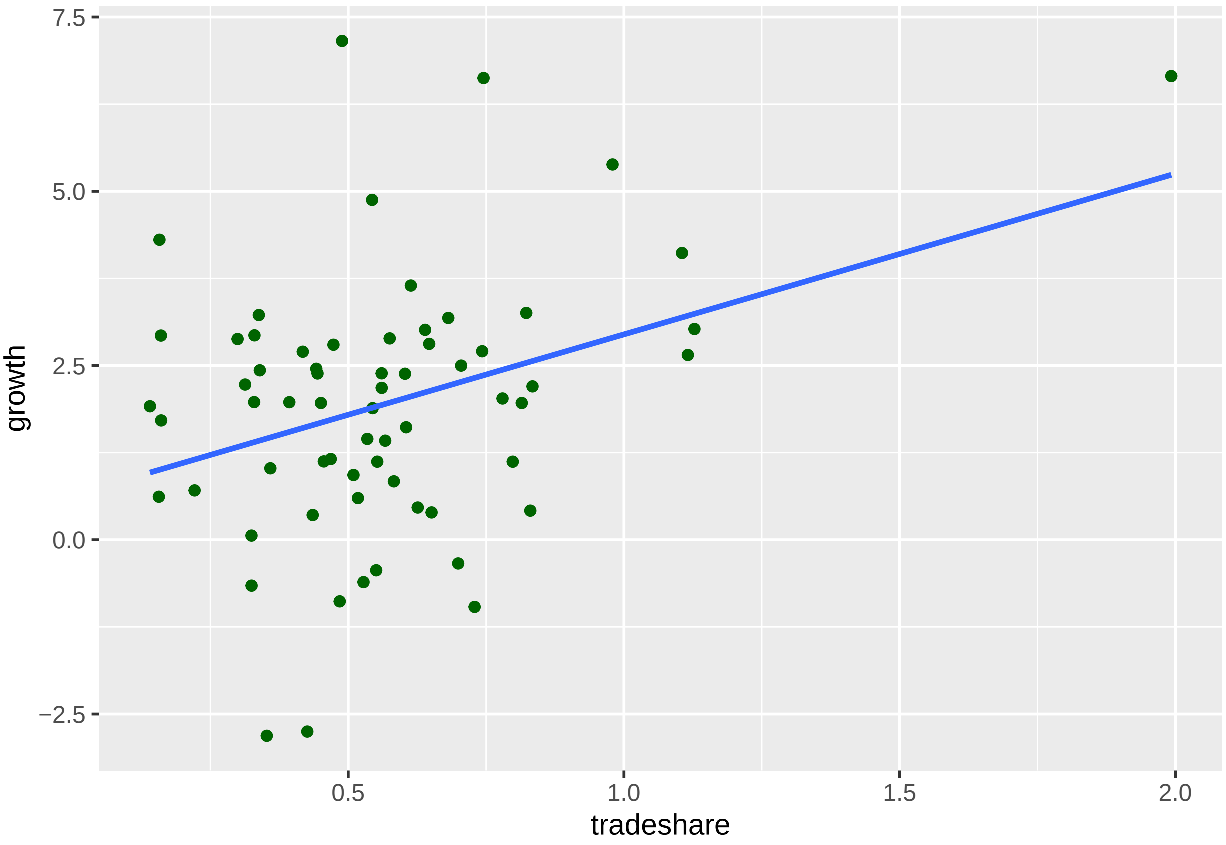
```
##
## Call:
## lm(formula = growth ~ tradeshare, data = df)
##
## Residuals:
```

```
##    Min     1Q Median     3Q    Max 
## -4.374 -0.886  0.233  0.925  5.389 
## 
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)   
## (Intercept)    0.640      0.490    1.31   0.1961   
## tradeshare     2.306      0.773    2.98   0.0041 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 
## Residual standard error: 1.79 on 63 degrees of freedom
## Multiple R-squared:  0.124,  Adjusted R-squared:  0.11 
## F-statistic: 8.89 on 1 and 63 DF,  p-value: 0.00407
```

