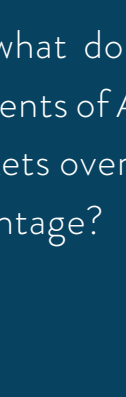


WHAT HAPPENS WHEN AMAZON HQ2 COMES TO ARLINGTON, VA, & LONG ISLAND CITY, NY?

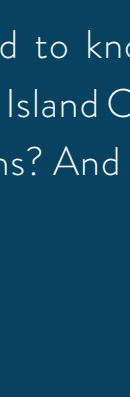


We've been keeping a close eye on Amazon over the last 14 months as it took applications from cities across the country and weighed options for the location of its second headquarters. But we weren't expecting this curve ball: Amazon plans to split HQ2 between two cities, Arlington, VA, and Long Island City, NY.

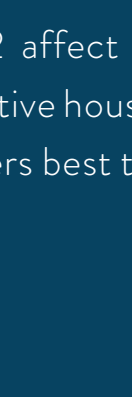
So how will the global retailer transform the cities it will soon call its second homes, and how big of a missed opportunity will it be for the original contending cities?



50,000 HIGH-PAYING JOBS¹



\$5 BILLION IN INVESTMENTS¹



INCREASED HOME VALUES²

Quantarium, the artificial intelligence arm of Mr. Cooper, the nation's largest non-bank mortgage servicer and a leading mortgage lender, reanalyzed the housing markets that Amazon considered for HQ2, and its two winners Long Island City and Arlington (Toronto and Northern Virginia are missing due to lack of data). The resulting data shows the potential for a positive impact to property values for the cities chosen to host the new HQ2 – but among the cities that did not win, the lost opportunity could still carry some weight.

So, what do homeowners need to know? How will HQ2 affect the residents of Arlington and Long Island City and their respective housing markets over the next 18 months? And how can homeowners best take advantage?

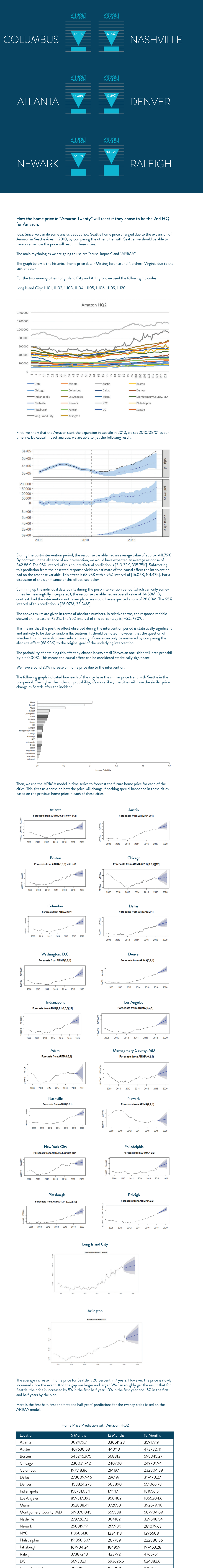
ESTIMATED PROPERTY VALUES IN THE AMAZON HQ2 CITIES²

IN MARCH 2019, SEPTEMBER 2019, AND MARCH 2020
(See analysis below)



For the two winning cities, Long Island City and Arlington: These two cities have huge differences in GDP and population, among other things. Both cities are very different from Seattle.

For those cities that didn't win the HQ2 bidding war, well...the loss could be pretty substantial over the next 18 months. Amazon would've brought 50,000 additional residents and \$5 billion in investments to the winning city, so each of the cities that entered a bid has lost at least some potential for an uptick in home values (not to mention the glory of hosting one of the world's biggest online retailers).



