

REAL-WORLD TAKEAWAYS

- In cities like New York, Los Angeles, Seattle, and Washington, DC, the median annual household income increased from 2010-2019.
- During this same time, the median rent also increased, but by less.
- As rents rise, some people are no longer able to afford their homes and become homeless.
- Local leaders face a challenge in recruiting high-paying jobs while ensuring their areas remain affordable to the less well-off.

MATHEMATICAL OBJECTIVES

- Describe a line-of-best fit as a line which is drawn through data points to show a long-term trend
- Interpret a linear equation in a real-world context
- Analyze real-world data and use it develop policy recommendations

LESSON AT A GLANCE
60 MIN.

			60 MIN.
LAUNCH		Watch a news clip about Amazon’s decision to build a second headquarters, or “HQ2.” Discuss possible upsides and downsides of a company like Amazon moving to your area.	5 min.
PART ONE	1	For a major US city (NYC, LA, Seattle, or Washington, DC), analyze the graphs of income and rent over a ten-year period. Use the equations of the lines-of-best fit to determine which has risen faster and consider the possible impacts on residents in the city.	15 min.
	2	Analyze the graph of rent vs. income. Interpret the slope of the line-of-best fit as the “additional rent for each additional dollar of income.”	15 min.
PART TWO	3	For the given city, analyze two graphs related to homelessness: total homeless vs. time and total homeless vs. annual rent. Interpret the meaning of the equations’ slopes.	15 min.
	4	Discuss ways to address the unintended consequences when a high-paying employer moves to town.	10 min.

TEACHING TIP

There are four versions of the student handout: one for New York City, Los Angeles, Seattle, and Washington, DC. The questions are the same in each handout, but the data is unique to each city. Consider having students work in groups and assigning each student (or assigning each group) a different city. The online teacher interactive allows you to view and compare the graphs for all four cities.

Also, of the 500,000 people experiencing homelessness in the U.S. at any given moment, many are children. It’s possible that some of your students have experienced or are currently experiencing homelessness. Please approach these conversations with extra sensitivity.

- L Students watch a news clip about Amazon’s announcement in 2017 that it would build a second headquarters (“HQ2”) somewhere in North America. The story describes how state and local leaders were eager for Amazon to move there, given the number of high-paying jobs the headquarters promised to bring. (In 2018, Amazon announced that it would construct HQ2 just outside of Washington, DC.)

DISCUSSION QUESTIONS

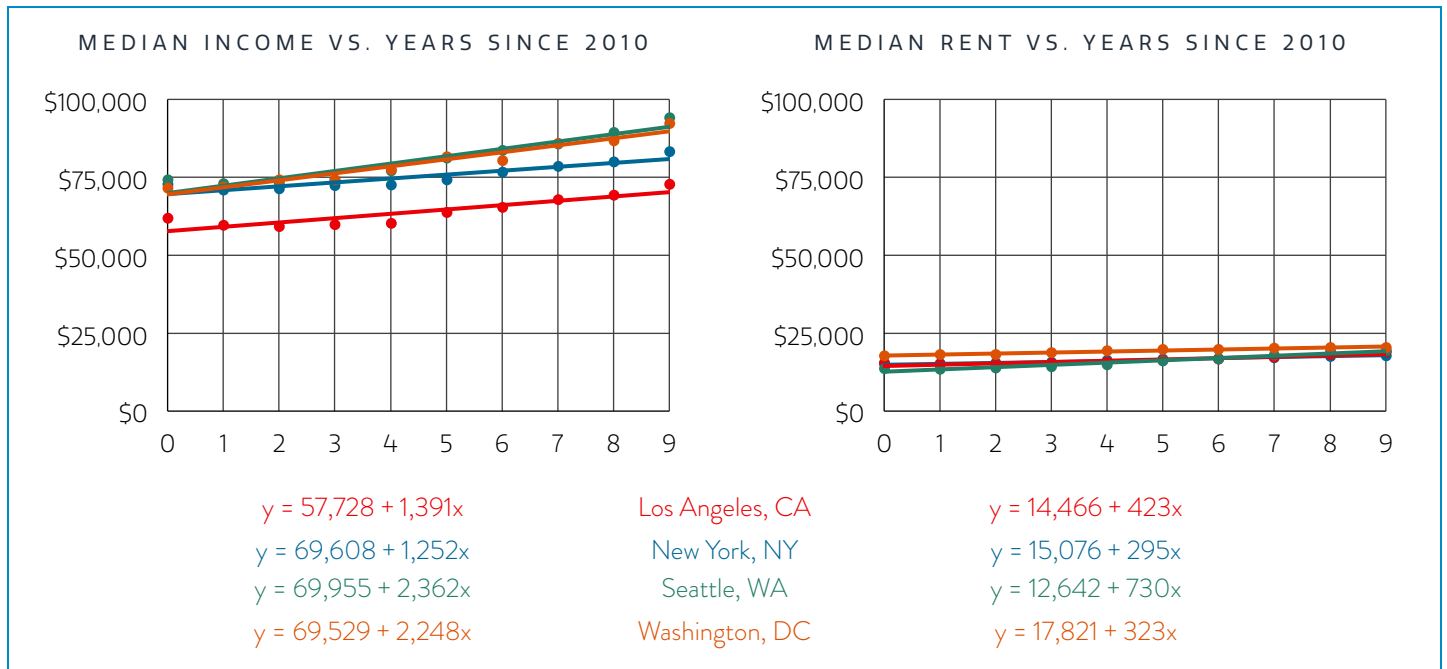
1. If you were a mayor of a town or city, would you want Amazon to build its new headquarters in your area?
2. What might be some upsides of having a company like Amazon move to town? Can you think of any downsides?