Add regression line to the scatterplot:

```
ggplot(data=df, aes(x=tradeshare, y=growth)) +
    geom_point(col="darkgreen") +
    geom_smooth(method = "lm", se=FALSE)
```

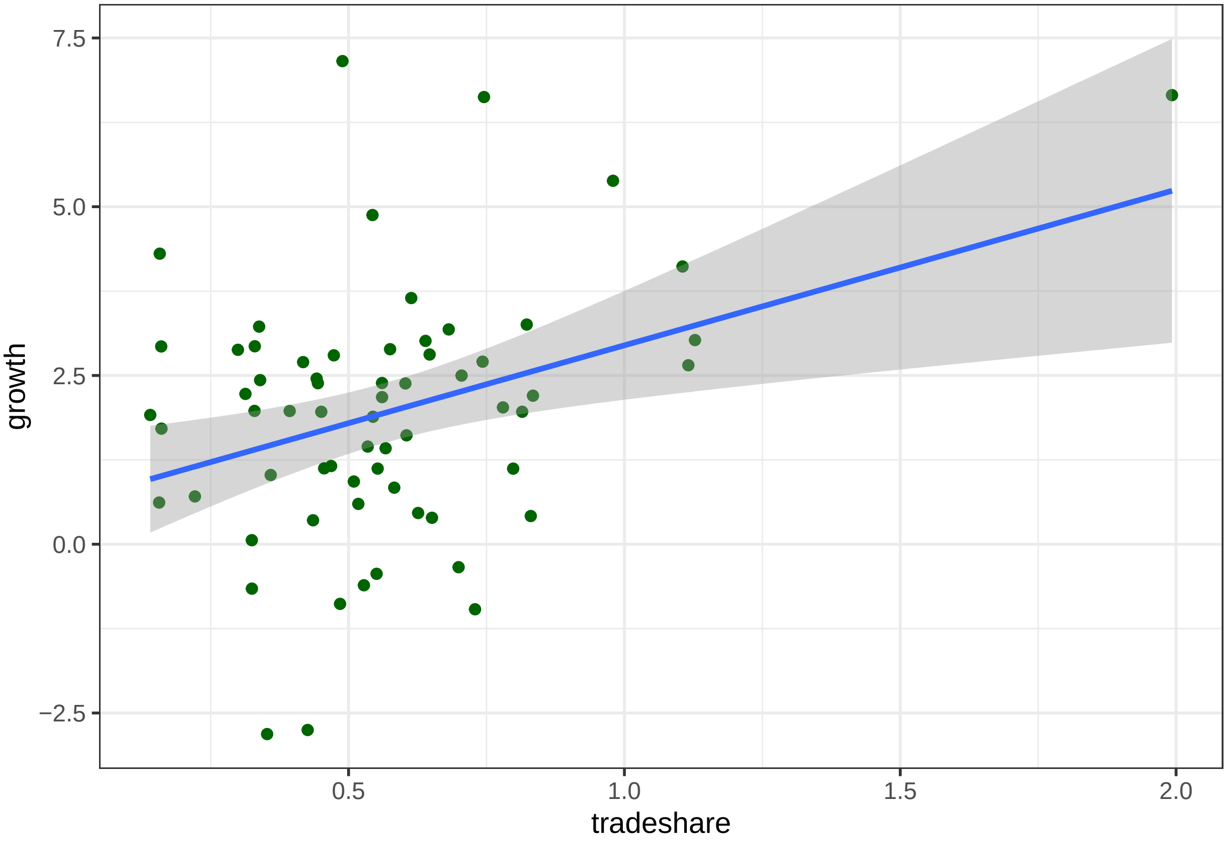
```
## `geom_smooth()` using formula 'y ~ x'
```



Add regression line to the scatterplot | confidence interval:

```
ggplot(data=df, aes(x=tradeshare, y=growth)) +
    geom_point(col="darkgreen") +
    geom_smooth(method = "lm", se=TRUE) +
    theme_bw()
```