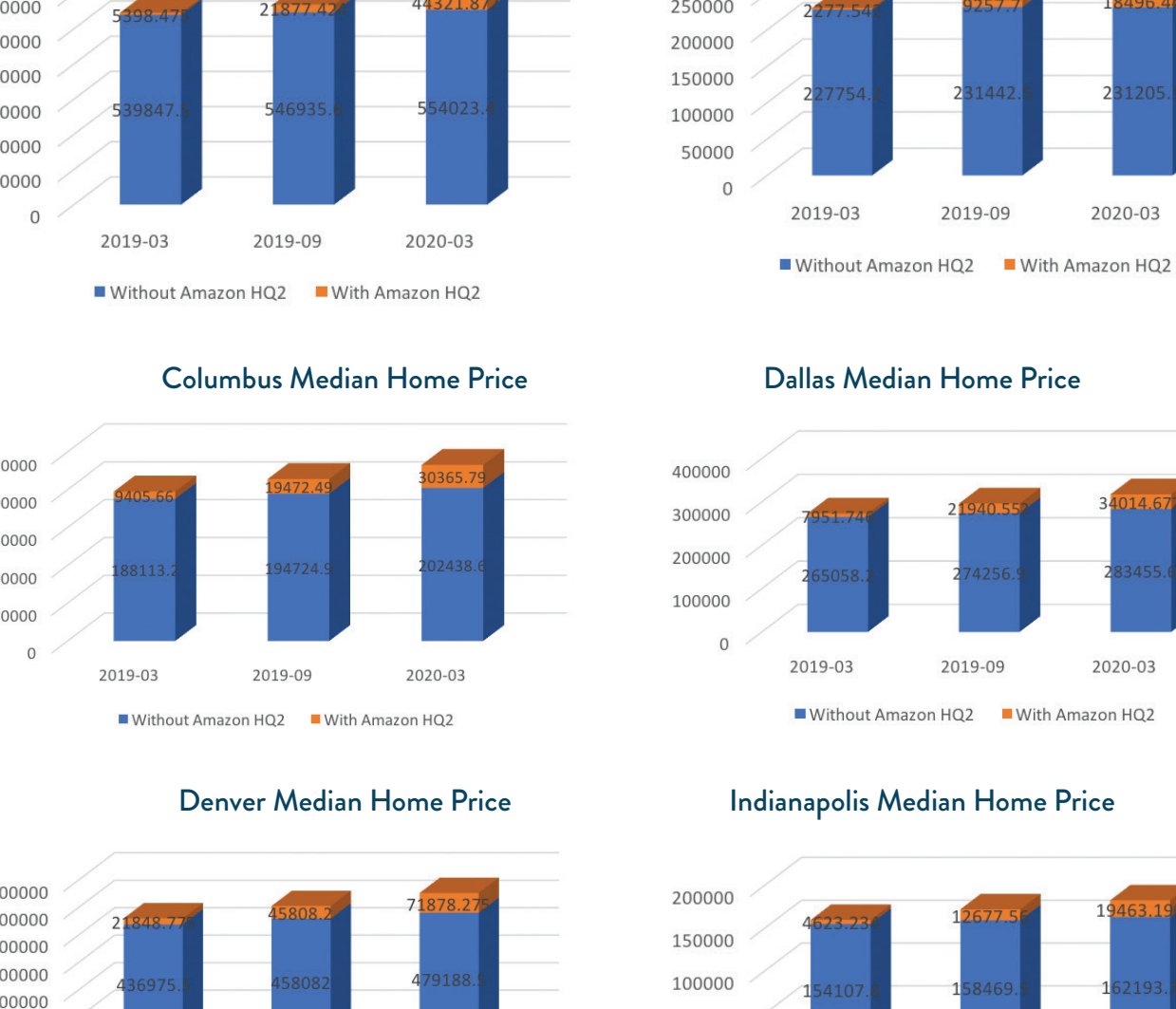
How the home price in "Amazon Twentys" will react if they chose to be the 2nd HQ for Amazon.

Idea: Since we can do some analysis about how Seattle home price changed due to the expansion of Amazon in Seattle Area in 2010, by comparing the other cities with Seattle, we should be able to have a sense how the price will react in these cities.

