

**Real-World Takeaways**

- In cities like New York, Los Angeles, and Seattle, the median annual household income increased between 2010 and 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**
**70 min.**

		Lesson at a Glance	70 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, or Seattle), analyze the graphs of income over time 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.	25 min.
	4	Discuss factors local leaders should consider when recruiting employers to their area, including ways to mitigate unintended consequences like homelessness.	10 min.

**Teacher Tip**

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

In this teacher guide, all of the exemplar responses are for New York, but similar reasoning applies to LA and Seattle, as well.

- 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 many state and local leaders were eager for Amazon to move there, given the number of high-paying jobs the new headquarters promised to bring.

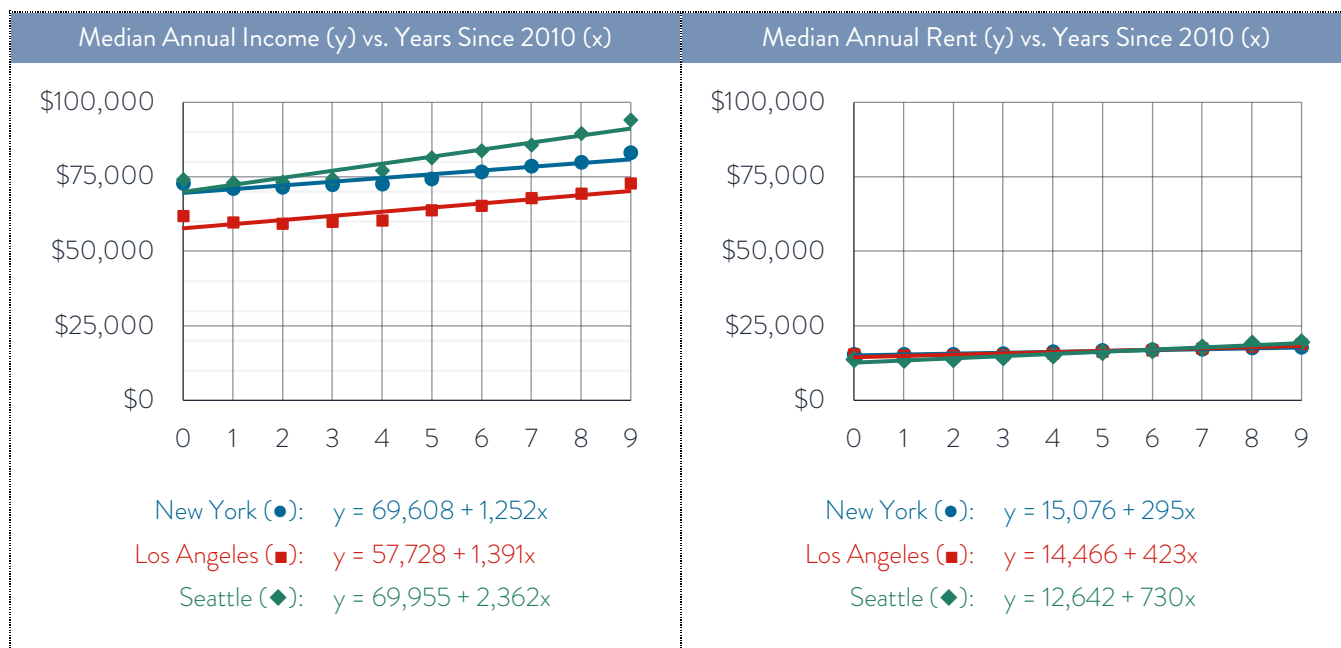
#### Discussion Questions

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 year, thousands of people move to [New York City](#)/[Los Angeles](#)/[Seattle](#). The following graphs show how the median annual income for a household and the median annual rent changed in the city from 2010 to 2019 (where year 0 = 2010, 1 = 2011, etc.). Based on the graphs, would you conclude that the typical household was better off or worse off over time? Explain.