KEY TAKEAWAYS

- When companies like Amazon move to new areas, they often bring with them many high-paying jobs.
- This is great for people who get these jobs. It can also be good for the local economy.
- There may also be downsides. Not only might the area have a hard time accommodating a large influx of new people (e.g. increased traffic, larger class sizes in school, etc.), but it might also make the area less affordable, especially for people who don’t get the new jobs.

- 1 Every day across the United States, people relocate to new cities. Many of them do this to start new, higher-paying jobs. As a city's residents earn higher incomes, the cost of living there often goes up.

The graphs below show how the median annual household income and the median annual rent changed from 2010-2019 in [CITY]. Judging from the graphs, would you conclude that the average household did better off or worse off over that decade? Explain. (Note: On the graphs, the x -axis represents years since 2010, where $0 = 2010$, $1 = 2011$, etc.)



Los Angeles, CA

According to the line-of-best-fit, each year the median annual income increased by \$1,391, while the median annual rent increased by \$423.

Even though the rent increased by a lot each year, the income increased by even more. The typical household in Los Angeles did better off over time.

New York, NY

According to the line-of-best-fit, each year the median annual income increased by \$1,252, while the median annual rent increased by \$295.

Even though the rent increased by a lot each year, the income increased by even more. The typical household in New York did better off over time.

Seattle, WA

According to the line-of-best-fit, each year the median annual income increased by \$2,362, while the median annual rent increased by \$730.

Even though the rent increased by a lot each year, the income increased by even more. The typical household in Seattle did better off over time.

Washington, DC

According to the line-of-best-fit, each year the median annual income increased by \$2,248, while the median annual rent increased by \$323.

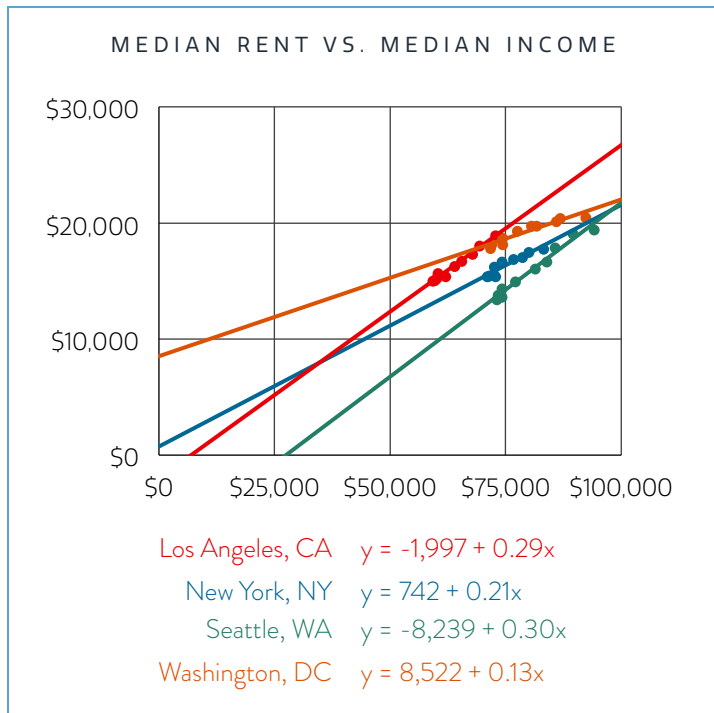
Even though the rent increased by a lot each year, the income increased by even more. The typical household in DC did better off over time.