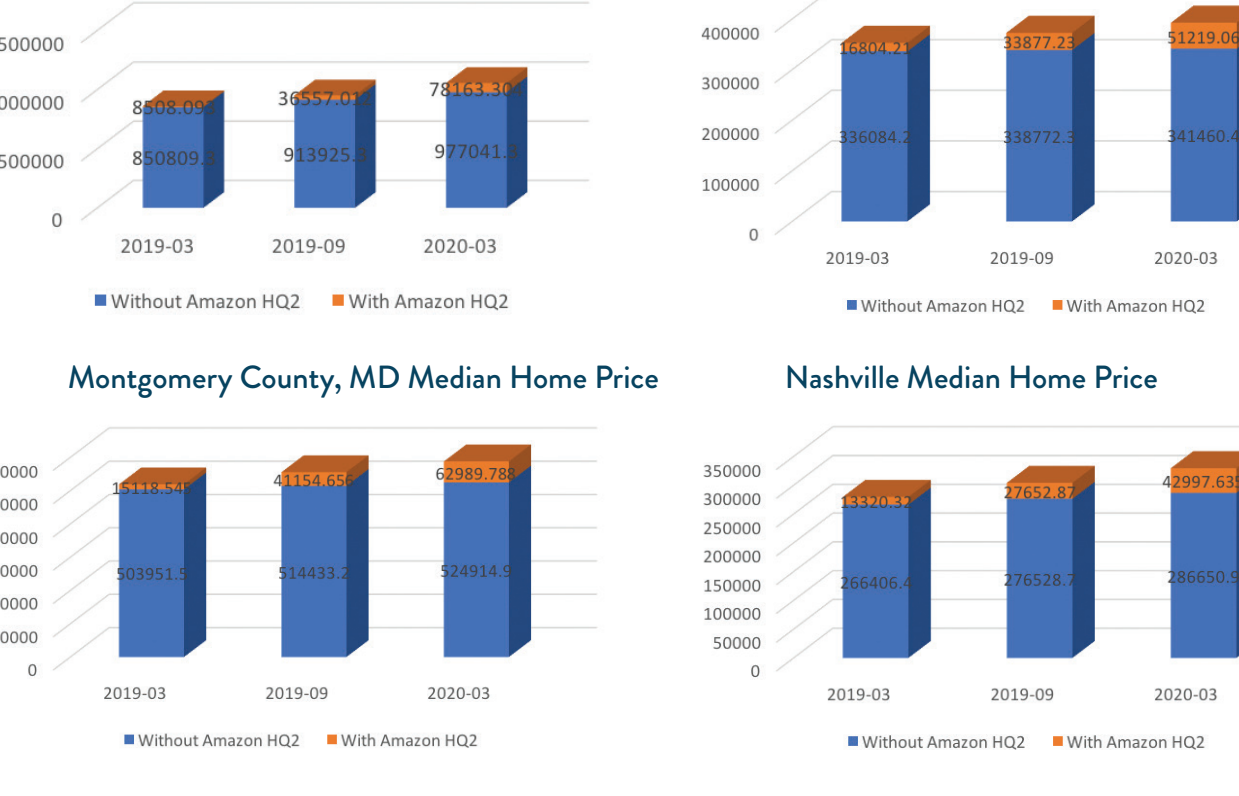
The main mythologies we are going to use are "casual impact" and "ARIMA".

The graph below is the historical home price data. (Missing Toronto and Northern Virginia due to the lack of data)

For the two winning cities Long Island City and Arlington, we used the following zip codes:
Long Island City: 11101, 11102, 11103, 11104, 11105, 11106, 11109, 11120



First, we know that the Amazon started the expansion in Seattle in 2010, we set 2010/09/01 as our timeline. By causal impact analysis, we are able to get the following result.



During the post-intervention period, the response variable had an average value of approx. 411.79K. By contrast, in the absence of an intervention, we would have expected an average response of 342.86K. The 95% interval of this counterfactual prediction is [310.32K, 395.75K]. Subtracting this prediction from the observed response yields an estimate of the causal effect of the intervention had on the response variable. This effect is 68.93K with a 95% interval of [16.05K, 101.47K]. For a discussion of the significance of this effect, see below.

Summing up the individual data points during the post-intervention period (which can only sometimes be meaningfully interpreted), the response variable had an overall value of 34.59M. By contrast, had the intervention not taken place, we would have expected a sum of 28.80M. The 95% interval of this prediction is [26.07M, 33.24M].

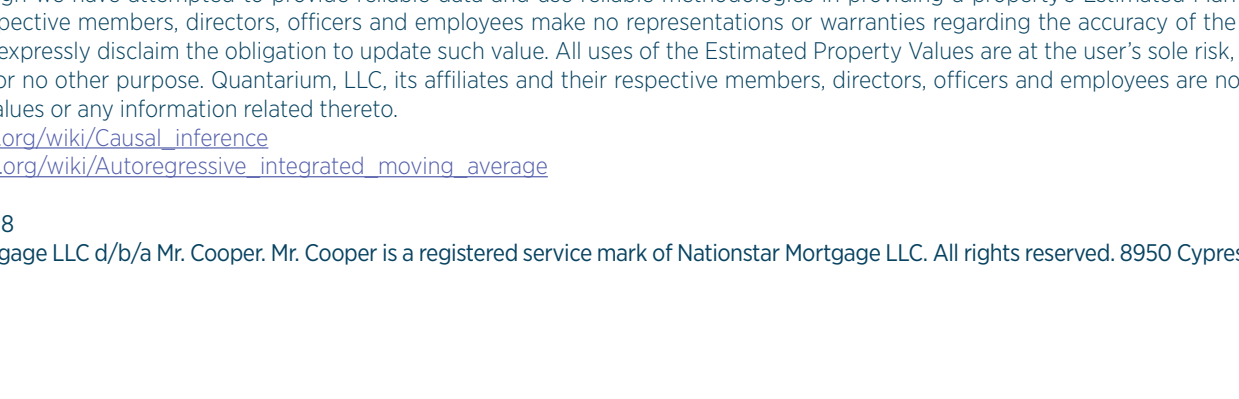
The above results are given in terms of absolute numbers. In relative terms, the response variable showed an increase of +20%. The 95% interval of this percentage is [+5%, +30%].