Answers may vary. Sample response for NYC:

For New York, the equation of the income vs. years trendline is  $y = 69608 + 1252x$ . The  $y$ -intercept indicates that the median annual income started at \$69,608 in year 0 (i.e. 2010), and the slope indicates that it then increased by \$1,252 each year. In the rent vs. years graph for NYC, the equation indicates that the median annual rent started at \$15,076 in 2010, then increased by \$295 per year.

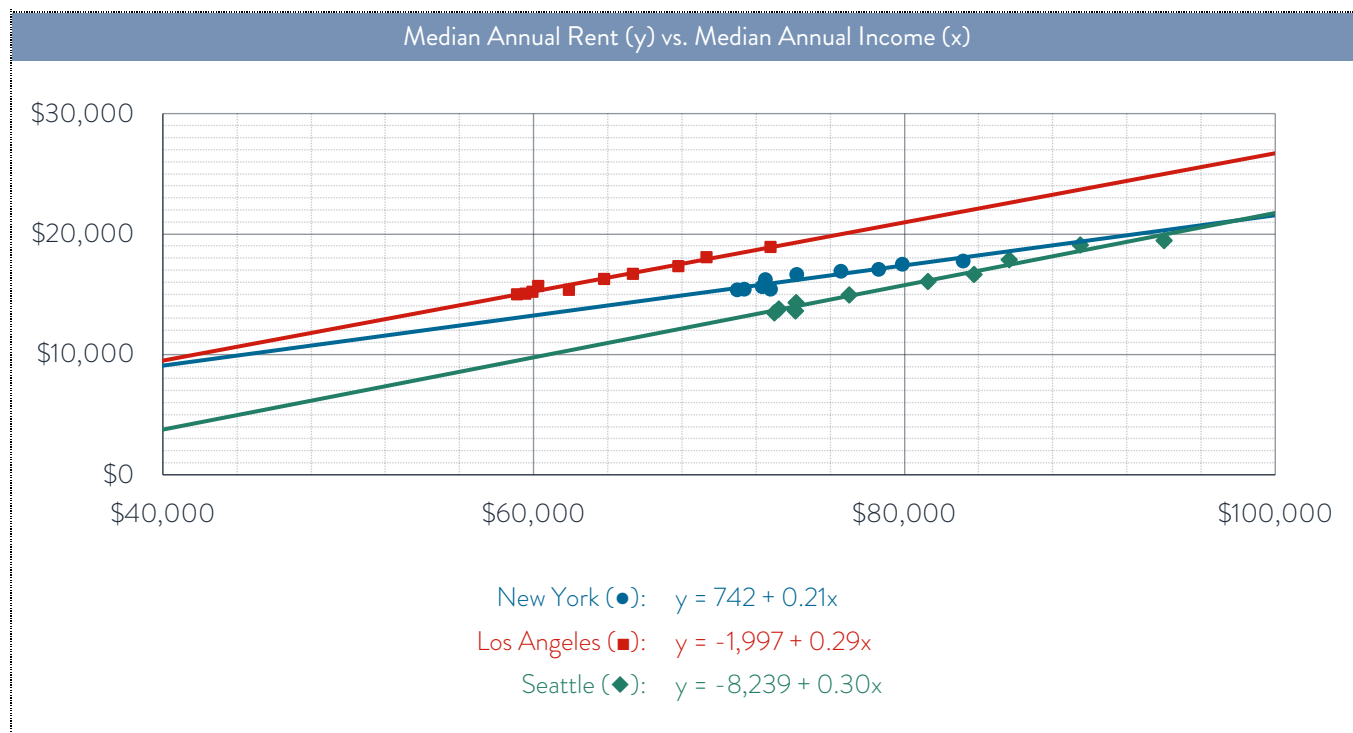
This is good on two fronts. First, the median income started out higher than the median rent; this means that in 2010 the typical household earned more in income than they paid in rent. Second, the income grew by more each year than the rent did. Even though the median rent went up by a lot – more than \$1200 per year! – the income went up by even more. Based on this, it seems that the typical New Yorker household got better off from 2010 to 2019 (and more specifically,  $\$1252 - \$295 = \$957$  better off per year).