TEACHING TIP

You may have noticed that the sample response doesn't mention anything about the y -intercept of the line-of-best-fit. Instead, it only focused on the slope, i.e. the rate of change in the annual income and the annual rent. Had we included an interpretation of the y -intercept, it might have sounded something like, "According to the line-of-best-fit for Los Angeles, the median income started at \$57,728 in 2010 (and then increased by \$1,391 each year)." This is true according to the line-of-best-fit. However, it risks confusing students. After all, students can see on the graph what the actual median income was in Los Angeles in 2010; the point is clearly above the line-of-best-fit.

In this lesson, by all means feel free to have students interpret the meaning of the y -intercept; it definitely helps to flesh out the story of what's happening in each city. If students do this, though, make sure that they understand what a line-of-best-fit is: it's a line that goes through actual data and helps us observe trends, but it isn't the data itself.

- 2 The graph below shows the relationship between the median annual rent and income in [CITY] from 2010-2019. For every additional dollar that the typical household earned, how did the typical rent change? Does this surprise you?



Los Angeles, CA

For every dollar that the median annual income increased, the median annual rent increased by \$0.29.

New York, NY

For every dollar that the median annual income increased, the median annual rent increased by \$0.21.

Seattle, WA

For every dollar that the median annual income increased, the median annual rent increased by \$0.30.

Washington, DC

For every dollar that the median annual income increased, the median annual rent increased by \$0.13.

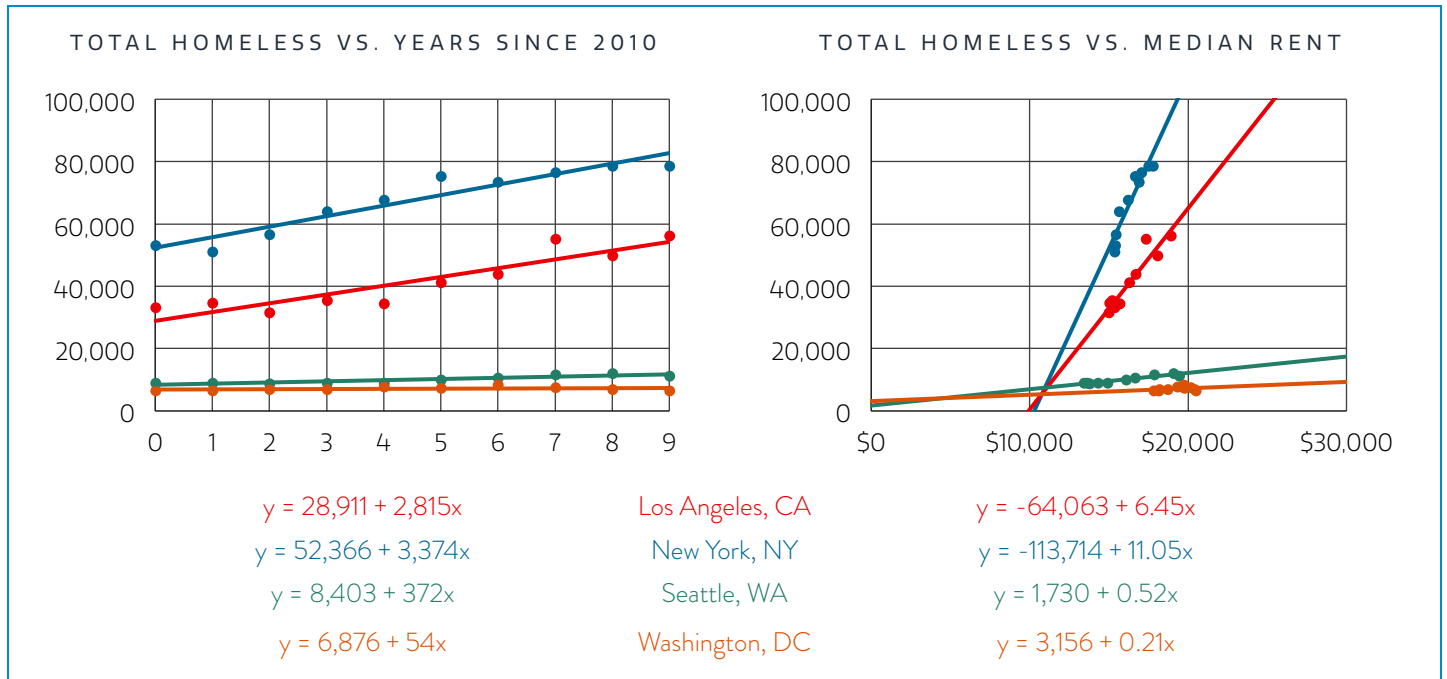
Answers will vary about whether students find these amounts surprising.

