

**CONTENDING WITH AMAZON'S RISE:
CAUSAL EFFECT OF AMAZON FULFILLMENT CENTERS
ON LOCAL LABOR MARKETS**

by

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I. INTRODUCTION¹

In 2017, 43% of all online sales within the United States involved Amazon.² In the same year, 64% of American households were subscribed to Amazon Prime, the e-commerce giant's flagship paid subscription service that affords customers free two-day delivery amongst other services.³

Clearly, the economic impact of Amazon on the American economy is immense. However, so are the government subsidies the company receives. By the end of 2016, Amazon was the recipient of just over \$1 billion in state and local subsidies.⁴ The primary reason behind such high levels of tax exemptions and credits was the company's promise of bringing new jobs into local communities through the expansion of its distribution network across the United States. With such development projects including the construction of numerous facilities such as sortation and mailing centers, some of which span as much as over 1,000,000 square feet,⁵ Amazon's employment creation is indisputable.

However, an increase in aggregate employment creation does not necessarily equate to a net increase in employment. For example, Amazon announced the expansion of 6,000 new jobs across 19 of its fulfillment centers, which consist mainly of distribution and storage warehouses, on May 26, 2015.⁶ However, if the majority of these jobs were simply employee relocations from other

¹ Much of this section has been drawn from a preliminary version of this thesis, "Contending with Amazon's Rise: Causal Effect of Amazon Fulfillment Centers on Local Labor Markets", submitted for a separate class.

² Shep Hyken, "Sixty-Four Percent Of U.S. Households Have Amazon Prime," Forbes, <https://www.forbes.com/sites/shephyken/2017/06/17/sixty-four-percent-of-u-s-households-have-amazon-prime/#639dc5694586>.

³ Shep Hyken, "Sixty-Four Percent Of U.S. Households Have Amazon Prime"

⁴ Michael J. Bologna, "Amazon Close to Breaking Wal-Mart Record for Subsidies," Bloomberg Tax, <https://www.bna.com/amazon-close-breaking-n57982085432/>.

⁵ Marc Wulfraat, "Amazon Fulfillment Center Network," MWPVL International, http://www.mwpvl.com/html/amazon_com.html.

⁶ Jessica Bruder, "With 6,000 New Warehouse Jobs, What Is Amazon Really Delivering?" Reuters, <http://blogs.reuters.com/great-debate/2015/06/17/with-6000-new-warehouse-jobs-what-is-amazon-really-delivering/>.

Amazon fulfillment centers, the net increase in jobs would have been significantly lower than 6,000. Such a scenario may very well be the case regarding Amazon's fulfillment centers, which is a cause for worry as net employment creation is the driving motivator behind the subsidies provided by local governments. To address this concern, this research paper investigates the nature of the causal impact of Amazon fulfillment centers on local employment and wages within the warehousing and storage industry.

To summarize key findings, this paper found that Amazon fulfillment centers do seem to have a positive causal impact not only on the total employment, but also on average annual wages within the warehousing and storage industry at the county level. Counties with Amazon fulfillment centers tend to exhibit higher levels of employment and annual wages after the opening of such centers. Furthermore, the paper found that this observed positive effect on employment was intensified by additional openings of fulfillment centers, and that such effects were heightened in counties with relatively lower population densities.

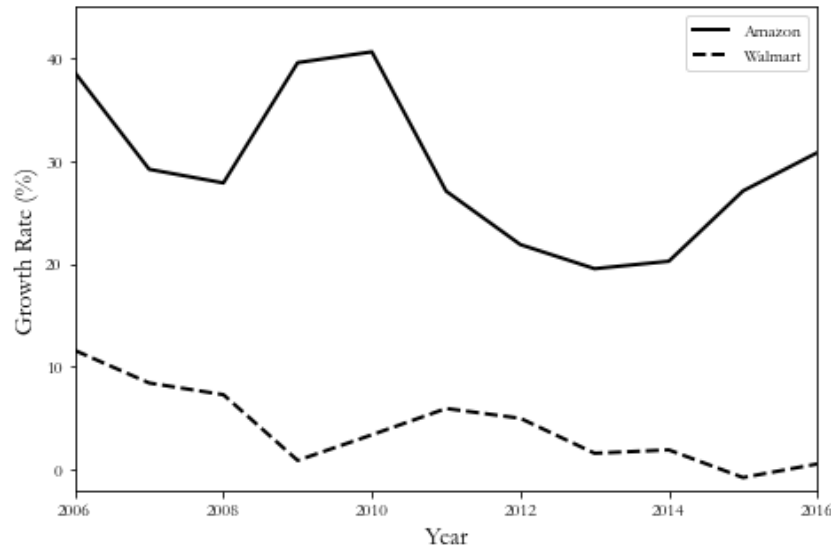
Background of Amazon

Since its founding in 1994, Amazon has grown to become one of the largest online retailers in the world. This ascension essentially started in 2005, when the company introduced its aforementioned Prime membership, which helped increase its net revenue from \$6.92 billion in 2004 to \$177.86 billion in 2017.⁷ Amazon's consistently soaring growth rate can be better understood when compared to the world's largest retailer, Walmart. While Amazon's average growth rate from 2006

⁷ "Amazon: Annual Revenue 2017," Statista, <https://www.statista.com/statistics/266282/annual-net-revenue-of-amazoncom/>.

to 2016 was around 30% per year, Walmart's has stagnated to around 0% in recent years.⁸ This is depicted in *Figure 1* below.

Figure 1. Yearly Growth Rate of Net Revenue of Amazon and Walmart from 2006-2016



While this growth has undeniable benefits to the American economy, it is also surrounded by underlying concerns such as the aforementioned issues of net employment creation. As one indicator of these concerns, Amazon recently became a prime target of the newly proposed BEZOS Act, a proposed law that aims to tax companies for all benefits their workers receive from government assistance programs.⁹ This is due to claims that Amazon's fulfillment center workers are paid below industry standards, and must therefore depend on food stamps.

Seemingly in response, Amazon announced shortly afterwards it was increasing the minimum wage of all its fulfillment center workers to an hourly compensation of \$15.¹⁰ Despite the general

⁸ "Walmart's Revenue 2006-2018," Statista, <https://www.statista.com/statistics/183399/walmarts-net-sales-worldwide-since-2006/>.

⁹ Jillian D'Onfro, "Bernie Sanders Introduces the BEZOS Act, Slamming Amazon's Low Wages," CNBC, <https://www.cnbc.com/2018/09/05/bernie-sanders-introduces-the-bezos-act-slamming-amazon-low-wages.html>.

