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How Has the Growth of E-commerce Sales Affected Retail Real Estate?

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Table of Contents

I. Introduction

II. Literature Review

III. Data

IV. Variable Analysis

    1. Dependent Variable Analysis

    2. Independent Variable Analysis

V. Empirical Strategy and Results

VI. Conclusion

VII. List of Tables

VIII. List of Figures

I. Introduction

Throughout the history of commerce, consumers have always had to venture outwards for their retail goods. This can include a trip to the bustling downtown of a nearby town or city, a walk over to a local shopping center, or a full-fledged expedition to a massive mega mall. What would happen if we no longer had to travel to collect goods, but they were instead sent to our home? This new industry has grown and developed into the large e-commerce network used today (Richter 2017). As this new method of commerce emerges, it raises a question regarding the previous methods of retail commerce. How has the growth of e-commerce and the changing retail landscape affected commercial and retail real estate prices?

Although there has been some past research that delves into answering this question, the research has generally been qualitative in nature. Dixon and Marston (2002) examine the changing pattern of e-commerce and retailing in the UK and use their research as well as past research to provide some overall conclusions on the impact e-commerce has had on retail real estate. They found that rental growth could slow slightly in future years, but that this will likely vary depending on the specific town or city investigated. Worzala and McCarthy (2001) survey retailers to see how they are adapting to the changes in the retail landscape. Although their surveying could be susceptible to some significant bias, their main findings concluded that retailers who sell unique products are less likely to view the internet as an important new channel of distribution, while retailers who sell standardized goods might look more heavily into online retail.[1] Baen (2000) took a similar approach as Worzala and McCarthy. When discussing with retailers they found that many e-commerce sales are occurring at traditional retail locations but are recorded as something else, either catalog or computer sales, which could potentially have a

[1] Few retailers felt the internet would impact their demand for retail space in the next 3 to 5 years, but rather further in the future. (Baen)

large impact on future statistics for online and physical in-store sales. Baen makes it clear that much additional research is needed after monitoring gross sales, e-commerce sales and retailers' profits over the next few years.

The purpose of this paper is to add to the existing literature by quantitatively examining the effect of the e-commerce market on retail commercial real estate prices in the United States. I estimate models both at the country-level (2000-2018) and the city-level (2014-2018). This allows one to more definitively see the importance of store location on the retail real estate market and provide a full picture of how the retail real estate market has been affected overall. Using a unique data set, I estimate the determinants of commercial retail real estate space. I hypothesize that there is an inverse relationship between the growth of e-commerce sales and the demand for physical retail real estate space. Alternatively, it is very possible that retailers do not see these two different types of sales as mutually exclusive and instead choose to grow both methods of sales, online and in store, even if the brick and mortar locations are losing sales compared to online. Retailers might find value in having productive physical retail locations and believe that losing ground in their brick and mortar locations will hurt their online sales as well.

In my research I found a fair bit of statistical significance amongst the variables in my regression tests. At the country level, my dependent variables are total retail space vacated in the U.S., Value of U.S. construction put in place, returns of the NCREIF property index, and the change in commercial real estate prices for the United States. Total e-commerce sales significantly influence three of my four dependent variables at the country level. My city level dependent variables include net absorption, vacancy rate, and asking rent of 66 individual cities. Total e-commerce sales has statistical significance on only one of these three dependent variables at the city level. Although e-commerce sales are not statistically significant across all

dependent variables, when significant the results show that there is an inverse relationship between the growth of e-commerce sales and the success of retail real estate space. Policy changes may need to be implemented if the effects on physical retail locations begin to hurt the countries' economy

The remainder of the paper is as follows. Section 2 describes the existing literature. The data and variables are discussed in Sections 3 and 4, respectively. Section 5 presents the empirical strategy and results. The final section concludes my work.