TEACHING TIP

Here's a good opportunity to point out why, when analyzing lines-of-best-fit, we shouldn't lean too heavily on the y-intercept. According to the line-of-best-fit for Los Angeles, the median income "started out" at $-\$1,997$. That would be wonderful! But alas, it's nonsensical.

- 3 At any given moment in the United States, more than 500,000 people are experiencing homelessness. Many of them had homes but lost them when they could no longer afford the rent. Watch the video about some of these people.

Then look at the graphs about homelessness in [CITY] between 2010-2019. How did the homeless population change as the rent increased, and what does this suggest about the relationship between homelessness and income?



Los Angeles, CA

According to the line-of-best-fit on the left, the homeless population increased by 2,815 people each year.

According to line-of-best-fit on the right, for every dollar that the median annual rent increased, 6.45 more people experienced homelessness.

New York, NY

According to the line-of-best-fit on the left, the homeless population increased by 3,374 people each year.

According to line-of-best-fit on the right, for every dollar that the median annual rent increased, 11.05 more people experienced homelessness.

Seattle, WA

According to the line-of-best-fit on the left, the homeless population increased by 372 people each year.

According to line-of-best-fit on the right, for every dollar that the median annual rent increased, 0.52 more people experienced homelessness.

Washington, DC

According to the line-of-best-fit on the left, the homeless population increased by 54 people each year.

According to line-of-best-fit on the right, for every dollar that the median annual rent increased, 0.21 more people experienced homelessness.

For every city, when the median annual income increased, the median annual rent increased. When the rent increased, the homeless population increased. If we were to graph homelessness vs. income, then, we'd expect an upward-sloping line. As a city's median annual income goes up, so does its homeless population.

At first glance this seems backwards; after all, if residents have more money, fewer of them should experience homelessness. In reality, though, the people whose incomes are going up aren't the ones who are becoming homeless. When some people earn a lot more, rents go up, which results in other people no longer affording their homes.

TEACHING TIP

A few notes about the homelessness figures.

First, the 500,000 figure does not represent the total number of people who experience homelessness in the United States in a given year. Instead, it's what's known as a "point-in-time" figure; it's the number of people who are without permanent shelter at *any given moment*. The upside of the point-in-time figure is that most of these people find housing relatively quickly. The downside is that over the course of a year, the total number of people who experience homelessness is far greater than 500,000.

Second, the homeless figures in the student handouts show the total number of people experiencing homelessness in each city. However, the online teacher interactive includes even more detailed information. In addition to the total homeless population, it also includes the sheltered population and the unsheltered population. Even though the lesson doesn't require it, students may find it interesting to compare cities. A law in New York requires the city to provide shelter to anyone who needs it. For this reason, almost all the growth in homelessness there has been *sheltered*. California does not have the same law, and almost all of its growth in homelessness has been unsheltered. (In fact, while the total homeless population in Los Angeles increased between 2010-2019, the sheltered homeless population actually decreased.)

Finally, students may be curious why the homeless populations are so different between cities. According to the line-of-best-fit, the homeless population increased by 3,374 people per year between 2010-2019 in New York, but it only increased by 54 people per year in Washington, DC. If time allows, consider having students research the populations of each city to determine where homelessness increased the most *relative to the city's total population*.

- 4 In 2017, internet giant Amazon announced that it would build a second headquarters somewhere in North America. It promised 50,000 new highly paid jobs and invited cities to apply to be home of the so-called “HQ2.”

Imagine you’re the mayor of a city. If a high-paying employer such as Amazon moved to your area, what are some things that you could do to address unintended consequences like increased rents and homelessness?

Students’ responses will vary. Strategies to address consequences like increases rents and homelessness might include:

- For renters, implement rent-control and/or limits on how much landlords can increase rent each year
- For owners, freeze property taxes or limit how much an existing resident’s property taxes can increase each year
- Adjust zoning to require that any new housing developments include affordable housing for low-income residents
- Construct homeless shelters with job re-training and other social services