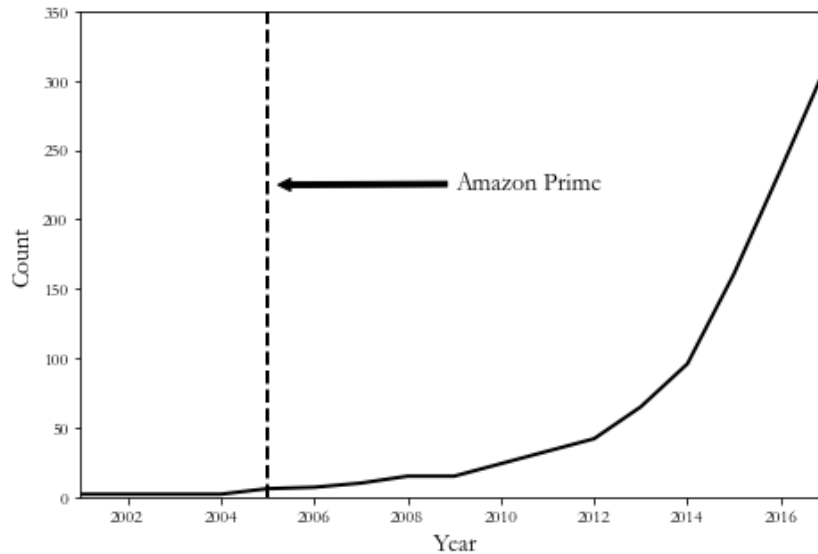
¹⁰ Karen Weise, "Amazon to Raise Minimum Wage to \$15 for All U.S. Workers," The New York Times, <https://www.nytimes.com/2018/10/02/business/amazon-minimum-wage.html>.

public receiving this news positively, many fulfillment center workers voiced their dissatisfactions. This was most likely a consequence of the elimination of monthly bonuses and stock grants that followed the rise in minimum wage, which employees fear will decrease their total compensation.¹¹

However, these allegations surrounding the mistreatment of Amazon fulfillment workers seem to be at odds with the company's own claims. According to Amazon, their fulfillment center employees are paid 30% higher wages than traditional retail stores, receive comprehensive benefits that cover health insurance and 401(k) matching, and are almost all full-time employees.¹² These seemingly different statements provide further support for the aim of this research paper.

Fulfillment Centers

Figure 2. Number of Amazon Fulfillment Centers from 2001 - 2017



¹¹ Karen Weise, "Why Some Amazon Workers Are Fuming About Their Raise," The New York Times, <https://www.nytimes.com/2018/10/09/technology/amazon-workers-pay-raise.html>.

¹² "Amazon Fulfillment Center Tours," Amazon, <http://amazonfctours.com/>.

Despite the concerns surrounding Amazon fulfillment centers, the company has been able to significantly expand its distribution network in recent years; and similar to its net revenue, the number of fulfillment centers seems to be growing at an exponential-like rate. This is shown in *Figure 2* below, which shows that there were only 6 fulfillment centers across the United States in 2005, when Amazon Prime was launched, but over 300 by 2017.¹³

These fulfillment centers also come in many different forms. While the majority are sortation centers that stock items ranging from smaller items such as books and watches to larger ones like beds, there are fulfillment centers with specific purposes such as Prime Now Hubs that stockpile popular items in metropolitan cities to ensure delivery within hours of order placement.¹⁴ Other examples include fulfillment centers that are specifically responsible for processing all Amazon customer returns, managing vendor products, and even storing frozen merchandise.¹⁵ These classifications are important mainly due to their variance in size. For example, while large sortation centers regularly exceed 1,000,000 square feet in size, Prime Now Hubs are on average much smaller, with some being as small as approximately 10,000 square feet.¹⁶

Another relevant feature of these fulfillment centers is that they tend to be clustered in highly-populated areas. Of the 92 counties with fulfillment centers in this paper's preliminary study, which will be detailed in later sections, 89 were classified as being part of metropolitan statistical areas. Because of this, many counties had several fulfillment centers, which are shown in *Table 1* below.

¹³ Marc Wulfraat, "Amazon Fulfillment Center Network"

¹⁴ Marc Wulfraat, "Amazon Fulfillment Center Network"

¹⁵ Marc Wulfraat, "Amazon Fulfillment Center Network"

¹⁶ Marc Wulfraat, "Amazon Fulfillment Center Network"

Table 1. County Distribution by Number of Amazon Fulfillment Centers

Number of Amazon Fulfillment Centers	Number of Counties
1	35
2	25
3	13
4	6
5 or more	13
Total	92

Relevant Literature

There have been many studies that have attempted to answer similar questions to the ones posed by this paper. Emek Basker's "Job Creation or Destruction? Labor-Market Effects of Wal-Mart Expansion" is such an example.¹⁷

In it Basker investigates the causal effects of Wal-Mart's entry on a county's labor market by determining the short- and long-term employment effects of its retail stores. She finds that while there is a short-term increase of 100 retail jobs upon a Wal-Mart entry, the increase is reduced to 50 within five years. Furthermore, this increase is made insignificant when factors such as the retail employment of neighboring counties and wholesale employment are factored in. Basker's study is significant in the sense that it faces many of the same endogeneity issues this paper faces, and that it provides solid methods for dealing with such issues.

¹⁷ Emek Basker, "Job Creation or Destruction? Labor Market Effects of Wal-Mart Expansion," MIT Press Journals, accessed May 3, 2019, <https://www.mitpressjournals.org/doi/abs/10.1162/0034653053327568>.

However, Basker’s study was conducted in 2002, and the retail industry differs from the warehousing industry in many significant ways. A more relevant study is “Unfulfilled promises: Amazon fulfillment centers do not generate broad-based employment growth” by Janelle Jones and Ben Zipperer at Economic Policy Institute.¹⁸ First published in February 2018, this study most likely represents the most recent literature on the causal impact of Amazon fulfillment centers on the local employment within counties. The study concluded that while the establishment of an Amazon fulfillment center did result in an increase in employment within the warehousing industry, the same did not hold when observing county-level employment. An explanation for this result offered by the study was the likely displacement of incumbent jobs, resulting in an undermining of the case for the government subsidies Amazon received and is projected to receive.

While the study conducted by Jones and Zipperer provides a solid foundation for, and perhaps comes closest to shedding light on the questions asked by this study, it approaches the issue through only an employment perspective. The causal effect of Amazon fulfillment centers on the wage levels must also be understood to complete the picture, which will be one of the aims of this paper.

Preliminary Study

To ensure the legitimacy of this paper’s data, a preliminary difference-in-differences study was conducted to compare results with the existent literature. It found that counties with newly opened Amazon fulfillment centers experienced employment growth within the transportation and warehousing industry by almost 10% more than the average county after 2 years. The opposite

¹⁸ “Unfulfilled Promises: Amazon Fulfillment Centers Do Not Generate Broad-Based Employment Growth,” Economic Policy Institute, accessed May 3, 2019, <https://www.epi.org/publication/unfulfilled-promises-amazon-warehouses-do-not-generate-broad-based-employment-growth/>.

effect was observed for wages, with average annual wages within a similar timeframe decreasing as much as 2% more in counties with an Amazon fulfillment center than the average county. Furthermore, these effects seemed to be exacerbated in urban counties when compared to non-urban ones. However, it is important to note that while this preliminary study utilized data on the transportation and warehousing industry, later analyses used data specifically on the warehousing and storage industry. This is because the transportation and warehousing industry includes sectors largely unrelated to Amazon's business such as air transportation and postal services.

To attain these preliminary results, 111 counties that had been exposed to at least one Amazon fulfillment center were identified. However, this list had to be trimmed as data on the employment and average wage levels were not available for some counties during specific years. Furthermore, since this study utilized years after the opening of an Amazon fulfillment center, any counties that were first exposed to Amazon's presence after 2015 were dropped as the data set contained data from 2001 to 2017 only. After this process, there were 92 counties with Amazon fulfillment centers, which the paper will refer to as "treated counties", that were compatible with the difference-in-differences analyses.

