Applied Statistics: Linear Equations

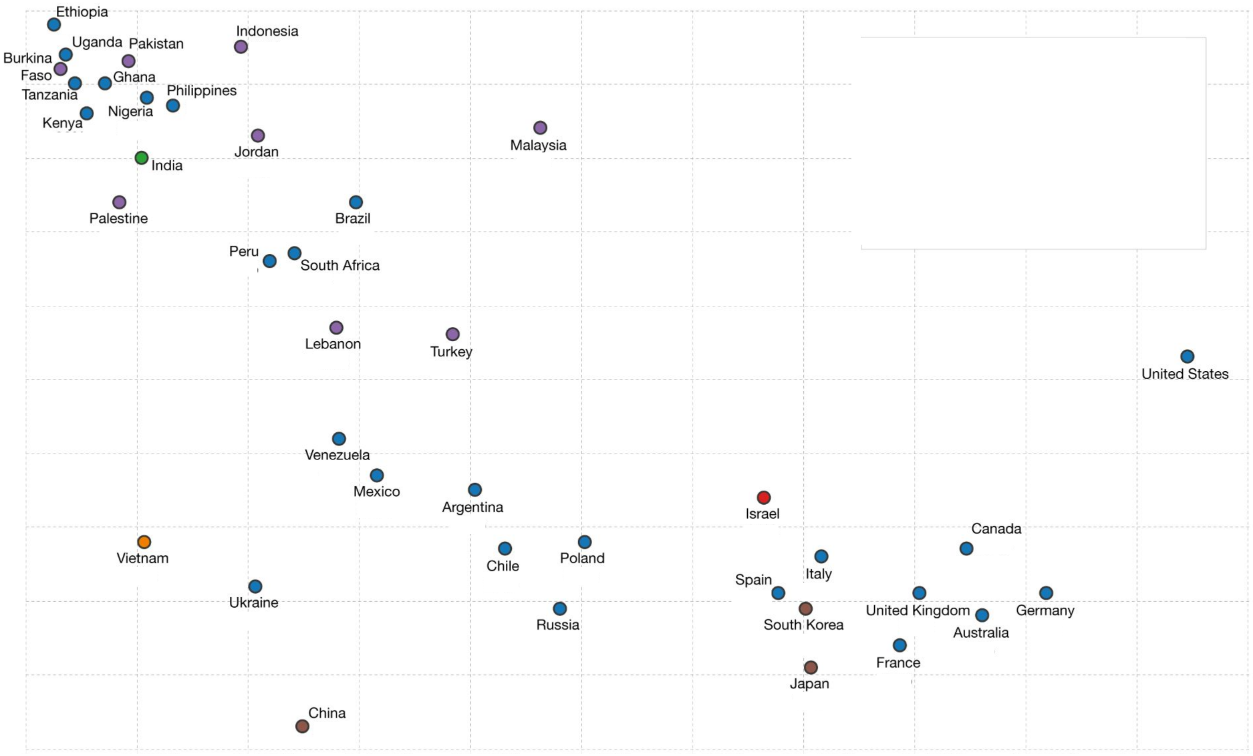
4/8

Plan for Today

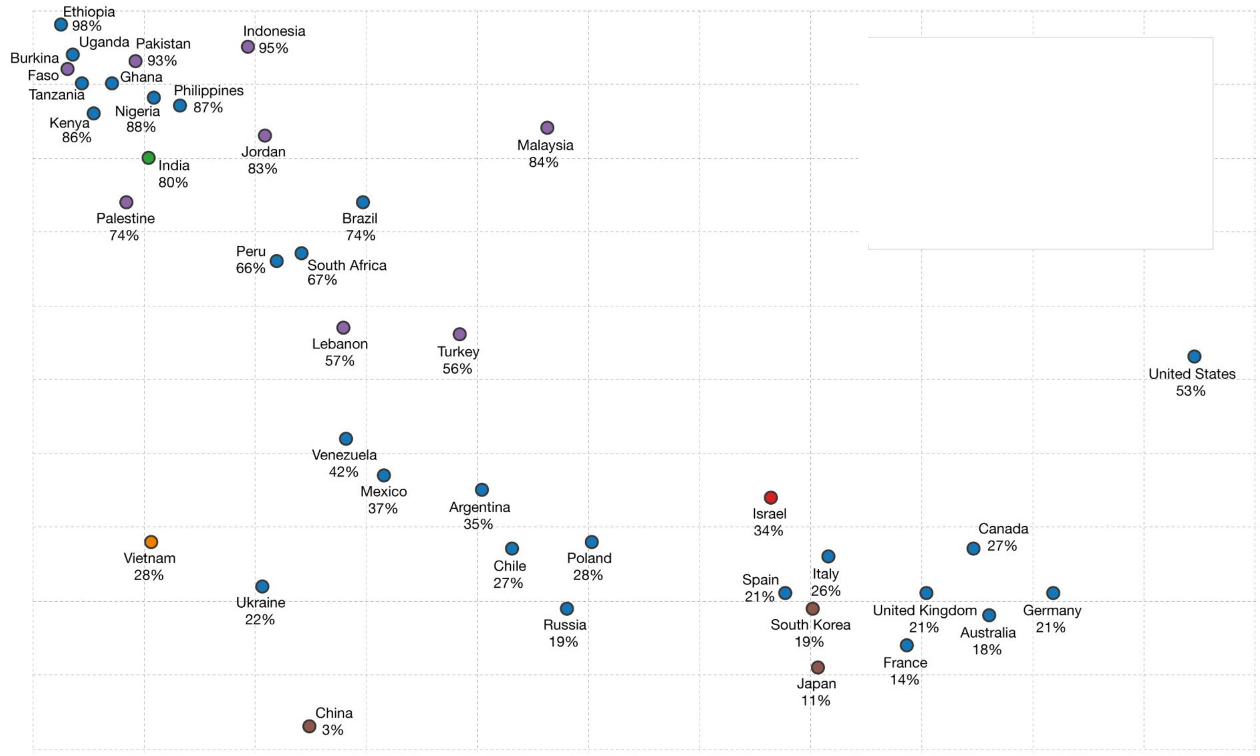
- What's Upcoming
- Graph discussion
- Linear equations
- Individual activity