II. Literature Review

At the turn of the century, the internet was gaining significant traction and getting the attention of many individuals, resulting in retailers beginning to sell their goods online and offer delivery directly to your door (Baen 2000). As e-commerce began to take off, researchers looked to see what might be impacted by the emergence of this new market. Dixon and Marston (2002) examine the changing pattern of e-commerce and retailing in the United Kingdom by investigating previous studies and dissecting industry data. Moreover, they attempt to explain the reasons for the e-commerce revolution. The authors point out the emergence of the dot.com boom and pressure from retailers to find ways of reaching new customers, as well as shining light on the different demographics of people that use the internet. It is important to note that at the time this paper was written, the internet was still a relatively new phenomenon. Not everyone had access to the internet and different age groups as well as class demographics played a large role in the level of access a person had to the internet.[2] In addition, the overall e-

[2] Around 39% of U.K. households had online access in 2001, compared with 32% in 2000. 23 million adults had access to the internet at some time, equivalent to 51%. There is evidence of a digital divide in the U.K. for different income and age groups. Only 7% of poorer households are online compared to 71% of more affluent households. Internet access varied based off regions as well. (D&M)

commerce market had not yet reached its potential as it was still common for many large retailers to not offer online shopping during this time period (Dixon and Marston 2002).

Worzala and McCarthy (2001) also surveyed retailers in an attempt to see the strategies and future plans for retailers' use of the internet as an alternative distribution outlet as well as their future outlook on retail stores. They hypothesize that retail box stores will have to adapt in order to offer something that shopping on the internet cannot and/or retailers will have to create a way for online shopping to connect shoppers to retail stores as well. Data was gathered by interviewing different retailers and doing background research on a retailers' web page for whether it even exists and if so, how it functions with their onsite retail locations.[3] They asked retailers how they are currently using the internet for their business, their future internet strategy, and its impact on the expansion of their retail locations. Their findings show that retailers were not worried as much about the internet as they were about general competition from other retailers and that many retailers' web pages were being used more for information and advertising than sales transactions. Retailers of unique products or those relying on services were less likely to view the internet as an important new channel of distribution while retailers selling standardized goods that were more concerned with potential loss of sales from the internet had taken a more aggressive web based selling strategy.[4] It is interesting to note that very few retailers believed that the internet would impact the need for retail space in the next 5 years.[5] When surveying the retailers, only 97 of a potential 276 retailers agreed to partake in the

[3] For the sample selected, 44% had web pages and 26% had a web page under construction (W&M)
[4] About 62% of retailers had over 30% of their sales occur online, 7% had 10-30% occur online, 30% had 5% or less, and 1% had no sales. (W&M)
[5] On a scale of 1 to 5 with 5 being very significant and 1 being very minimal, respondents had a mean rating of 1.71 for fear of lost store traffic and 1.72 for fear of lost sales. (W&M)

study, equivalent to about a 35% response rate. These retailers varied by industry.[6] This method of gathering data via survey leaves the researchers susceptible to response bias and immediately raises concerns regarding the legitimacy of the data.[7] If retailers all decided for similar reasons not to take the survey then the study could be biased and compromised. For example, if the retailers that chose not to partake in the study were all genuinely nervous about internet sales affecting their business, then the researchers will only have data from a biased selection of retailers and not the retail market as a whole.

Dixon and Marston (2002) investigate how different industries were being affected by e-commerce and how e-commerce could either add or subtract from their brick and mortar locations. They find that larger, well-established retailers with a large range of products are suffering more from the emergence of e-commerce than smaller retailers with a valuable brand. Retailers are responding by turning more of their attention towards these online platforms and working to build their online sales to compete with other retailers. Baen (2000) explores a different aspect of the relationship between e-commerce, brick and mortar stores, as well as real estate prices. Baen (2000) hypothesizes how e-commerce may affect traditional real estate property values and explains that many e-commerce sales are occurring at traditional retail locations but are recorded as something else, either catalog or computer sales.[8] This paper also explores commercial real estate rents more through a tenant and landlord relationship. Baen (2000) analyzes retail leases and searches for evidence of retailers shifting from on-site sales to

[6] Of respondents 66% were independent retailers, 14% anchor tenants, 8% franchises and 6% regional tenants. The sample also showed that 28% of respondents sold home products, 18% sold lifestyle products, 17% sold apparel and accessories, and the rest varied from food and health to consumer services. Many of these respondents were smaller retailers with over half of the retailers, 52%, had less than $1 million in total sales in 1998. (W&M)

[7] When surveying the retailers, only 97 of a potential 276 retailers agreed to partake in the study, equivalent to about a 35% response rate.