This means that the positive effect observed during the intervention period is statistically significant and unlikely to be due to random fluctuations. It should be noted, however, that the question whether this increase also bears substantive significance can only be answered by comparing the absolute effect (68.93K) to the original goal of the underlying intervention.

The probability of obtaining this effect by chance is very small (Bayesian one-sided tail-area probability p = 0.003). This means the causal effect can be considered statistically significant.

We have around 20% increase on home price due to the intervention.

The following graph indicated how each of the city have the similar price trend with Seattle in the pre period. The higher the inclusion probability, it's more likely the cities will have the similar price change as Seattle after the incident.



Then, we use the ARIMA model in time series to forecast the future home price for each of the cities. This gives us a sense on how the price will change if nothing special happened in these cities based on the previous home price in each of these cities.

The average increase in home price for Seattle is 20 percent in 7 years. However, the price is slowly increased since the event. And the gap was larger and the larger. We can roughly get the result that for Seattle, the price is increased by 5% on the first half year, 10% in the first year and 15% in the first and half years by the plot.

Here is the first half, first and first and half years' predictions for the twenty cities based on the ARIMA model.

Location	6 Months	12 Months	18 Months
Atlanta	302475.7	330511.28	359177.9
Austin	407630.58	440113	473782.41
Boston	545245.975	568813	598345.27
Chicago	230031.742	240700	249701.94
Columbus	197518.86	214197	232804.39
Dallas	273009.946	296197	317470.27
Denver	458824.275	503890	551066.78
Indianapolis	158731.034	171147	181656.5
Los Angeles	859371.393	950482	1055204.6
MIami	352888.41	372650	392679.46
Montgomery County, MD	191070.045	555588	587904.69
Nashville	279726.72	304182	329648.54
Newark	250319.19	265980	281079.63
NYC	1185051.18	1234418	1296608
Philadelphia	191360.507	207789	222880.56
Pittsburgh	167904.24	184959	197453.28
Raleigh	373872.18	423792	476576.61
DC	569302.1	593262.6	624382.6
Long Island City	988216.3	1053015	1115282
Arlington, VA	682562.2	745076.1	824887.6

Based on the similarity measure, which includes population, GDP etc. between each of these cities and Seattle, we can make reasonable coefficient assumption in front of each of the cities.

For NYC, LA, Chicago, DC and Boston, they will have the smallest reaction to be the HQ2 for Amazon. This cities already have relatively high GDP and populations. Moreover, there are many big companies already in such cities.

For Dallas, Montgomery County, MD, Philadelphia and Indianapolis, these cities will be expected to have a modest reaction to become the HQ2.

For Newark, Raleigh, Atlanta, Miami, Nashville, Austin, Columbus, Pittsburgh and Denver. These cities are more likely have a huge leap in their housing market based on the current local economy.

For the two winning cities Long Island City and Arlington. These two cities have huge different on GDP, population etc. Both cities are very different from Seattle. Long Island City has a much larger population while Arlington only has a very low population. We believe the Amazon will have more impact on housing price in Arlington than in Long Island City.

Here is how the data visualized for each of the city:

1. <https://www.businessinsider.com/amazon-hq2-jobs-2018-3>
 2. The Estimated Property Values, by market, are computer-generated estimates of the designated housing markets' value using both the application of ARIMA and Causal Analysis models and Quantarium's proprietary mathematical formulas and techniques for the stated time periods. Values for several of the markets being considered by Amazon have not been evaluated due to the lack of data. The data collected in order to develop the Estimated Property Values is taken from local government records and is deemed reliable, but not guaranteed.
 The data and information derived from the data utilized in the Estimated Property Values is provided on an "AS AVAILABLE" and "AS IS" basis and is provided for informational purposes only. Although we have attempted to provide reliable data and use reliable methodologies in providing a property's Estimated Market Value, Quantarium, LLC, its affiliates and their respective members, directors, officers and employees make no representations or warranties regarding the accuracy of the Estimated Property Values on any specific date and expressly disclaim the obligation to update such value. All uses of the Estimated Property Values are at the user's sole risk, and shall be for personal non-commercial use and for no other purpose. Quantarium, LLC, its affiliates and their respective members, directors, officers and employees are not liable for the accuracy of the Estimated Property Values or any information related thereto.
 3. https://www.wikipedia.org/wiki/Causal_inference
 4. https://www.wikipedia.org/wiki/Autoregressive_integrated_moving_average