What's Upcoming/Ongoing

- Week 11 Homework – due Sunday.
- Daily Survey 30 – due Sunday.
- Checkpoint 3 – due Monday night.
- Reading Assignment 4 Writeup – due Wednesday, April 13th.
  - If you've already done 3 RA writeups, no need to do this!
- Project 2 – due Wednesday, April 20th.

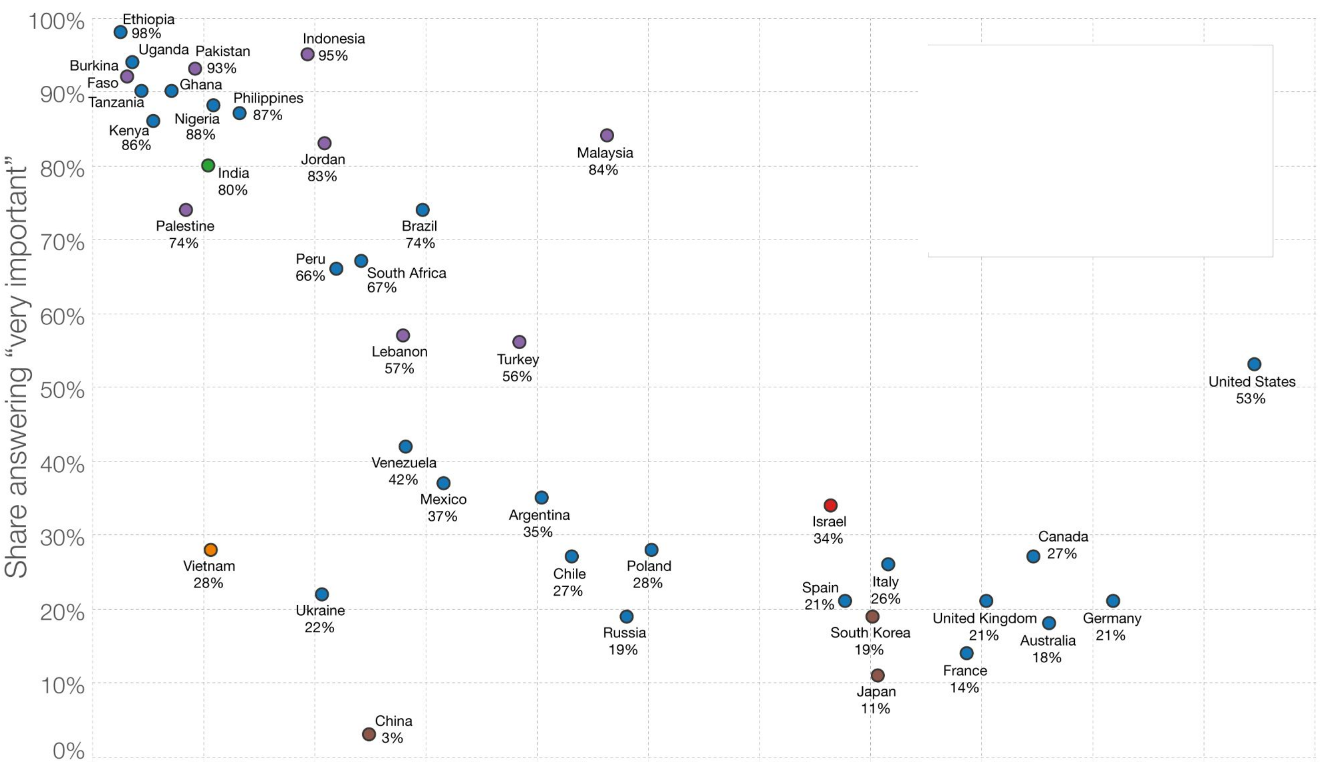


Ethiopia
Uganda
Pakistan
Indonesia
Burkina Faso
Ghana
Tanzania
Philippines
Nigeria
Kenya
Jordan
Malaysia
India
Palestine
Brazil
Peru
South Africa
Lebanon
Turkey
United States
Venezuela
Mexico
Argentina
Israel
Canada
Vietnam
Chile
Poland
Italy
Spain
Ukraine
Russia
South Korea
United Kingdom
Germany
Australia
France
Japan
China