For each of these 92 treated counties, the employment and average wage levels were normalized from two years before to two years after the treatment of a fulfillment center. The base year was set as the year prior to the opening year as the majority of employment created from a new fulfillment center typically occurs very shortly after its opening. Furthermore, for counties that were treated with more than one fulfillment center during the 2001 to 2017 period, only the earliest opening year was used. This is was to ensure that the years before the base year were not affected by any prior fulfillment centers. These 92 different normalized figures of employment and average

wage levels were then used to conduct analyses such as the average employment level change within treated counties.

An identical methodology was then applied for the control group, which in this case was all counties within the United States, using the same base years as the treated counties.

Figure 3. Average Standardized Levels of Transportation and Warehousing Employment upon Opening of an Amazon Fulfillment Center

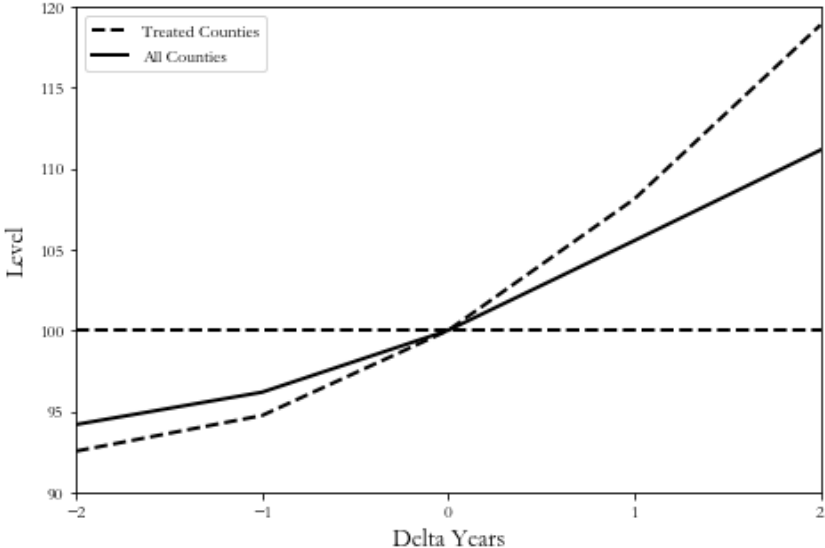
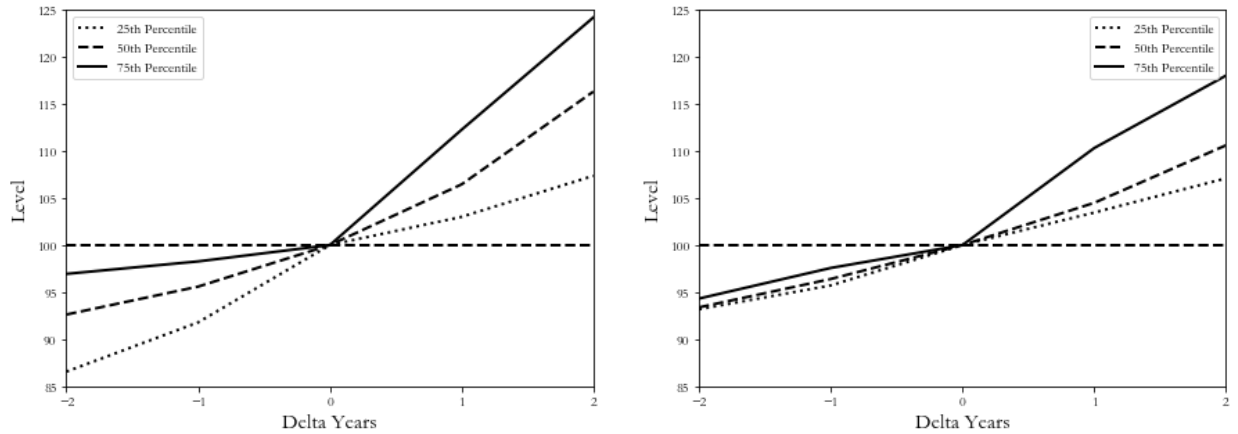


Figure 3 above shows the average level change in employment upon the opening of an Amazon fulfillment center and presents a preliminary case that these centers do seem to have a positive causal impact on local employment.

This is because while treated counties exhibited very similar average employment levels to all counties in the years preceding the opening of a fulfillment center, once a center opened treated counties experienced strictly higher growth in employment levels. More specifically, we see that treated counties on average experienced around 10% higher employment levels than the average county two years after the opening of a fulfillment center.

A similar analysis was then conducted investigating the interquartile ranges of employment levels for treated and all counties, shown in *Figure 4* and *Figure 5* below.

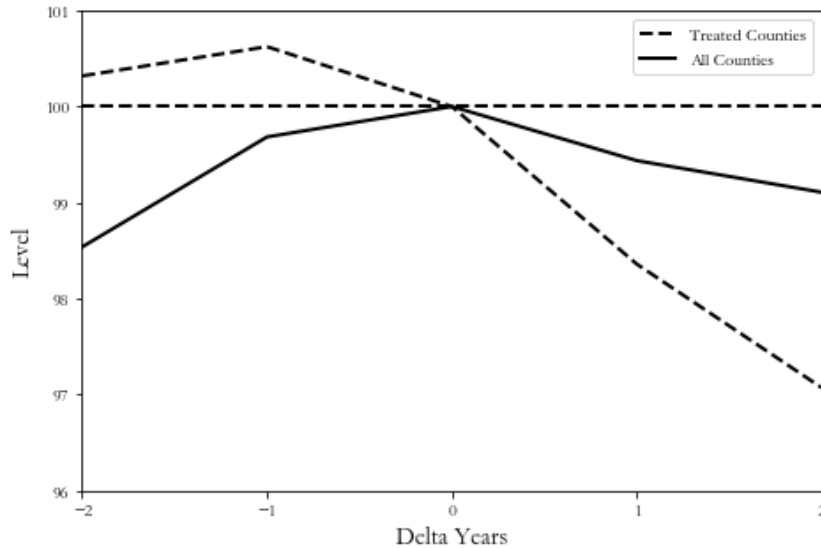
Figure 4 & 5. Interquartile Ranges of Standardized Transportation and Warehousing Employment for Treated (Left Figure) and All Counties (Right Figure)



These figures suggest that employment levels within the transportation and warehousing industry experienced a general upwards trend in recent years. This is shown by how the 75th percentile of employment levels in the years preceding treatment remained below the base year, and how the 25th percentile of employment levels in the years following treatment were above the base year.

Figure 6 below shows a similar analysis, except with average annual wages instead of employment. However, this result is more interesting for two main reasons. The first is that the figure seems to suggest Amazon fulfillment centers have a negative association with local average annual wages. This is supported by how the average annual wages in treated counties decrease substantially more than in the average county after the opening of a fulfillment center.