#### Teacher Tip

If students haven't studied lines-of-best-fit, they may ask why the lines don't go through all of the points. The points represent the actual median incomes and median rents each year from 2010 to 2019, and they show that both generally increased over time. However, neither measure went up by a perfectly constant amount each year; in other words, the relationships aren't perfectly linear. In situations like this, we can use a line-of-best fit to model the *general trend*. (Since the mathematical focus of this lesson is on interpreting the terms in a linear equation – and since students at this point probably haven't been formally introduced to regressions – the lesson does not include the specific  $R^2$  values for each relationship. The correlations are strong, though. For NYC/LA/Seattle, the values for the *income vs. years* regressions are 0.84/0.80/0.91 and the values for the *rent vs. years* regressions are 0.96/0.88/0.95.)

Since students only see the data for a single city on their handouts, you can use the teacher interactive to compare cities to one another.

- 2 The graph below shows the relationship between the median annual rent and the median household income in New York/Los Angeles/Seattle between 2010 and 2019. What does the equation tell you, and how do you expect this would affect residents there?



Answers may vary. Sample response for NYC:

The slope of a line always represents the additional units of  $y$  for each additional unit of  $x$ . In this case,  $y$  represents the median annual rent in the city and  $x$  represents the median annual income. Therefore, the slope of the line represents the additional rent for each additional dollar of income. For New York, the slope of the rent vs. income line is 0.21. This means that for every additional dollar that the medium income rose, the median annual rent rose by \$0.21.

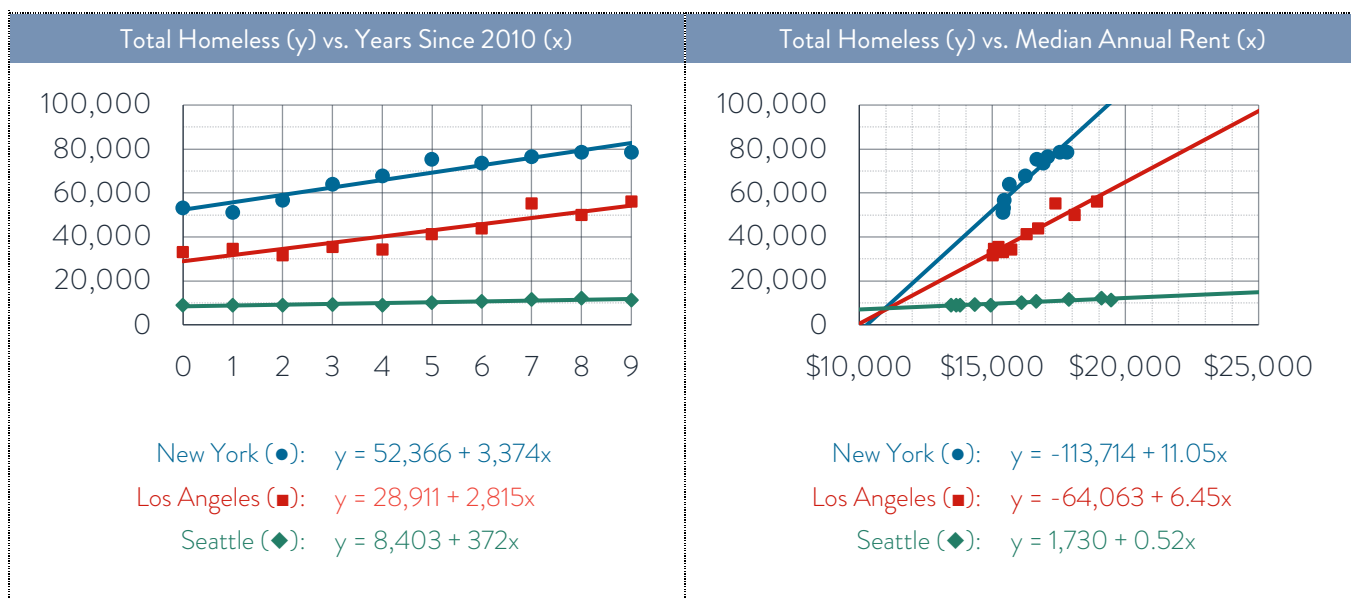
Even though people in NYC earned more money on average between 2010 and 2019, much this additional income – 21% – went to rent. Not all of it did, though, which suggests that New Yorkers did better off over time. This is consistent with the conclusion from earlier.