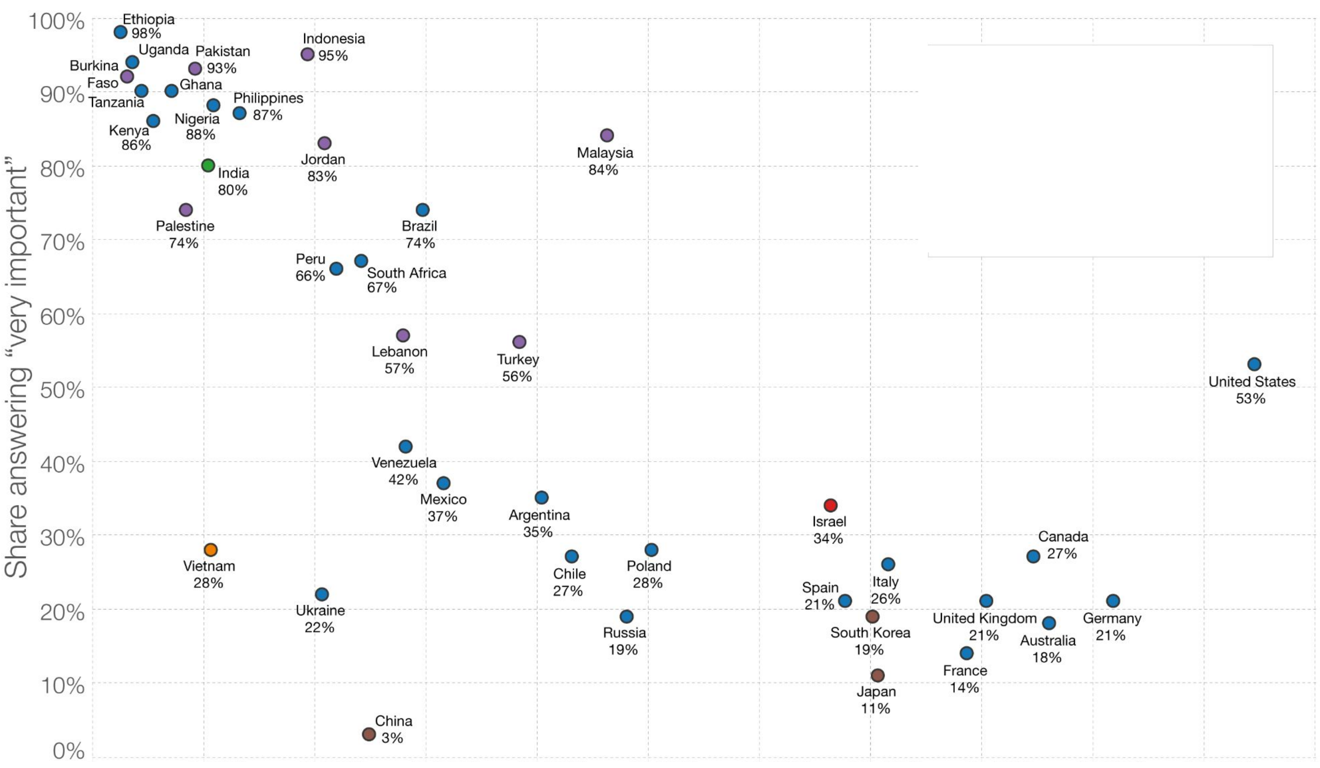


Ethiopia 98%
Indonesia 95%
Uganda
Pakistan 93%
Burkina Faso
Ghana
Tanzania
Philippines 87%
Nigeria 88%
Kenya 86%
Malaysia 84%
Jordan 83%
India 80%
Palestine 74%
Brazil 74%
Peru 66%
South Africa 67%
Lebanon 57%
Turkey 56%
United States 53%
Venezuela 42%
Mexico 37%
Argentina 35%
Israel 34%
Canada 27%
Vietnam 28%
Chile 27%
Poland 28%
Italy 26%
Spain 21%
Ukraine 22%
United Kingdom 21%
Germany 21%
Russia 19%
South Korea 19%
Australia 18%
France 14%
Japan 11%
China 3%