[8] More off-site retail sales may result in less foot traffic, lower impulse sales by non-anchor tenants, lower profit margins due to comparative web shopping and greater competition. Meanwhile, more on-site retail sales that are accounted for as off-site sales, catalog sales, or computer orders. (Baen)

off-site sales. Much of this information was gathered from surveying retailers that have been exposed to or impacted by e-commerce. In the end, Baen (2000) warns real estate owners that tenants are not the only ones that should be worried about e-commerce because eventually it will be their problem as well.

Dixon and Marston (2002), Worzala and McCarthy (2001), and Baen (2000) all do a thorough job of looking at e-commerce overall and seeing how it is changing and developing, but they do not come to any quantitative conclusions. These papers are largely speculation because they were written from 1999-2002 when the e-commerce revolution was merely beginning. Without the data needed to run proper regression testing, the authors had to form their opinions on how retail real estate would be effected based not on data and modeling, but simply the concerns that retailers, customers, and real estate owners expressed about the industry and about how the early numbers indicated who was shopping online and in what industry they were shopping. Their research is a great building block for me to see whether retailers' perceptions of e-commerce in the early 2000's held true. Although these papers have a similar sentiment to the research I have conducted, there is still lots of room to further their research.

I can run regression tests to find concrete quantitative answers as well as look more in depth at the effect on United States retail real estate specifically. I now have access to meaningful retail real estate data such as total retail space vacated, value of commercial construction, returns of the NCREIF property index, commercial real estate prices, net absorption, vacancy rates, and retail asking rents as well as data following the growth of e-commerce retail sales. I think it will be important to test for other potential reasons for a decline in commercial real estate pricing aside from just e-commerce. Potential reasons could be the stock market price, inflation rates, or even demographic factors like poverty rate. I believe that

with the statistics available to me today, my empirical model and regression testing will give definitive answers to many of the questions raised by previous researchers.

III. Data

I use data from a number of different sources. Data on the growth of total e-commerce retail sales and e-commerce retail sales as a percentage of total retail sales is from the Federal Reserve Economic Database (FRED). This data is ideal for my purposes as it follows the growth of e-commerce in the United States from 1999 through 2018 on a quarterly basis. Having the ability to also see how e-commerce retail sales has grown as a percentage of total retail sales provides further insight into how e-commerce has changed and developed relative to all retail sales. I collect data on retail sales only as this data is the most relevant to the retail real estate space. I look at the retail industry as a whole as opposed to individual subsections in order to ascertain how all of the retail sector has been affected by the emergence of the e-commerce market. I only use data from 2000 onward as the previous literature focused on the pre-2000 time period.

Data on retail and commercial real estate space is from Statista and Cushman & Wakefield. Statista includes information on the total retail space vacated, the value of U.S. commercial construction put in place on a yearly basis, the returns of the National Council of Real Estate Investment Fiduciaries (NCREIF) property index, and the percent change in commercial real estate prices for the United States. This data is ideal for my purposes as it provides information on how the commercial real estate space has adapted since the inception and evolution of e-commerce. Arguably, vacated space and additional construction show whether companies are more or less committed to their physical stores and on-site sales. The

NCREIF property index is a total rate of return measure of investment performance of a collection of the largest individual commercial real estate properties acquired. The NCREIF data therefore reflects private market investments only. The data is given on an annual basis from 2000 onward. The percent change in commercial real estate prices reflects how much commercial real estate prices change from year t-1 to year t in percent.

The Cushman & Wakefield Marketbeat U.S. Shopping Center Reports data includes information on overall vacancy rates, overall net absorption, and overall asking rent. These reports are ideal for my analysis as they provide an overall picture of the retail real estate market and how it changes each year. By comparing these changes with the growth of e-commerce retail sales, I examine if there are any links between the changes in the two industries. Cushman & Wakefield provide data at the US level and the city level from 2014 onward. Specifically, they have data on 66 cities that are representative of the overall US retail real estate market. Although this sample is limited in years, a more in depth look at the city level allows one to ascertain if retail real estate differs amongst locations across the U.S.