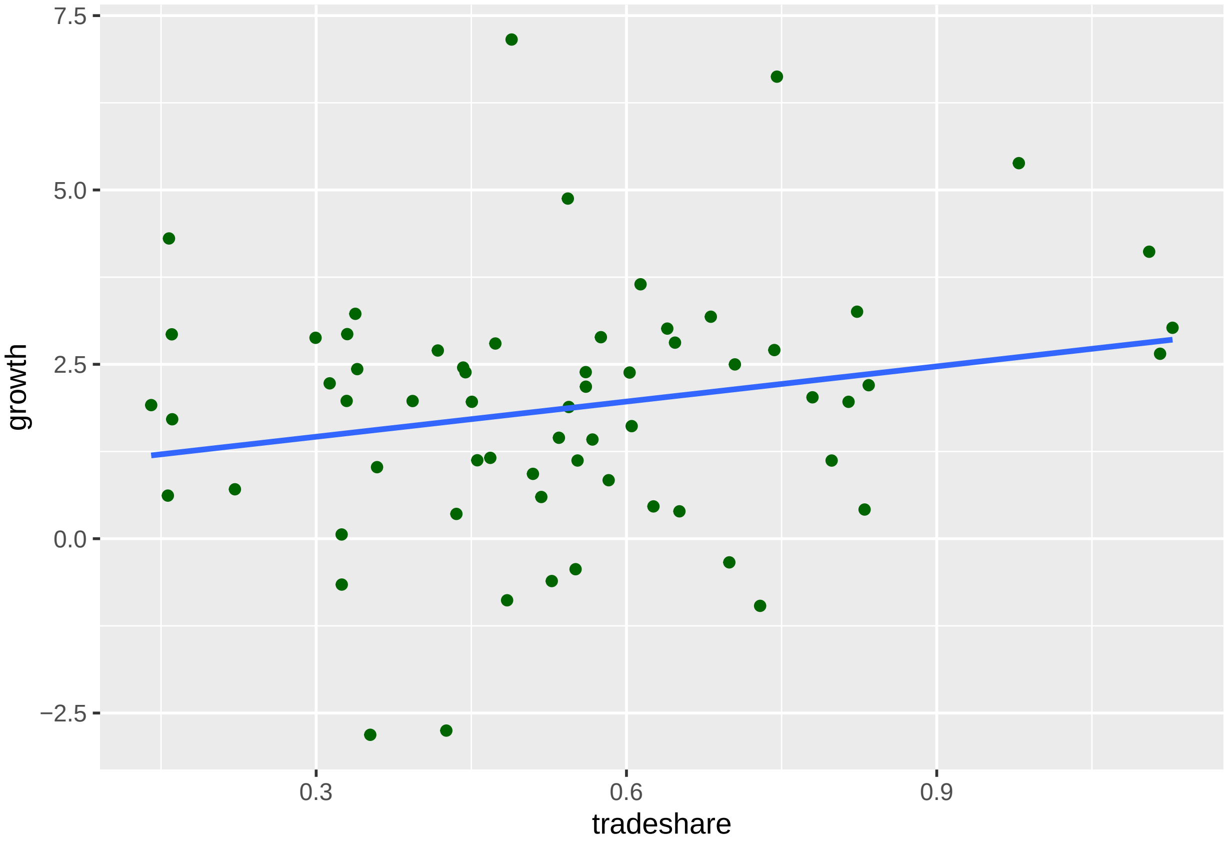
```
## `geom_smooth()` using formula 'y ~ x'
```



Regression without the outlier

```
df2 <- subset(df, country != "Malta")
ggplot(data=df2, aes(x=tradeshare, y=growth)) +
    geom_point(col="darkgreen") +
    geom_smooth(method = "lm", se=FALSE)
```