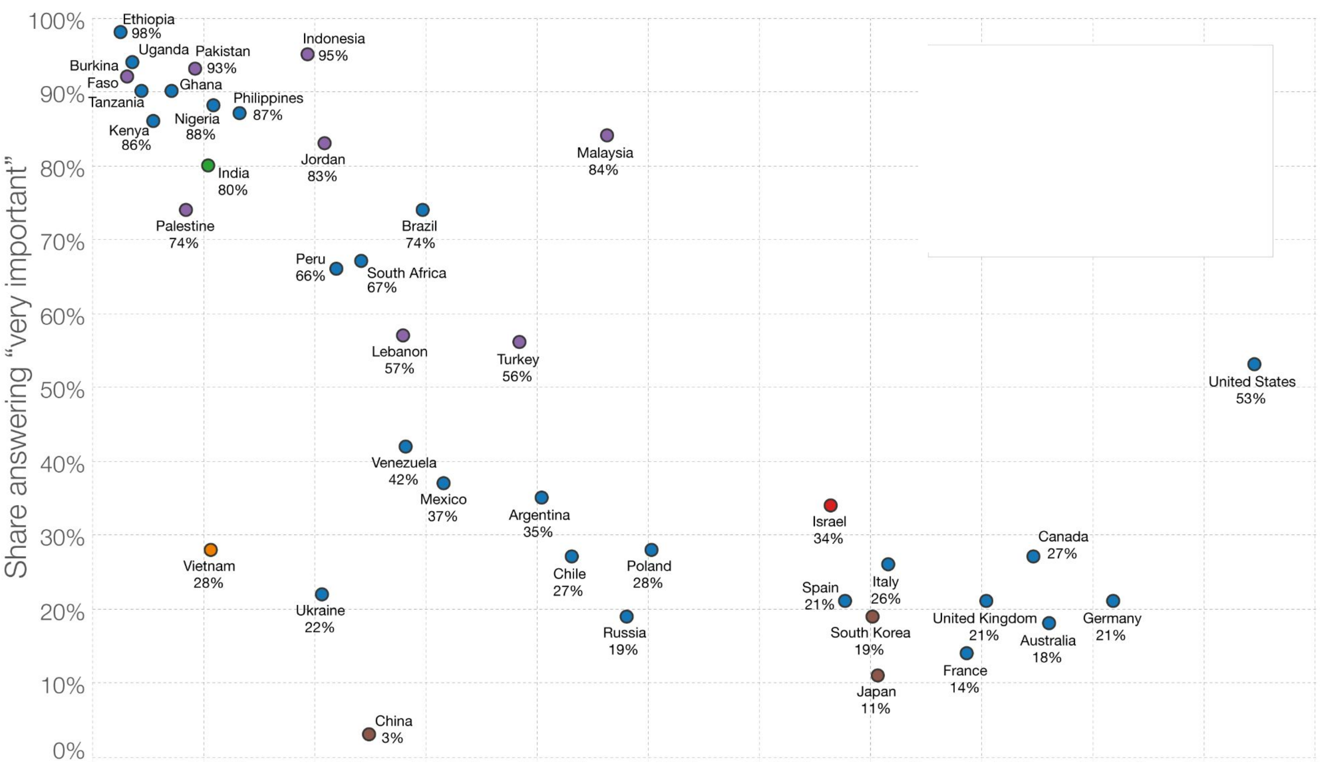
Importance of Religion vs [redacted]