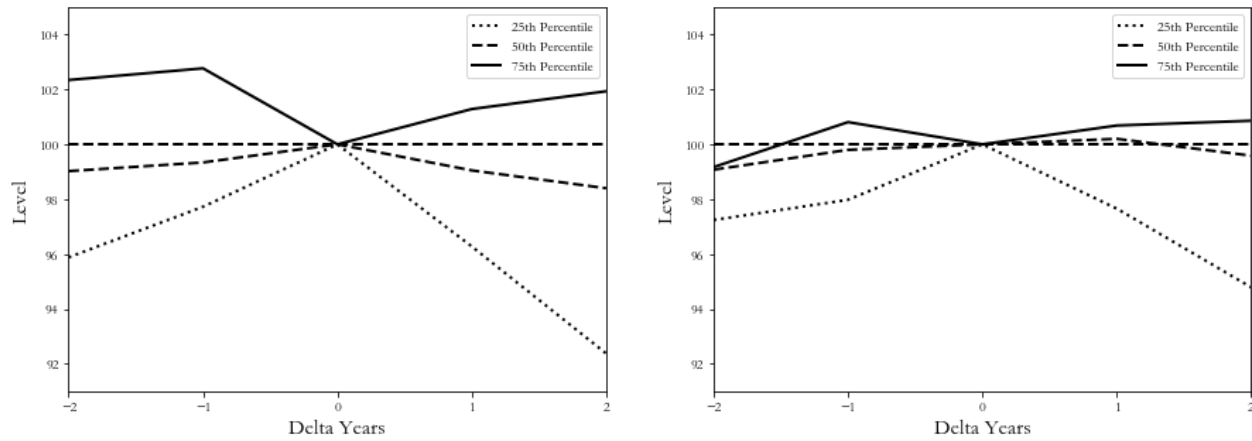
Figure 6. Average Standardized Levels of Transportation and Warehousing Annual Wages upon Opening of an Amazon Fulfillment Center



The second reason is that the figure shows a possible tendency for Amazon to locate in counties with already decreasing levels of annual wages. While all counties exhibited slight increases in annual wages in the years preceding treatment, treated counties actually showed decreases in annual wages during these years.

To gain further insight into this issue, a similar analysis was conducted on the interquartile ranges of annual wages for treated and all counties in *Figure 7* and *Figure 8* below. *Figure 7* suggests that the results from *Figure 6* seem to be driven by particularly high 75th percentiles in the years preceding treatment, and low 25th percentiles in the years following treatment. Furthermore, it also shows that the causal impact of fulfillment centers on the annual wages is less clear or, at the very least, weaker than the impact on employment. This is because the interquartile range of annual wages contained the base level for both years preceding and following treatment.

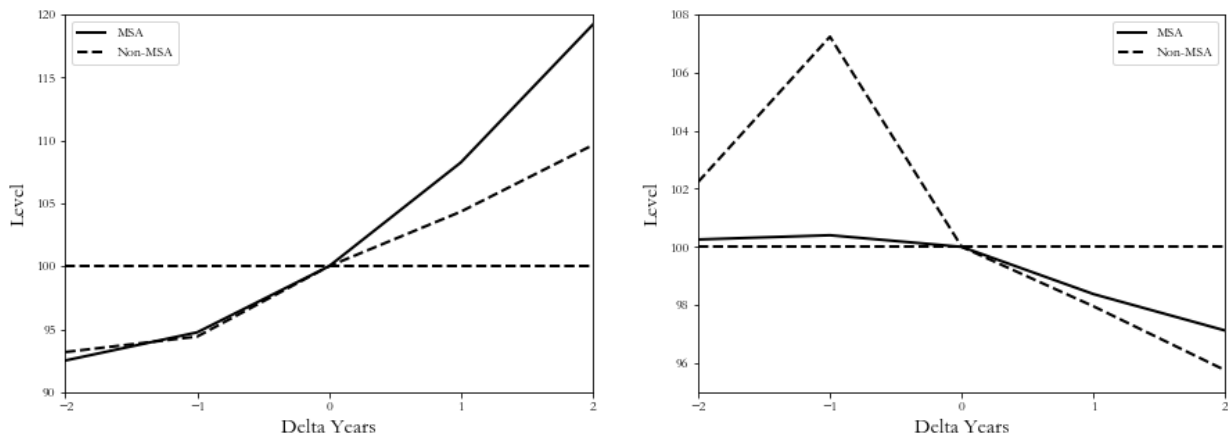
Figures 7 & 8. Interquartile Ranges of Standardized Transportation and Warehousing Annual Wages for Treated (Left Figure) and All Counties (Right Figure)



In an attempt to briefly gain insight on the differences between urban and non-urban counties, we also conducted similar analyses for treated counties that were metropolitan statistical areas and ones that were not. Metropolitan statistical areas are regions that have high levels of population density and economic integration with nearby regions, whereas micropolitan statistical areas are regions in an urban cluster with populations between 10,000 and 50,000. These results, shown in *Figure 9* and *Figure 10* below, suggest that urban counties benefit more from the establishment of an Amazon fulfillment center.

However, it is important to note that these results are not as statistically robust as the previous figures. This is because of the 92 treated counties, 89 of them were classified as being part of metropolitan statistical areas, with only 3 being in either micropolitan statistical areas or neither. This issue becomes clear in *Figure 10*, where the non-metropolitan statistical area counties seem to have unrealistically volatile levels of wage level change.

Figure 9 & 10. Average Standardized Levels of Transportation and Warehousing Employment (Left Figure) and Average Annual Wages (Right Figure) for Treated MSA/Non-MSA Counties



Academic and Practical Significance

The main significance of this research paper rests with the ambiguity of Amazon’s net employment creation. An in-depth analysis of this issue would allow policymakers to ascertain if their efforts in attracting Amazon fulfillment centers are effective, or whether they should focus on improving their public goods like health care and education instead.

An additional timely significance of this paper comes from Amazon’s recent decision to raise its minimum wage. In such situations, companies may be incentivized to hire fewer employees or seek more efficient forms of automated labor to compensate for new costs. These scenarios seem to be supported by Amazon’s recent investments in warehouse automation technology.¹⁹ Understanding the current relationship between Amazon fulfillment centers and local labor markets may help determine the validity of these concerns.

¹⁹ Jessica Bruder, "With 6,000 New Warehouse Jobs, What Is Amazon Really Delivering?"

II. DATA & METHODOLOGY

Endogeneity and Other Sources of Biases

As evidenced by the previous papers detailed in the literature review, studies that aim to estimate the causal effects of the openings of establishments in select locations have many potential biases that must be considered. This study is no different, and the most prevalent issue is one of endogeneity regarding Amazon's choice in deciding which county to establish their fulfillment centers.

This is because it is extremely unlikely that Amazon is randomly choosing the locations of its fulfillment centers. Fulfillment centers are primarily used to facilitate the efficient storage and transportation of goods, and for a company that distinguishes itself on its quick services like Amazon the location of their fulfillment centers will be crucial in maximizing this efficiency. Because of this Amazon most likely has its own strategic criteria when choosing in which counties to establish its fulfillment centers. Evidence of this can be seen from the preliminary study, where almost all of the counties in which Amazon fulfillment centers have been established were metropolitan statistical areas, suggesting Amazon's preference for relatively highly-populated counties. These unobservable tendencies will bias the results of this paper's analyses if left unaccounted for, and thus must be addressed.