It is important before moving forward to note the difference between commercial and retail real estate. Commercial real estate statistics refer to all commercial real estate, often including office and industrial space. Retail real estate, on the other hand, is a specific subset of the commercial real estate space and often pertains only to physical retail locations or brick and mortar stores where shopping occurs in person. I argue that the commercial real estate statistics are still very valuable for my research as the movement in the commercial space as a whole is indicative of what is happening in the retail real estate market specifically.

IV. Variable Analysis

1. Dependent Variable Analysis

My outcome variables are represented by an array of statistics on commercial and retail real estate from 2000 to 2018. In particular, at the country level these dependent variables are total retail space vacated in the U.S., value of U.S. construction put in place, returns of the NCREIF property index, and the percent change in commercial real estate prices.

Table 1 reveals that the total retail space vacated in the U.S. averages around 82 million. Total retail space vacated shows how much retail space that was previously occupied is now without a tenant. The relatively high standard deviation shows that retail space vacated fluctuates greatly. The returns of the NCREIF property index, which reflect the performance of companies' private investments in commercial real estate space, have a mean slightly over 2%. With a range from -8.29% to 5.4% and a median of 2.89%, close to the same value as the mean, it is interesting to note that there are evidently some very low outliers for the return of the NCREIF, but they do not affect the mean or median because there are significantly more returns closer to the higher end of the range.

Table 1 also shows the average percent change in commercial real estate prices from a year ago is about 8%, showing that the prices have in general increased from the prior year. The high standard deviation, which is higher than the mean, shows how volatile these prices can be and how much they can change over the course of one year. *Table 2* and *Figure 1* reveal that the only time period where one observes negative changes to real estate pricing is during the economic crisis from late 2007 through early 2010. A similar pattern is presented when looking at the value of US commercial construction put in place, in billions of U.S. dollars (see *Table 1*).

Table 2 and *Figure 2* show that the largest deviation from the mean, which again shows a significant decrease in value, is around the time of the economic downturn in 2008.

These outcome measures of interest at the city-level are net absorption, the vacancy rate, and the asking rent. Net absorption is a measurement, in million square feet, of the net change of the supply of retail space in the retail real estate market. It is measured by deducting the retail space vacated by tenants and new space made available on the retail real estate market from the total space that is leased. A high net absorption shows that there is a lot of demand for the space while a lower net absorption shows there is a lack of demand. Vacancy rates, measured in percent, tell us how much retail space is vacant and without a tenant each year. Asking rents measure the average asking price per square foot of retail space in each individual city.

Table 3 presents the summary statistics from 2014-2018 by city. It can be seen that the mean net absorption rate is lower almost each year. This decreasing net absorption rate suggests that the demand for retail real estate spacing is decreasing as well. Perhaps surprisingly, there are some contradictory patterns for vacancy rates. The mean for vacancy rates are actually decreasing each year from 2014 to 2018 as well, showing that less retail space is available to rent each year. It seems contradictory that the demand for retail real estate space and the vacancy rates of retail space could both decrease. One possible explanation for these seemingly opposing statistics is that no more new retail space is being created or that the total amount of space leased is decreasing. If space being leased decreases more than vacancy rates, the net absorption can still decrease, as seen in the net absorption equation.

Table 3 also reveals that the mean asking rent, in dollars, has decreased almost every year, besides a slight uptick in 2018 from 2017. The rents in 2018 are still significantly lower than any of the asking rents for years other than 2017. The high sample variance and standard

deviations are a reflection of the diverse selection of cities that Cushman & Wakefield chose to investigate. According to the company, these specific cities were investigated in an attempt to show a complete picture of the US retail real estate market by selecting cities with many different characteristics and retail markets. As a result, these cities range heavily in asking rent price, likely due to their significantly different locations and desirability.