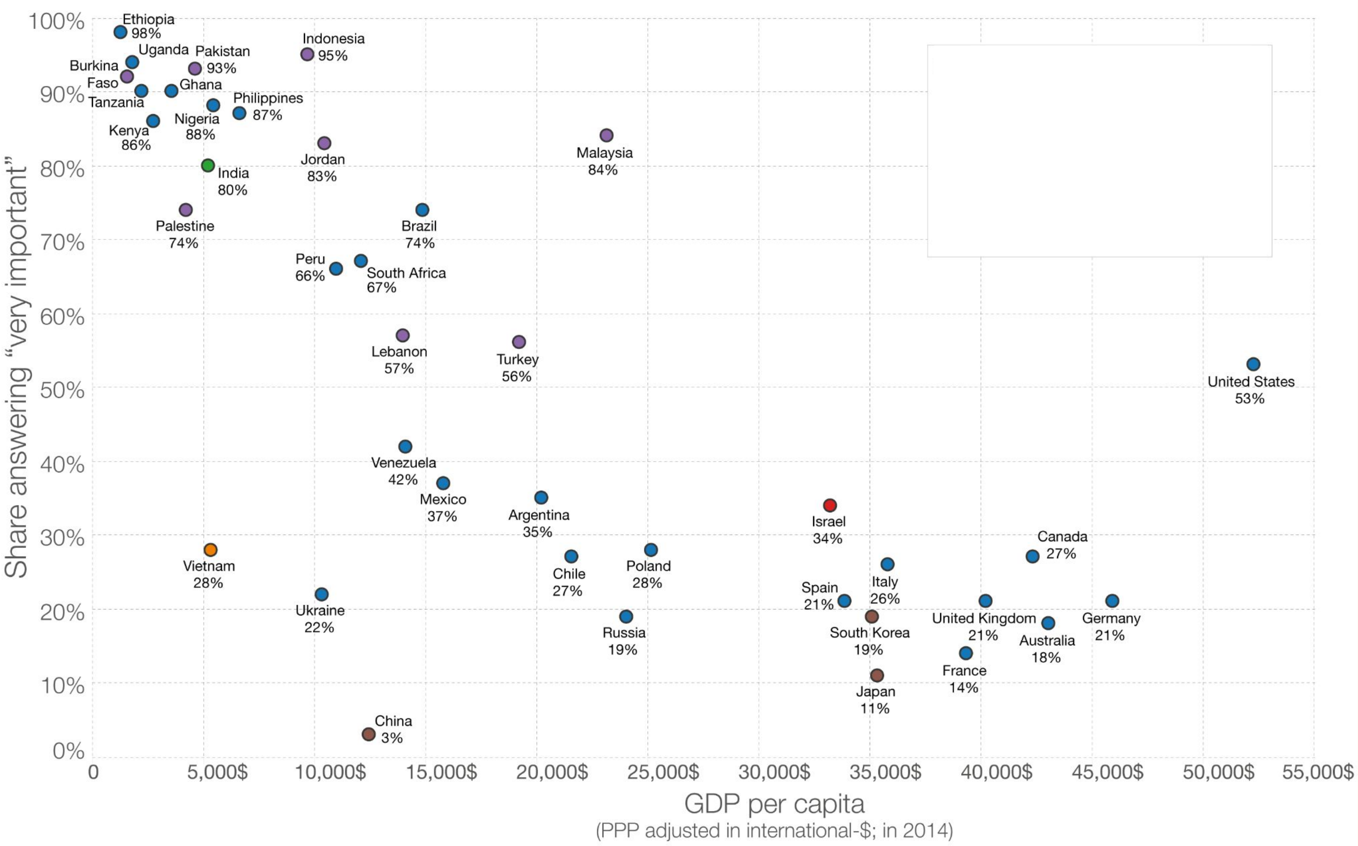
Importance of Religion vs



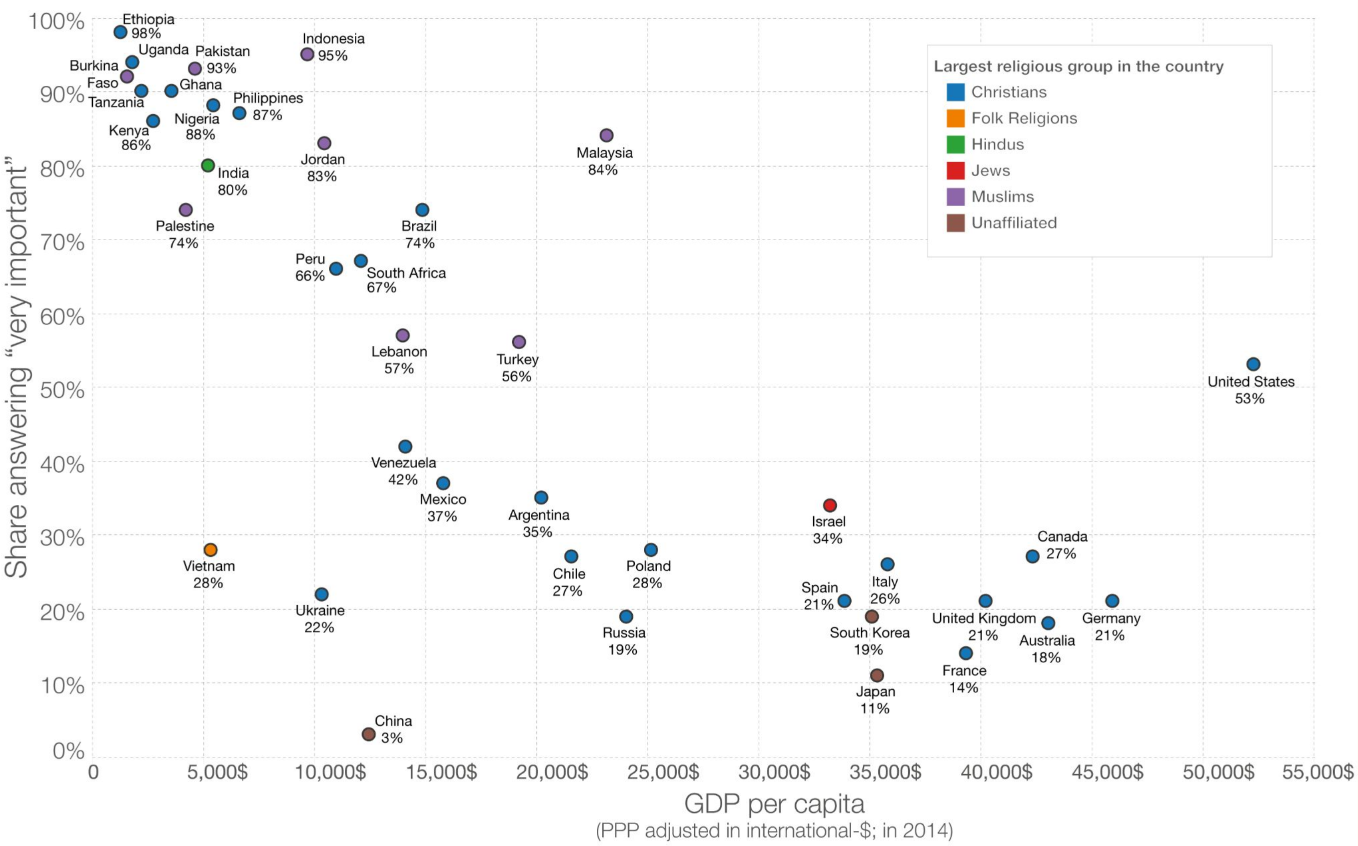
Importance of Religion vs ?