#### Teacher Tip

Consider asking students what the  $y$ -intercept of the line means. For Los Angeles, the  $y$ -intercept of the rent vs. income line is -1997, which suggests that when income = \$0, rent = -\$1,997. This is clearly nonsensical, and it offers a good opportunity to point out the danger in taking a trendline too literally. The line represents a general trend, but it shouldn't be interpreted as a perfect reflection of reality.

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

Then analyze the graphs below describing homelessness in New York/Los Angeles/Seattle and explain what they tell you. Based on this, if you sketched a graph of New York's/LA's/Seattle's homeless population vs. its median income, what do you expect it would look like?



Answers may vary. Sample response for NYC:

According to the graph on the left, in 2010 there were approximately 52,366 people experiencing homelessness in New York City at any given moment. After that, the figure grew by 3,374 people each year. The video describes how people often lose their homes when rent becomes too expensive. Since we know from earlier that the median rent in New York City generally got more expensive over time, it's not surprising that homelessness also increased. In fact, we can see this in the graph on the right. In the equation of the homeless vs. rent line, the slope is 11.05. This suggests that for every dollar that the annual rent increases, another 11.05 people experience homelessness!

In general, when rent goes up in a city, homelessness goes up. And when median income goes up, rent goes up. This suggests that if we graphed a city's homeless population vs. its median income, the graph would go up; in other words, as a city's typical 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.

#### Teacher Tip

Of the 500,000 people who experience homeless at any given moment, many are students. It's possible that some of your students have experienced homelessness or are currently. Please be sure to approach this question with an extra level of sensitivity. One way to do this is to avoid referring to "homeless people" and to instead refer to "people experiencing homelessness." Not only does this depersonalize the situation, but it's also more accurate. The 500,000 figure is what's known as a "Point-in-Time" figure; it's the number of people who are without permanent shelter at a given moment. The upside is that most of these people find housing relatively quickly. The downside is that this means that over the course of an entire year, far more than 500,000 people in America will experience homeless at some point.

- 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.”

If you were the mayor of a city or town, what factors would you consider in deciding whether to recruit a company like Amazon to your area, and how would you prevent or address negative consequences like homelessness?

*Answers will vary about who students think should be most responsible for ensuring that people have access to safe and affordable housing. Some may argue that the government has a responsibility to build shelters for people in the community, while others may argue that if someone can no longer afford to live in a city, they would be better off if they moved to somewhere more affordable. Other students might reason that if a company moves to town and pays high salaries that cause rents to go up, then they may have a role to play in addressing homelessness, too. (One of the videos highlights the increase in homelessness in Seattle, which is where Amazon is based.)*

*In terms of what students can do to help alleviate homelessness and homelessness-related issues, suggestions may range from the policy-related to the more personal. These may include:*

- *contact local leaders to request that any new housing developments include affordable housing for low-income residents*
- *build high-quality homeless shelters, preferably with job training and other services*
- *volunteer at homeless shelters and soup kitchens*
- *set aside a certain amount of money to donate to homeless people on the street each day*
- *according to the Pope, one of the most valuable things people can do is to always say hello to homeless people on the street, making sure to look them in the eye*

#### Teacher Tip

The homeless figures in the handouts are for the total number of people experiencing homelessness in New York City, Los Angeles, and Seattle. However, the teacher interactive online includes even more information. In addition to “total homeless,” it includes data on “sheltered homeless” and “unsheltered homeless.” Even though the lesson doesn’t specifically require it, consider taking a few minutes to look more closely at how homelessness differs in each city. In New York, almost all of the growth in the homeless population has been *sheltered*; New York has a law that requires the city to provide a bed for anyone who needs one. California does not, and almost all of the growth in homelessness there has been in the *unsheltered* population. In fact, while total homelessness has gone up in LA since 2010, sheltered homelessness has actually gone down.