2. Independent Variable Analysis

I consider a number of determinants of retail commercial real estate. Specifically, total e-commerce retail sales and e-commerce retail sales as a percentage of total retail sales, both based on the first quarter of each year from 2000 to 2018 at the country-level. Total e-commerce retail sales are recorded quarterly and reflect the total dollar amount in billions. On the other hand, e-commerce retail sales as a percentage of total retail sales measures the ratio of e-commerce retail sales to total retail sales. This is accomplished by dividing e-commerce retail sales over the total amount of retail sales, also in billions of dollars, that occur online and in the physical retail store.

Table 6 and Figure 3 show steady growth of e-commerce sales in Q1 of each year since 2000. The graph of total e-commerce sales shows a relatively straight line, indicative of this steady growth in sales. E-commerce has grown from being less than one percent of total retail sales, 0.8% in 2000, to 9.4% in 2018. Each and every single year since 2000 there has been at least some positive increase in the percentage of total retail sales that are e-commerce sales, varying from 0.2% all the way to a full 1% change from 2017 to 2018. Looking more carefully at this table, it can be observed that the e-commerce sales as a percentage of total sales is not only increasing year by year, but the gap by which it is increasing is getting larger as well. The changes from 2013-2014 (+0.6%), 2014-2015 (+0.7%), 2015-2016 (+0.9%), 2016-2017 (0.6%),

and 2017-2018 (+1%) are all larger percent changes than in any of the previous 13 years. This shows that e-commerce sales are taking away from brick and mortar retail sales more and more each year that e-commerce exists.[9]

Although the total amount of e-commerce sales increases each year as well, there does not appear to be a pattern of larger increases over time in total e-commerce sales like that of the e-commerce sales as a percent of total retail sales data. *Table 7* shows the year over year change in the total e-commerce retail sales. The largest percentage jump in e-commerce retail sales is actually in the first years studied when e-commerce sales soared almost 30% higher in 2001 than 2000, a jump to 8135 from the minimum of 5691. Before 2006 there is at least a 20% increase in e-commerce sales each year 4 out of 6 times, but since 2006 there has not been a 20% increase in sales once. Each year ranges from an 11% to 16% increase, except for the one outlier of 2008 to 2009 when sales dropped half a percent. This increasingly steady growth of e-commerce sales could represent a lack of changes in the market, empirically. For example, there are no longer any new revelations that have shaken up the retail sales market and sent people running to shop online. Instead, people just continue to slowly increase their online shopping out of other factors like convenience.

Table 1 also contains summary statistics for my other dependent variables, the control variables, that will be present in my country level data. The yield of the 10-year treasury bond

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[9] At the beginning of the interview process for Worzala and McCarthy, only 44% of retailers had a web page, while 26% had a web page under construction. Most retailers indicated that they used their web pages for informational or advertising purposes rather than sales transactions, although, almost a third of the retailers have generated sales over the Internet. Of the retailers surveyed, only one percent had over 30% of their sales generated online while 62% had 10-30% generated online and the other 37% had 5% or less of their sales generated online. (W&M)

rates is only present in my country level regression testing. The yield averages 3.346% and reflects what percent return a person would get for locking up their money in a 10-year United States treasury bond. This value is always positive in my sample, shown by the minimum and maximum. The violent crime rate, also only used in my country level regression testing, provides the instances where someone was a victim in a violent crime out of 100,000 people. With a mean of 438.49 and a low standard deviation, it is clear that this value does not shift too significantly on an annual basis. The other four of these variables in *Table 1*, the stock market price, unemployment rate, inflation rate, and poverty rate, are used for both my country level and city level data.

The stock market price has a large effect on United States real estate values and is an essential variable for my testing. The stock market price has a mean of 1479.79 but is incredibly volatile during the time period that my data covered. During these years, the United States suffered their worst recession since the great depression and therefore saw a large downturn in the stock market. Unemployment rates often follow a similar trend as the stock market price. This variable represents the total percentage of people in the U.S. that are currently unemployed and has a mean of 6%. During the period I have studied, unemployment rates saw a larger spike up, to a maximum of 9.8%, than down, to a minimum of 4%, but still had a median lower than the mean at 5.5%. This indicates that these higher unemployment rates from the economic recession are outliers. Inflation rates show the value of a dollar and often reflect changes in the general price level of goods and services. Inflation rates have been equally as volatile during the period studied, showing a mean of 2.184% and a standard deviation value that is over half the mean at 1.106%. Lastly, poverty rates reflect the portion of the United States population that is currently below the poverty line on a given year. This value is much less volatile than the other

economic control variables used in my country and city level data. The poverty rate has a mean of 13.18% and very low standard deviation comparatively.