To address this problem, this paper uses the number of Whole Foods retail stores in a given county as an instrumental variable. This is because among Whole Foods's target demographics are millennials, young families, and recent college graduates,²⁰ which are all groups of people who

²⁰ Mounica Vennamaneni, "Whole Foods Market, Marketing Strategies and Programs Analysis," Medium, <https://medium.com/@mounicav/whole-foods-market-marketing-strategies-and-programs-analysis-53d6f12b6055>.

would likely be frequent users of online services like Amazon. In other words, an average Whole Foods consumer would likely be similar to the average Amazon consumer. The paper uses this reasoning to assume that Amazon and Whole Foods both use similar cost-benefit analyses when deciding to locate to a county. Therefore, the likelihood of Amazon locating their fulfillment centers in counties with Whole Foods retail stores is higher than in counties without. However, there is no reason to assume that other warehouses would have the same target demographic as Whole Foods, and thus would be relatively unaffected by the number of Whole Foods stores in a county. If this assumption is true, then the presence of Whole Foods stores would affect county-specific employment and annual wages within the warehousing and storage industry mainly through its influence on Amazon fulfillment centers, qualifying it as a suitable instrumental variable.

Furthermore, there are other biases existent such as the aforementioned issue of not being able to accurately identify the source of any changes in county-level employment or wages. This is because there are numerous ways in which a change in employment or wage levels of a county can be unrelated to the establishment of an Amazon fulfillment center. For example, it may just be the case that during the years following the establishment of an Amazon fulfillment center in a certain county, the region as whole experiences high levels of economic growth for reasons completely unrelated to Amazon. Such a scenario, while hypothetical, is entirely possible and would result in the overestimation of the causal impact of Amazon fulfillment centers on local labor markets. To account for these issues, the paper utilizes two-way fixed effects regressions, which will be detailed later in the paper.

These are examples of such biases that this paper will attempt to address when conducting its empirical analyses.

Sources of Data

To conduct the analyses required to answer the aforementioned questions, this research paper utilized data from seven main sources: The Bureau of Economic Analysis, the Bureau of Labor Statistics, Economic Research Service, the United States Census Bureau, the Centers for Disease Control and Prevention, supply chain and logistics firm MWPVL International, and data company ScrapeHero.

The Bureau of Economic Analysis provides labor-related data specific to the county level on an annual basis.²¹ Using this data source, the paper was able to extract the total employment and average wages within the transportation and warehousing industry (NAICS 49) for all counties from 2001 to 2017, which was used for the aforementioned preliminary study. However, it is important to note that some counties were missing some data points for some years due to miscellaneous reasons such as the counties simply being too small. The data for such counties were excluded from this study for reasons of standardization and relevance, which the paper will explain later. The Bureau of Economic Analysis also provided data on the GDP of a county across the years 2012 to 2015.²² This paper uses this data as a potential control variable as it is likely that the income of a county is correlated with the number of Amazon fulfillment centers in a county. This is because Amazon would likely receive more demand for their products in counties where the residents can better afford their products and services.

Data on other potential control variables were provided by the Census Bureau, as well as the Economic Research Service. While the Census Bureau provided data on the age demographics of

²¹ "County, Metro and Other Local Areas," U.S. Bureau of Economic Analysis (BEA), <https://www.bea.gov/data/by-place-county-metro-local>.

²² "GDP by County," U.S. Bureau of Economic Analysis (BEA), n.d., <https://www.bea.gov/data/gdp/gdp-county>.

individual counties across the years from 2010 to 2017,²³ the Economic Research Service provided data on the education levels of individual counties across the years 2013 to 2017.²⁴ Using the Census Bureau data, the share of the population with ages between 20 and 39 for each county averaged across 2010 to 2017 was obtained. Using the Economic Research Service data, the share of the population who graduated from at least high school, and from some college, for each county averaged across 2013 to 2017 was obtained. These variables are well suited as potential control variables as young adults would likely be Amazon's target demographic as consumers, and education levels would likely have a strong correlation with the sales of Amazon's products.

While the Bureau of Economic Analysis provides data regarding the transportation and warehousing industry, the Bureau of Labor Statistics provides data specific to the warehousing and storage industry (NAICS 493) through the Quarterly Census of Employment and Wages.²⁵ Using this data source, the paper was able to extract the total employment and average wages within the warehousing and storage industry for all counties from 2001 to 2017. However, it is important to note that since this data is more granular than the data from the Bureau of Economic Analysis, there were fewer counties with complete data across all the years within the data set.

To classify counties as either urban or non-urban, the paper utilized data regarding metropolitan statistical areas, and population density from the Census Bureau,²⁶ as well as county population data from the Centers for Disease Control and Prevention.²⁷ The Census Bureau identified whether

²³ "County Population by Characteristics: 2010-2017," County Population by Characteristics: 2010-2017 (US Census Bureau, February 12, 2019), <https://www.census.gov/data/tables/2017/demo/popest/counties-detail.html>.

²⁴ "Educational Attainment for the U.S., States, and Counties, 1970-2017," USDA ERS, accessed April 26, 2019, <https://www.ers.usda.gov/data-products/county-level-data-sets/download-data/>.

²⁵ "Quarterly Census of Employment and Wages," U.S. Bureau of Labor Statistics, September 5, 2018, <https://www.bls.gov/cew/datatoc.htm>.

²⁶ "Core Based Statistical Areas (CBSAs), Metropolitan Divisions, and Combined Statistical Areas (CSAs)," US Census Bureau, <https://www.census.gov/geographies/reference-files/time-series/demo/metro-micro/delineation-files.html>.

²⁷ "Urban Rural Classification Scheme for Counties" (Centers for Disease Control and Prevention, n.d.), https://www.cdc.gov/nchs/data_access/urban_rural.htm.

counties were metropolitan statistical areas, micropolitan statistical areas, or neither. As mentioned before, metropolitan statistical areas are regions that have high levels of population density and economic integration with nearby regions, whereas micropolitan statistical areas are regions in an urban cluster with populations between 10,000 and 50,000.

Data on Amazon's fulfillment centers were sourced from MWPVL International, a specialized supply chain, logistics, and distribution firm.²⁸ This unique source details the location, year of opening, type, and size in square feet of all Amazon's fulfillment centers. Furthermore, this data from MWPVL International specifies the type of Amazon fulfillment centers, such as whether they are regular large sortation centers or Prime Now Hubs. Using this data on the fulfillment center types, it is possible to determine whether there is a significant difference between the types of fulfillment centers regarding their effect on local employment and wage. The data set also includes details on the number of fulfillment centers, although small, that have been either discontinued or merged with other larger centers.

Data regarding the instrumental variable used by this paper was sourced through ScrapeHero, a data collection company that compiles high quality data sets on retail store locations for many companies.²⁹ Using this source, the paper was able to obtain the number of Whole Foods retail stores in a given county in 2019.

Combining the aforementioned data, the data set constructed allows the tracking of the development of county-specific changes in average wages and employment within the

²⁸ Marc Wulfraat, "Amazon Fulfillment Center Network"

²⁹ "Whole Foods USA - Store Location Analysis," ScrapeHero, April 2, 2019, <https://www.scrapehero.com/whole-foods-market-locations/>.

warehousing and storage industry for counties that have been exposed to an Amazon fulfillment center across the years from 2001 to 2017.

Data Trimming

Before any analyses were conducted, the data set needed to be trimmed. This was because not all counties within the United States are the same. For example, Los Angeles County is over 4,000 square miles large and has a population of roughly 10 million people. On the other hand, Kalawao County in Hawaii is just under 12 square miles large and has a population of only 88 people. This attribute of counties becomes even more of a cause for concern when considering the aforementioned endogeneity issue of Amazon's selection of counties.