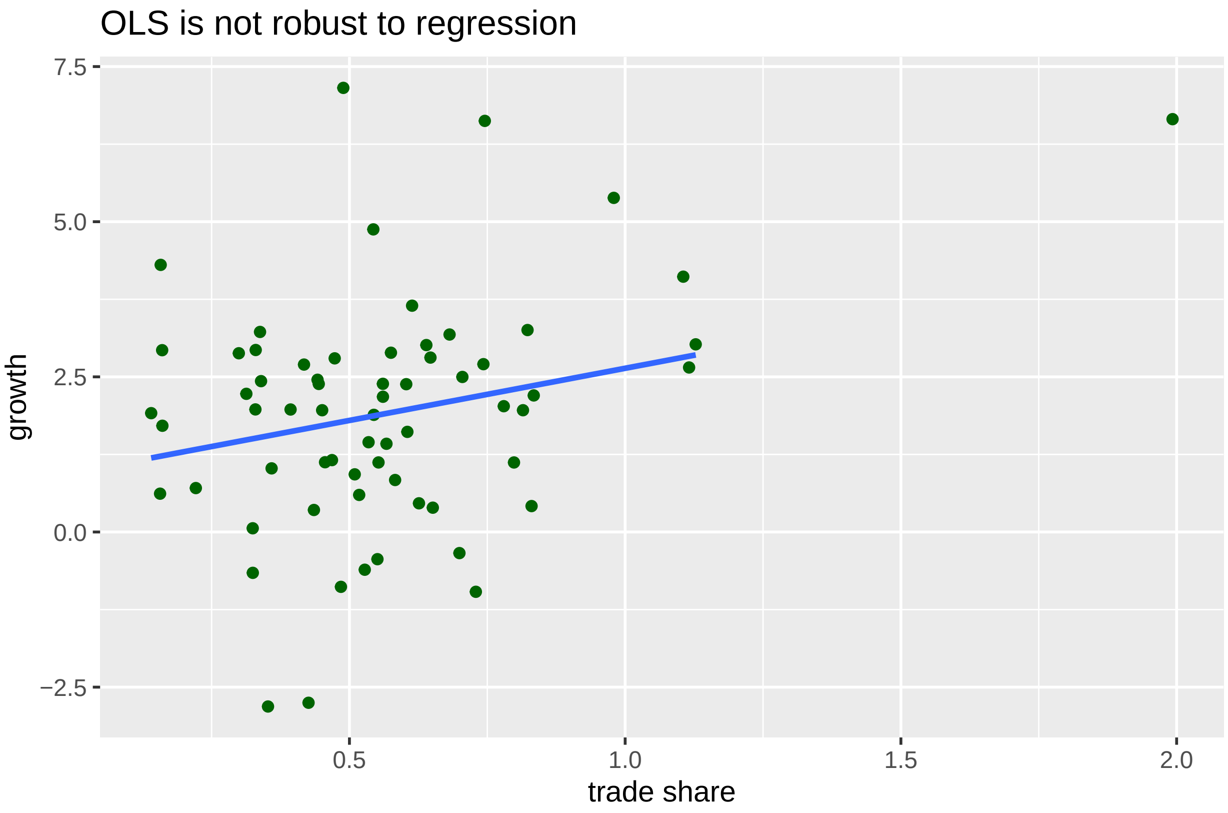
```
## `geom_smooth()` using formula 'y ~ x'
```



Regression without the outlier

```
ggplot(data=df, aes(x=tradeshare, y=growth)) +
    geom_point(col="darkgreen") +
    geom_smooth(method = "lm", se=FALSE, data=df2) +
    labs(title = 'OLS is not robust to regression',
         caption="Regression line with outlier omitted",
         x="trade share")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



Regression line with outlier omitted

Predict Malta

```
# get regression coefficients
ols2 <- lm(growth ~ tradeshare, data=df2)
b0 <- coef(ols2)[1]
b1 <- coef(ols2)[2]
# get Malta trade share
x_obs <- df[df$country == "Malta", "tradeshare"]
y_hat <- b0 + b1 * x_obs
y_hat
```

```
##   tradeshare
## 1     4.3068
```

```
# or use the built-in predict:
predict(ols2, newdata=x_obs)
```

```
##      1
## 4.3068
```

Prediction with/without Malta in sample, compared

```
# observed value:
y_obs <- df[df$country == "Malta", "growth"]
y_obs
```

```
## # A tibble: 1 x 1
##   growth
##    <dbl>
## 1   6.65
```

```
# predicted value with outlier:
predict(ols, newdata=x_obs)
```

```
##      1
## 5.2361
```

```
# predicted value without outlier:
predict(ols2, newdata=x_obs)
```

```
##      1
## 4.3068
```