Table 5 not only reflects four of the dependent variables explained in the paragraph above, but also a control variable used only at the city level. This variable, the crime index, compiles a variety of information on the total amount of crime and the varying degrees of this crime that occurs in each city. This index has a U.S. average of 280.6, but the sample of U.S. cities I have collected have a mean of 474.23. The disparity in the means are likely from the sample I chose being predominantly cities, as cities tend to have higher levels of crime than suburbs. Due to the fact that I do not incorporate suburbs into my data, my mean is much higher.

By gathering this extensive list of variables and compiling the data together, I end up with good samples to gather quantitative data from both the country and city levels. In order to see exactly how the growth in e-commerce sales has affected the retail real estate market, a series of regression tests is run. The remainder of the paper formally analyzes the relationship between my independent and dependent variables.

V. Empirical Strategy and Results

In order to determine the changes to the retail real estate space on the country level, I estimate the following model using ordinary least squares (OLS):

$$Y_t = \alpha + \delta ECOMSA_t + \beta\chi_t + \varepsilon_t \qquad (1)$$

where Y is measured as the total retail space vacated in U.S., the value of U.S. construction put in place, the returns of the NCREIF property index, or the percent change of commercial real estate prices in the U.S. depending on the estimation specification. ECOMSA represents my

main dependent variable, total e-commerce retail sales[10]. χ is a vector of control variables including the stock market price, the unemployment rate, the inflation rate, the yield of 10-year treasury bond rates, the poverty rate, and the crime rate. ε is an error term with the usual properties and the subscript t represents time.

Columns 1 through 4 of Table 8 presents the country-level results based on equation (1) for the four dependent variables, total retail space vacated in U.S., value of U.S. construction put in place, returns of the NCREIF property index, and the change in commercial real estate prices for the U.S., respectively. There are several noteworthy patterns. First, e-commerce sales significantly influence all measures of retail commercial real estate except total retail space vacated in the U.S. In particular, E-commerce sales are statistically significant and have a negative coefficient when run against the NCREIF property index. The coefficient shows that in order for the returns of the NCREIF property index to drop one percent, total e-commerce retail sales must increase by one trillion dollars. Relatively speaking, this correlation is negligible and does not show much, but although small, the growth of E-commerce sales does have a negative impact on the NCREIF return. The NCREIF index represents the performance of private investments into the commercial retail real estate space and if the performance of this index begins to suffer, it likely eludes to the retail real estate market as a whole slowing down. Therefore, if the growth of e-commerce sales can affect the returns of this index negatively, it shows that e-commerce can be a potential problem for retail real estate.

[10] E-commerce retail sales and e-commerce retail sales as a percentage of total sales are highly significantly correlated (see Figure 5). As such, I estimate equation 1 first with e-commerce retail sales and all other X variables as previously defined. I then re-estimate equation 1 replacing e-commerce retail sales with e-commerce retail sales as a percentage of total sales. This was done in an attempt to test the e-commerce market in its entirety. The results are qualitatively similar, thus for brevity I only present the results with e-commerce retail sales. The results for the specifications with e-commerce retail sales as a percentage of total sales are available upon request.

E-commerce sales are also statistically significant and have a slight negative coefficient when run against the change in commercial real estate prices for the United States. It would take an increase of five trillion dollars in e-commerce retail sales to lower commercial real estate prices by one percent. It is interesting to note that e-commerce sales as a percent of total sales has a higher level of correlation and a significantly greater coefficient which shows that a one percent increase in e-commerce sales as a percent of total sales will decrease commercial real estate prices by 7.64%. These negative correlations are evidence that growth in e-commerce sales, as well as their percentage of total retail sales, have a negative impact on commercial real estate prices. The emergence of e-commerce as a new mode of purchasing retail goods appears to be having an effect on retail real estate. These statistically significant findings support my null hypothesis that the emergence of the e-commerce market has hurt retail real estate.