To address this difference in counties, certain counties were dropped depending on their population density. Population density was used because it was clear in the preliminary study of this paper that Amazon seemed to have a strong preference for population dense counties when establishing their fulfillment centers. To determine which counties were dropped, the minimum population density of the counties treated with Amazon fulfillment centers was identified. Any counties with population densities less than half than this figure were dropped from the data set.

Furthermore, because of the granularity of the warehousing and storage industry data, many counties lacked data for some or all years from 2001 to 2017. Such counties were also dropped for two main reasons. The first is that an absence of data usually means that total employment in the warehousing and storage industry in these counties is too small to report due to privacy concerns. As mentioned before, such counties are unlikely to be comparable to counties treated by Amazon fulfillment centers, and thus were dropped from the data set. The second reason is that this study requires a panel data set spanning the years from 2001 to 2017. When running the fixed effects

regressions that this study conducted, it would be ideal to not have any missing data points for any counties within the timeframe of this data set.

After these counties were dropped, there was data on 357 counties remaining in the data set, of which 109 counties were ones treated with an Amazon fulfillment center. This number of treated counties was larger than the 92 treated counties identified in the preliminary study because counties treated after 2015 no longer had to be dropped.

Empirical Methodology

With this trimmed panel data set, this paper conducted two-way fixed effects regressions using three different dependent variables: a dummy variable describing whether a county has at least one Amazon fulfillment center in a given year, and two intensity variables describing the number of Amazon fulfillment centers and total square footage of Amazon fulfillment centers in a given county in a given year.

Two-way fixed effects ordinary least squares regressions were run to capture the aforementioned biases that arise from differences in trends within counties and across years. For example, some counties may have been exhibiting high levels of GDP growth for reasons unrelated to Amazon's arrival, which would likely have a positive impact on the total employment within that county's warehousing and storage industry. Furthermore, even if Amazon's arrival were to have a positive effect, perhaps the year during which the fulfillment center was established was during the Great Recession in 2008. This would likely have a negative effect on that county's warehousing and storage industry employment levels for reasons again unrelated to Amazon's arrival.

These two-way fixed effects regressions with dummy variables for counties and years were run on the entire data set, but also on two other data sets reflecting the urbanity of the county. These data

sets, described as rural and urban later on in the paper, were separated based on the population densities of the counties. The median population density of all counties in the data set was identified, and counties below and above this figure were placed into the rural and urban counties data sets respectively.

To address the endogeneity issue of Amazon's selection of counties, a two-stage least squares regression was run using the presence of Whole Foods in a county as an instrumental variable. However, due to data on the number of Whole Foods stores in a county being restricted to 2019 only, the data set used for these two-stage least squares regressions was not a panel data set. Instead, the most recent values for Amazon's presence in 2017 were used.

For the first-stage regressions, the county variables depicting Amazon's presence in terms of treatment, number of fulfillment centers, and total square footage were regressed on the Whole Foods presence in counties, along with other county-specific control variables such as GDP levels. However, instead of utilizing ordinary least square to run these regressions, other more suitable models were used. For the variable indicating the presence of Amazon, a binary variable, a probit model was used. For the variables indicating the number and square footage of Amazon fulfillment centers, negative binomial regressions were utilized to account for the wide dispersion and numerous zero values of the variables. To run this model, the values for the square footage variable were rounded to the nearest integer.

The second-stage regressions were then run using, as explanatory variables, the new Amazon presence variables obtained through the fitted values from the first-stage regressions to replace the original unfitted values.

Basic statistics of the variables used in these regressions can be seen in *Table 2* below.

Table 2. Statistics of Variables within Data Set

	Mean	Standard Deviation	Minimum	25%	50%	75%	Maximum
Employment	1303.33	2169.10	8	232	613	1444	33153
Average Annual Wages	39545.65	10831.80	13466	32916	38122	44097	174862
Year of Amazon Treatment	2014.03	3.02	2000	2013	2015	2016	2017
Treatment of County	0.3053	0.4606	0	0	0	1	1
Treatment of Amazon	0.0713	0.2581	0	0	0	0	1
Number of Amazon Centers	0.1448	0.6932	0	0	0	0	12
Square Footage of Amazon (10,000s)	6.13	33.54	0	0	0	0	634.67
Treatment of Whole Foods	0.4286	0.006353	0	0	0	1	1
Number of Whole Foods Stores	1.22	2.66	0	0	0	1	29
GDP (\$100 millions)	322.49	7.02	2.60	64.95	159.51	358.91	6215.20
GDP per Capita (\$1,000s)	51.85	21.15	16.91	37.59	47.49	61.82	159.41
Population Share of Young Adults	0.2705	0.0342	0.1672	0.2478	0.2657	0.2898	0.4001
Population Share with Some College	0.6009	0.08820	0.345	0.537	0.606	0.659	0.813
Population Density (sq. miles)	1228.52	3175.94	35.5	230.7	468.2	1149.6	35369.2
Population	545436.7	796417.67	14318	154339	319985	648295	9962789

III. RESULTS

Employment

The paper found initial evidence that the arrival of Amazon fulfillment centers appears to have a positive effect on the warehousing and storage industry of a county. The results of the two-way fixed effects ordinary least squares regressions are outlined in *Table 3* below. No control variables were included as the fixed effects regressions capture these county-specific differences.

Table 3. Two-Way Fixed Effects Regressions of Amazon Fulfillment Centers on County-Specific Warehousing and Storage Employment

	Total Employment		
	(1)	(2)	(3)
Treatment of Centers	1,126.818*** (54.017)		
Number of Centers		661.148*** (17.874)	
Center Sqft. (10,000s)			19.789*** (0.340)
Observations	6,069	6,069	6,069
R2	0.071	0.194	0.373
Adjusted R2	0.010	0.141	0.332
F Statistic (df = 1; 5694)	435.151***	1,368.210***	3,393.655***
Note:	* p < 0.1	** p < 0.05	*** p < 0.01

Table 2 shows that on average counties that have been treated with Amazon fulfillment centers exhibit employment levels of roughly 1,126 higher within the warehousing and storage industry than counties that have not been treated. Furthermore, the results showed that this positive effect

of Amazon's presence is even more strongly explained by the number and total square footage of fulfillment centers.

While all three variables representing Amazon's presence are statistically significant, it is noteworthy that their R^2 values differ significantly, with the total square footage variable being the highest at 0.373, and the number of fulfillment centers following at 0.194. In contrast, the simple dummy variable indicating Amazon's presence in a county had an R^2 value of only 0.071. This is most likely due to many counties having several fulfillment centers, and that many fulfillment centers differed greatly in their size, making the total square footage variable the most accurate in measuring Amazon's presence.

Average Annual Wages

However, the paper was unable to find convincing initial evidence through the fixed effects regressions that Amazon's arrival impacted a county's annual wages within the warehousing and storage industry in a significant manner.

The results from *Table 4* suggest that Amazon's presence may have a negative impact on the annual wages of workers within the warehousing and storage industry. However, these results are much weaker than the ones regarding employment; the R^2 values are significantly lower, with the highest being 0.005 for the total square footage variable.