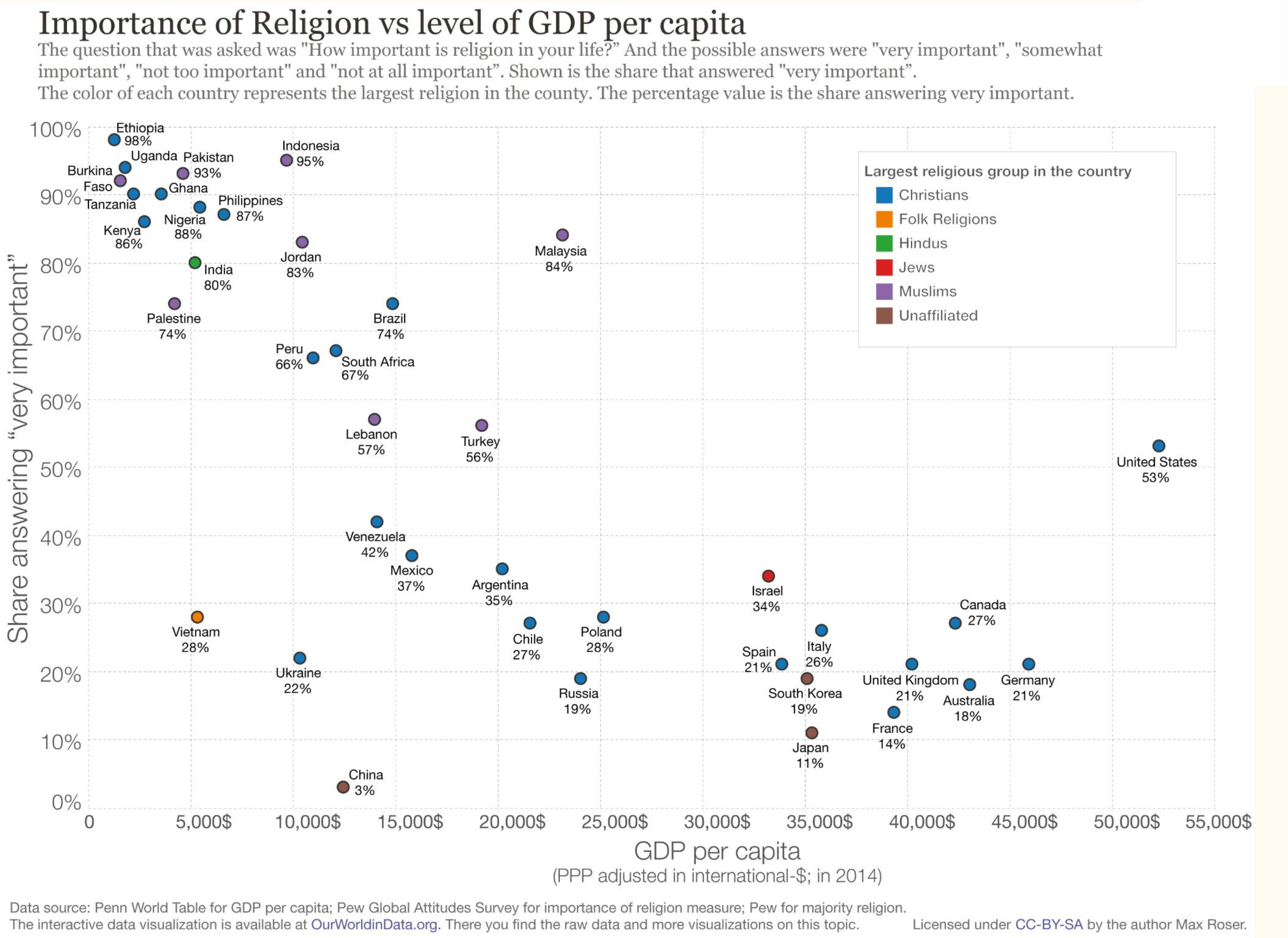


Importance of Religion vs level of GDP per capita



Importance of Religion vs level of GDP per capita





Importance of Religion vs level of GDP per capita
The question that was asked was "How important is religion in your life?" And the possible answers were "very important", "somewhat important", "not too important" and "not at all important". Shown is the share that answered "very important".
The color of each country represents the largest religion in the county. The percentage value is the share answering very important.
Largest religious group in the country
Christians
Folk Religions
Hindus
Jews
Muslims
Unaffiliated
Share answering "very important"
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Ethiopia 98%
Uganda
Pakistan 93%
Indonesia 95%
Burkina Faso
Ghana
Tanzania
Philippines 87%
Nigeria 88%
Kenya 86%
India 80%
Jordan 83%
Malaysia 84%
Palestine 74%
Brazil 74%
Peru 66%
South Africa 67%
Lebanon 57%
Turkey 56%
United States 53%
Venezuela 42%
Mexico 37%
Argentina 35%
Israel 34%
Canada 27%
Vietnam 28%
Chile 27%
Poland 28%
Italy 26%
Spain 21%
Ukraine 22%
Russia 19%
South Korea 19%
United Kingdom 21%
Germany 21%
Australia 18%
France 14%
Japan 11%
China 3%
0
5,000$
10,000$
15,000$
20,000$
25,000$
30,000$
35,000$
40,000$
45,000$
50,000$
55,000$
GDP per capita
(PPP adjusted in international-$; in 2014)
Data source: Penn World Table for GDP per capita; Pew Global Attitudes Survey for importance of religion measure; Pew for majority religion.
The interactive data visualization is available at OurWorldinData.org. There you find the raw data and more visualizations on this topic.
Licensed under CC-BY-SA by the author Max Roser.