The other instance where e-commerce sales were statistically significant at the country level was when run against the value of U.S. construction put in place. E-commerce sales are statistically significant and an increase in sales causes a slightly positive increase in new construction value. This is slightly confusing, as one would expect less construction to be built when e-commerce sales are growing, but this can likely be answered by looking at the retail market as a whole. An increase in e-commerce sales likely means the retail market is doing well in general, possibly leading to a slight, although negligible, increase in new retail construction.

Second, violent crime has a statistically significantly effect irrespective of retail commercial real estate measure used. For example, when run against total retail space vacated, violent crime rates are statistically significant and the coefficient shows that a one percent increase in violent crime rates creates an additional 894,000 SF of vacated retail space. This correlation makes intuitive sense as areas that have more violent crime are inherently less

desirable locations to live, work and shop. When violent crime rates rise, retail businesses will suffer and therefore vacate their retail space. Looking at the results with the change in commercial real estate prices for the United States, violent crime rate is statistically significant at a higher level and the correlation shows that a one percent increase in crime rates decrease commercial real estate prices by 0.4%. This further makes evident what was seen in some of the other country level regressions, that as violent crime rates increase, commercial real estate prices and the retail real estate industry as a whole suffers. The other two instances of the statistical significance of violent crime rates have similar effects on the dependent variables as poverty rates.

When run against value of U.S. Construction put in place, poverty rates and violent crime rates are statistically significant and have positive value coefficients. A one percent increase in poverty rate increases the value of U.S. construction put in place by almost $9 billion, a very large increase, while a one percent increase in violent crime rates increase the value by $233 million. This seems confusing at first, but it is possible that new construction is being added to places with already high poverty and crime rates as ways to improve the areas and lower these rates. Areas with higher poverty and crime rates also provide cheaper land for developers to build on. If developers believe that these rates will not impact their profits, then they will build new construction regardless. It is easier to explain the effect Poverty rates and Violent crime rates have on the returns of the NCREIF property. They both have negative coefficients which shows that as poverty rates and crime rates increase, the NCREIF index does worse. Yet again poverty rates have a very large impact, a one percent increase in poverty rates results in a three percent decrease in the NCREIF, while violent crime rates decrease the NCREIF index by 0.142%. These are two rates that the U.S. tries to keep as low as possible because both have

negative impacts on the economy and the country as a whole. It makes intuitive sense that as these rates rise, indexes that show how markets are performing, like the NCREIF showing how commercial real estate is performing, would suffer.

Unemployment rate is found to have a statistically significant effect on two of my dependent variables. Unemployment rates are significant at the highest level and have a negative correlation to U.S. construction put in place. A one percent increase in unemployment rate decreases the value of construction put in place by $12 billion, an enormous effect. This shows that as more construction is put into place, unemployment rates lower significantly. New retail space will lead to new jobs and therefore less unemployment. When run against the returns of the NCREIF property index, unemployment rates are statistically significant again, but have a positive coefficient which shows that a one percent increase in unemployment rates increase the NCREIF index by almost 2.4%. The positive correlation with unemployment rates is a bit harder to explain, but this can be attributed to the fact that the returns on private investments in commercial real estate likely hinge only slightly on unemployment rate.

Inflation rates have no statistical significance on my dependent variables while the yield of 10-year treasury bond rates and the stock market price are each statistically significant when run against one variable. The yield of 10-year treasury bond rates have a positive coefficient on the returns of the NCREIF property index which indicates that a one percent increase in the yield increases the NCREIF index by almost three percent. The high level of significance can be explained by the fact that an increase in the yield represents confidence in the long-term economy which would in turn positively effect indexes like the NCREIF property index. An increase in the yield also represents times of economic growth which can lead to anticipation of growing inflation rates. Price inflation would not only correlate with high yields, but also higher

returns of the NCREIF. The stock market price only has a statistically significant effect on the value of U.S. construction put in place. The stock market price has a slight negative correlation which shows that a one percent increase in the stock market price decreases the value of U.S. construction put in place by $19 million. This negative correlation means that as new construction is built, the stock market suffers slightly, which does not make much sense economically. With my limited data and the lower level of significance for this variable, the correlation should likely be neglected.