Table 4. Two-Way Fixed Effects Regressions of Amazon Fulfillment Centers on County-Specific Average Annual Warehousing and Storage Wages

	Average Annual Wages		
	(1)	(2)	(3)
Treatment of Centers	-338.738 (399.750)		
Number of Centers		-337.848** (141.925)	
Center Sqft. (10,000s)			-15.572*** (3.054)
Observations	6,069	6,069	6,069
R2	0.0001	0.001	0.005
Adjusted R2	-0.066	-0.065	-0.061
F Statistic (df = 1; 5694)	0.718	5.667**	25.994***
Note:	* p < 0.1	** p < 0.05	*** p < 0.01

This weak connection, however, is not particularly unexpected. This is because there are many aspects of Amazon fulfillment centers that make it difficult to truly ascertain the change in wages. For example, it may very well be the case that Amazon fulfillment centers workers receive better employee benefits than do workers at other warehousing or storage companies. Such examples include benefits like the aforementioned comprehensive health insurance plans and 401(k) matching. Furthermore, due to the seasonal nature of Amazon's business, it could very well be the case that a significant portion of their employees is part-time.

Since this study was only able to measure employee compensation using just annual wages figures, these other benefits provided by Amazon fulfillment centers were not able to be measured. This could very well have led to the inconclusive results seen in *Table 4*.

Urbanity of Counties

Using the aforementioned methodology of determining the urbanity of counties, the same two-way fixed effects regressions were run on similar data sets containing only rural and urban counties respectively. The paper found that the causal effect of Amazon fulfillment centers did seem to be affected by the population density of counties. Specifically, rural counties tended to benefit greater than urban counties from Amazon’s presence in terms of employment levels within the warehousing and storage industry. These results can be seen in *Table 5* below.

Table 5. Two-Way Fixed Effects Regressions of Amazon Fulfillment Centers on County-Specific Warehousing and Storage Employment for Rural and Urban Counties

	Total Employment (Rural)			Total Employment (Urban)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment of Centers	2,682.788*** (107.378)			626.483*** (64.314)		
Number of Centers		1,440.219*** (30.625)			391.868*** (21.523)	
Center Sqft. (10,000s)			21.465*** (0.459)			17.782*** (0.506)
Observations	3,043	3,043	3,043	3,060	3,060	3,060
R2	0.180	0.437	0.434	0.032	0.104	0.302
Adjusted R2	0.123	0.399	0.395	-0.034	0.042	0.254
F Statistic (df = 1; 2846)	624.228***	2,211.557***	2,183.032***	94.886***	331.480***	1,236.336*
Note:	* p < 0.1		** p < 0.05		*** p < 0.01	

There are a few significant observations from the results of *Table 5*. The first is that Amazon’s presence seems to account for the variation in employment within the warehousing and storage industry more in rural counties than in urban ones. This is evidenced by the higher R² values for the regressions of rural counties than urban counties, which were 0.434 and 0.302 respectively for

the total square footage variable. There are many potential explanations for this, but the most probable scenario seems to be that rural counties have less employees within the warehousing and storage industry to begin with. Thus, the impact of Amazon's arrival on their employment levels would likely be more significant.

The second observation is similar to the first, and is that Amazon's presence seems to have a larger causal impact on employment levels within the warehousing and storage industries for rural counties than urban ones. This is evidenced by the higher coefficients for all three Amazon presence variables for rural counties than urban ones. Again, there are many potential reasons for this observation. A particularly interesting and likely explanation could be that urban counties have more developed warehousing and storage industries than rural counties. Thus, the instances of labor displacement from other warehouses or storage companies within counties to newly established Amazon fulfillment centers could be higher in urban counties than rural ones. This could be one of the driving forces behind the lower impact of Amazon's presence on employment levels within urban counties. If true, this explanation is intriguing as it implies that Amazon's presence in less population dense counties encourages job creation more than in population denser ones.

However, like the regressions on annual warehousing and storage wages in all counties, the effect of Amazon's presence within rural and urban counties remained weak at best. These results can be in seen in *Table 6* below.

Table 6. Two-Way Fixed Effects Regressions of Amazon Fulfillment Centers on County-Specific Warehousing and Storage Average Annual Wages for Rural and Urban Counties

	Average Annual Wages (Rural)			Average Annual Wages (Urban)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment of Centers	-1,094.914 (726.898)			-388.693 (538.131)		
Number of Centers		-732.677*** (250.005)			-273.411 (187.102)	
Center Sqft. (10,000s)			-9.662*** (3.741)			-23.609*** (4.962)
Observations	3,043	3,043	3,043	3,060	3,060	3,060
R2	0.001	0.003	0.002	0.0002	0.001	0.008
Adjusted R2	-0.068	-0.066	-0.066	-0.068	-0.068	-0.060
F Statistic (df = 1; 2846)	2.269	8.589***	6.670***	0.522	2.135	22.633***
Note:	* p < 0.1		** p < 0.05		*** p < 0.01	

Addressing the Endogeneity Issue

While informative, the fixed effects regressions do little to address the endogeneity issue surrounding Amazon’s choice of counties when establishing its fulfillment centers. To overcome this, two-stage least squares regressions were run using the presence of Whole Foods in a county as the instrumental variable. The Amazon presence variables were regressed onto this instrumental variable and a control variable, county GDP per capita, of which the results can be seen in *Table 7* below. Regressions with other control variables such as the aforementioned education and age demographic variables were also run, but due to issues like multicollinearity the following regressions were deemed the most ideal.

Table 7. First-Stage Regressions (Two-Stage Least Squares) of Whole Foods Stores on the Presence of Amazon within Counties

	Treatment of Amazon (Probit)	Number of Centers (Negative Binomial)	Center Sqft. (10,000s) (Negative Binomial)
	(1)	(2)	(3)
Treatment of Whole Foods	0.829*** (0.163)	1.394*** (0.242)	0.877** (0.417)
County GDP per Capita	0.012*** (0.004)	0.009* (0.005)	
Constant	-1.573*** (0.210)	-1.641*** (0.288)	2.842*** (0.274)
Observations	353	353	353
Log Likelihood	-186.708	-378.266	-834.995
Theta	-	0.435*** (0.078)	0.067*** (0.007)
Note:	* p < 0.1	** p < 0.05	*** p < 0.01

Table 7 shows evidence supporting the presence of Whole Foods as a suitable instrumental variable. This is shown by how the coefficients for the presence of Whole Foods remain statistically significant when determining Amazon’s presence, even when controlled for by county GDP per capita. Furthermore, the coefficients are positive, which is the expected result given the paper’s hypothesis on the effect of Whole Foods’s presence on Amazon fulfillment centers.

Using new Amazon presence variables from the fitted values of the regressions in *Table 7*, second-stage regressions were run to determine unbiased effects of Amazon’s presence on warehousing and storage employment levels. These results can be seen in *Table 8* below. These regressions with the fitted values variables were then compared alongside similar ordinary least squares regressions using the original variable values.