Finding Relationships Between Numerical Variables

Examples:

- Is there a relationship between a student's grade on a midterm exam and their grade on a final exam?
- Is there a relationship between poverty rate in a state and high school graduate rate in that state?

Finding Relationships Between Numerical Variables

What do we want to be able to do?

- Describe how two things are related
  - Visually
  - Qualitatively
  - Quantitatively
- Say whether the relationship is physically and statistically meaningful
- Use the relationship to make predictions

Linear Equations

We'll be looking at **linear equations** in the form

$$y = a + bx,$$

where a and b are constants (numbers).

Some linear equations:

- y = 3 + 4x
- y = 0.01 - 1200x
- y = -5x
- y = 6x - 2

Example

Juanita is opening a lemonade stand. She spends \$12 on supplies and then sells lemonade for \$1.50 per cup.

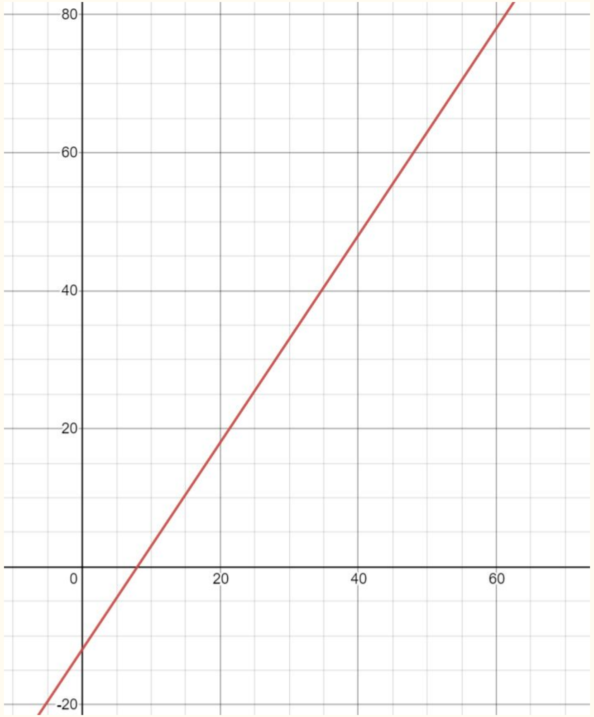
What equation represents her profit p in terms of number of cups sold c?

Example

Juanita is opening a lemonade stand. She spends \$12 on supplies and then sells lemonade for \$1.50 per cup.

Profit is given by: p = 1.5c - 12, where:

- The profit is p.
- The number of cups is c.
- -\$12, the loss to supplies, is the **y-intercept.**
- \$1.50/cup, the price per cup, is the **slope.**



Parts of a Linear Equation

In a linear equation $y = a + bx$:

- The constant term, a, is the **y-intercept.**
- The coefficient of x is the **slope.**

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In a linear equation $y = a + bx$:

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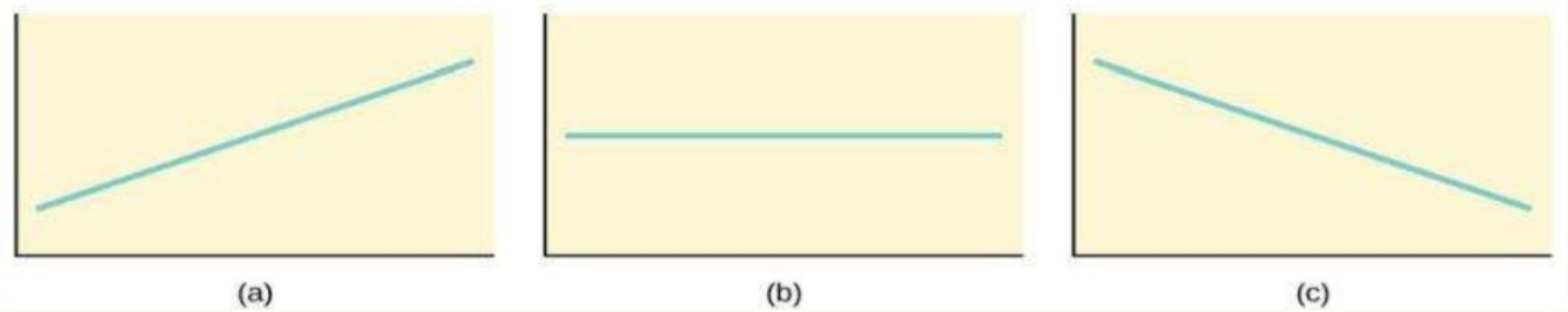
- The coefficient of x is the **slope.**