Table 8. Two-Stage and Ordinary Least Squares Regressions of Amazon Fulfillment Centers on County Warehousing and Storage Employment

	Total Employment (Fitted Values)			Total Employment (Original Values)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment of Centers	6,784.402*** (1,481.563)			3,794.076*** (378.941)		
Number of Centers		1,900.437*** (430.686)			1,467.427*** (79.913)	
Center Sqft. (10,000s)			76.893*** (15.286)			37.005*** (1.597)
County GDP per Capita	-30.116** (13.602)	-22.237* (12.571)		-8.800 (8.280)	-11.156* (6.538)	
Constant	1,444.467*** (490.943)	1,643.981*** (502.697)	-132.564 (458.357)	1,267.676*** (439.214)	1,414.057*** (355.633)	964.867*** (126.502)
Observations	353	353	353	353	353	353
R2	0.067	0.064	0.067	0.232	0.497	0.605
Adjusted R2	0.062	0.058	0.065	0.227	0.494	0.604
F Statistic (df = 2; 350)	12.664***	11.906***	-	52.769***	172.636***	-
F Statistic (df = 1; 351)	-	-	25.303***	-	-	537.220***
Note:	* p < 0.1		** p < 0.05		*** p < 0.01	

The results of *Table 8* are consistent with the results from the previous fixed effects regressions and show that Amazon's effect on warehousing and storage employment is a positive one. While the regressions with original values have higher R² values, they yielded similar results with the coefficients of the variables from the fitted values remaining statistically significant and, contingent on the validity of the instrumental variable, unbiased.

The same methodology was used to determine the unbiased effect of Amazon's presence on warehousing and storage average annual wages, with the results shown in *Table 9* below.

Table 9. Two-Stage and Ordinary Least Squares Regressions of Amazon Fulfillment Centers on County Warehousing and Storage Average Annual Wages

	Average Annual Wages (Fitted Values)			Average Annual Wages (Original Values)		
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment of Centers	6,547.571 (4,536.083)			90.121 (1,281.959)		
Number of Centers		3,546.012*** (1,306.189)			-381.377 (333.369)	
Center Sqft. (10,000s)			223.449*** (48.930)			-16.106** (8.036)
County GDP per Capita	146.501*** (41.644)	117.840*** (38.126)		192.321*** (28.011)	200.541*** (27.273)	
Constant	35,671.96*** (1,503.115)	36,400.81*** (1524.586)	39,146.36*** (1,467.180)	35,295.14*** (1,485.862)	35,194.96*** (1,483.586)	45,737.19*** (636.691)
Observations	353	353	353	353	353	353
R2	0.137	0.149	0.056	0.132	0.135	0.011
Adjusted R2	0.132	0.145	0.053	0.127	0.130	0.008
F Statistic (df = 2; 350)	27.700***	30.744***	-	26.504***	27.254***	-
F Statistic (df = 1; 351)	-	-	20.855***	-	-	4.018**
Note:	* p < 0.1		** p < 0.05		*** p < 0.01	

Again, these regressions using fitted values variables were compared with similar regressions of the original variable values. However, unlike the results regarding warehousing and storage employment levels, they yielded very different results. While the ordinary least squares regressions using the original variable values generally showed a weak negative connection between Amazon's presence and warehousing and storage average annual wages, similar to the results in the previous fixed effects regressions, the second stage regressions with the fitted values variables depict a strong and also positive relationship. This is shown by the higher R² values of the regressions with the fitted values variables, along with positive and statistically significant

coefficients for the number and total square footage of Amazon fulfillment centers variables. This is an interesting result that suggests Amazon fulfillment centers have not only a statistically significant impact on warehousing and storage annual average wages, but a positive one as well, assuming the validity of the paper's instrumental variable.

IV. CONCLUSION

The results of this research paper suggest that Amazon fulfillment centers do have a causal relationship with local labor markets. For employment, Amazon fulfillment centers seem to create new jobs within the warehousing and storage industry. There is also evidence that suggests this positive causal impact of Amazon's presence applies to the average annual wages of the warehousing and storage industry as well. Furthermore, for both warehousing and storage employment and average annual wages, this relationship seems to be strengthened by the number and total square footage of Amazon's fulfillment centers.

The intensity of Amazon's impact on the employment and annual average wages within the warehousing and storage industry also seems to depend on the urbanity of counties. This is evidenced by how counties with lower levels of population densities were affected more and had the variation of their warehousing and storage employment and annual average wages levels better explained by the establishment of an Amazon fulfillment center.

Policy Implications

However, from a policy perspective the nature of these causal relationships does not seem to support the case for policymakers to continue offering Amazon generous subsidies in hopes of attracting their fulfillment centers. This is due to several reasons, the most obvious being that it seems unlikely Amazon would place significant weight on tax benefits when choosing the location of their fulfillment centers. Due to Amazon's online business model that empathizes speed and efficiency, the location of their fulfillment centers would be a key consideration. This would mean Amazon likely has a list of preferred locations to open their fulfillment centers in. This possibility is further supported by the findings of this paper that Amazon seems to have a very strong

preference in establishing its fulfillment centers in metropolitan statistical areas. In such a case, local government subsidies would be a poor use of potential resources that could instead be used for improving public goods like education and health services.

Furthermore, the concerns behind the consequences of Amazon's decision to raise their minimum wage for fulfillment center workers remain. Even if Amazon's current causal impact on local employment and wage were in reality significantly positive, whether such an effect would be sustained in the future is unclear. With evidence of Amazon looking towards automated labor as a potential substitute for their fulfillment center workers,³⁰ the case for policymakers to continue providing government subsidies to Amazon continues to become less advisable.

However, continuing to offer Amazon subsidies may be an advisable option for counties with lower population densities. This is because, as evidenced by the findings of the paper, Amazon's presence seems to increase and account for the variation in the employment levels of these counties more than in counties with higher levels of population densities.

Limitations and Looking Forward

While these analyses have shed further light on the Amazon's relationship with local communities, the findings of this paper can be improved upon as there are ways to further improve the accuracy and relevance of the analyses conducted.

While the instrumental variable used in the paper is suitable for the analyses conducted, it could be further refined to increase its effectiveness. For example, while there was data available on the number of Whole Foods stores in each county in 2019, there was no data available on the number of Whole Foods stores per year from 2001 to 2017 as there was for Amazon fulfillment centers.

³⁰Jessica Bruder, "With 6,000 New Warehouse Jobs, What Is Amazon Really Delivering?"

Obtaining such data would allow for the construction of a panel data set for the two-stage least squares regressions, enabling more robust analyses.

Furthermore, other potentially more suitable instrumental variables exist that would further improve the results of this paper. An example of such an ideal instrumental variable would be a list of candidate counties that were internally considered by Amazon for the opening of a new fulfillment center, but were eventually not chosen. This would allow for the identification of counties that are very similar to counties with Amazon fulfillment centers by Amazon's standards, but did not receive the effects of such centers.

Another limitation of this paper that could be improved upon in future studies is the improvement of the wages variable. This paper used data on the annual average wages within the warehousing and storage industry of each county to analyze the causal relationship of Amazon on the compensation of workers within the warehousing and storage industry. However, as mentioned before there are many problems with these variables. For example, while Amazon's presence may increase the number of jobs within the warehousing and storage industry, it may result in each employee working fewer hours. Therefore, this paper's analyses could be supplemented by studying other forms of wage data such as the total number of compensated hours or hourly wage levels within the warehousing and storage industry.

Finally, as mentioned before Amazon also recently increased their minimum wage to \$15 per hour at the end of 2018. This will almost certainly change Amazon's effect on the compensation of workers within the warehousing and storage industry. However, this change is not reflected in this study as the most recent data used is limited to 2017. Therefore, once future data becomes available the analyses of this paper should be reconducted to determine the effects of Amazon's most recent employee compensation model.

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