Examples:

- In $y = 2700x + 1000$, the y-intercept is 1000, and the slope is 2700.
- In $y = 20 + 0.8x$, the y-intercept is 20, and the slope is 0.8.
- In $y = 5x - 4$, the y-intercept is -4, and the slope is 5.
- In $y = 0.01 - 1200x$, the y-intercept is 0.01, and the slope is -1200.

Interpreting Slope

- Slope tells you how much y changes as x changes by 1 unit.
- **Example:** a slope of 0.8 says that for every increase of x by 1, y will increase by 0.8.
- **Example:** a slope of -2 says for that for every increase of x by 1, y will increase by -2 (so it will decrease by 2!).
- The units of slope are the units of y divided by the units of x.



(a): positive slope (b): slope $= 0$ (c): negative slope

Interpreting y-Intercept

- The y-intercept is the y-value where the graph of the line crosses the y-axis.
- It is the y-value when $x = 0$.
- The units of the y-intercept are the units of y.

Example:

For lemonade, p = 1.5c - 12

The y-intercept was -$12 because the $12 was an upfront loss, separate from the number of cups of lemonade Juanita sold.

Back to the Example

Juanita is opening a lemonade stand. She spends \$12 on supplies and then sells lemonade for \$1.50 per cup.

Profit is given by: $p = 1.5c - 12$

At the end of the day, Juanita had sold 60 cups of lemonade. What was her profit?

Any initial estimates? (\$20? \$40? \$60? \$80? \$100?)

Back to the Example

At the end of the day, Juanita had sold 60 cups of lemonade. What was her profit?

Profit is given by: $p = 1.5c - 12$

Here, we're told that $c = 60$.

So profit $p = 1.5(60) - 12$

$p = 90 - 12$

So the profit is $p = \$78$.

Back to the Example

Juanita is opening a lemonade stand. She spends \$12 on supplies and then sells lemonade for \$1.50 per cup.

Profit is given by: $p = 1.5c - 12$

At the end of the day, Juanita's profit is \$78. How many cups of lemonade did she sell?

Example

Juanita is opening a lemonade stand. She spends \$12 on supplies and then sells lemonade for \$1.50 per cup.

Profit is given by: $p = 1.5c - 12$

At the end of the day, Juanita's profit is \$78. How many cups of lemonade did she sell?

First, an estimate: 25 cups? 50 cups? 75 cups? 100 cups?

Example

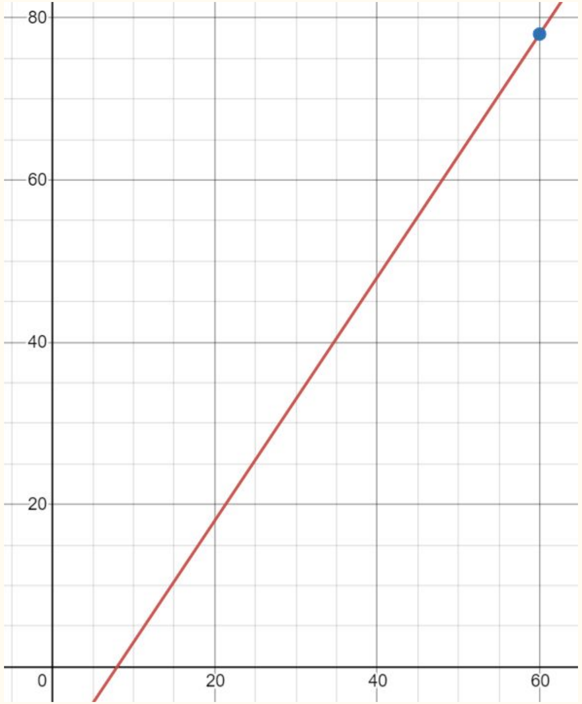
At the end of the day, Juanita's profit is \$78. How many cups of lemonade did she sell?

Profit: $p = 78 = 1.5c - 12$

$1.5c = 78 + 12$

So $1.5c = 90$

Then $c = 90/1.5 = 60$ cups of lemonade.



Activity

- Some practice with linear equations
- Some practice with hypothesis testing and paired vs. two-sample data
- Some practice with interpreting histograms