I estimate the following fixed effect panel model for my city level analysis:

$$Y_{ct} = \alpha + \delta ECOMSA_{ct} + \beta\chi_{ct} + \varepsilon_{ct} \qquad (2)$$

where Y is measured as net absorption, vacancy rates, or asking rent, depending on the estimation specification. All variables are as previously defined with the exception that the χ vector does not include the yield on 10-year treasury bond rates and replaces the crime rate used in equation 1 with a crime index. ε is an error term with the usual properties and the subscript c represents the 66 individual cities, while t represents time.

Columns 1 through 3 of Table 9 presents the city-level results based on equation (2) for the three dependent variables, net absorption, vacancy rates, and asking rent. It is interesting to note that each independent variable has statistical significance on only one dependent variable at most. Unfortunately, this is a reflection of the fact that my city level regression testing did not have nearly as much statistical significance as the country level testing. Total e-commerce retail sales are statistically significant on asking rent only. It was encouraging for my research to see e-commerce sales testing at the highest level of significance and the increase in e-commerce sales having a negative correlation on asking rents. For every trillion dollars that e-commerce

sales increase, the average asking rent of retail space drops one dollar per square foot. This is by no means a tremendous correlation, but it is still meaningful. E-commerce sales currently increase by hundreds of billions of dollars a year, causing asking rents to lower by fractions of a percent. Asking rent is a very strong indicator of how a real estate market is performing because it reflects the supply and demand dynamic at that time. If asking rent is lowering, it means that the real estate is becoming less desirable. If retail real estate is becoming less desirable because of a growth in e-commerce sales specifically, it supports my hypothesis.

Unemployment rate is the only control variable that has a negative effect on a dependent variable. Statistically significant at the highest level, the coefficient shows that for every one percent the unemployment rate rises, asking rents in cities across the U.S. drop on average $10 per square foot of retail space, a relatively large drop. The effect of the unemployment rate on asking rent is relatively self-explanatory. Rising unemployment rates signal that local businesses are not doing well, which means that asking rents will have to be lower in order for retail real estate space to maintain their tenants. Inflation rates and the stock market price are also statistically significant, and both have positive effects on asking rents. The stock market price increasing shows that the United States economy is doing well, therefore asking rents will increase as an effect of this strong economy. Although inflation rates rising can be detrimental to the economy and individuals, it can cause interest rates to rise and force businesses to raise their prices. This increase in nationwide prices will in turn cause retail real estate asking rents to increase as well.

When looking at the regression test using net absorption as my dependent variable, poverty rates are significant and have a positive coefficient. This means that for every percent that the poverty rate rises, net absorption will increase by over eight billion square feet. This is

over 100 times more than net absorption moves on an average year. The positive effect on net absorption does not mean that the retail real estate market does better when poverty rates are higher, but it could instead be attributed to the fact that there is not as much retail space being created and constructed anymore and therefore less to deduct from the total amount of space leased. This lack of new construction likely hurts the local communities' developers and construction workers, as well as likely showing slower real estate growth in the communities as a whole, which can lead to high poverty rates amongst its citizens. To summarize the findings in all of my regression tests, an increase in e-commerce sales negatively impacts NCREIF returns, Commercial real estate prices, and retail real estate asking rents.

VI. Conclusion

This paper set out to discover if the growth of e-commerce sales and the emergence of an online retail marketplace has affected the retail real estate market. The previous literature written on this subject by Dixon and Marston, Worzala and McCarthy, and Baen was written from 2000 to 2002 when the e-commerce market was just beginning to form. Their research, primarily in the United Kingdom, hinged largely on surveying and speculation and provided only qualitative information. I took the concepts that they based their research on and applied them to today's fully formed and still growing e-commerce market. The purpose of my paper was to find quantitative answers on whether the growth of the e-commerce market has affected retail real estate. By collecting United States data on e-commerce sales growth, a variety of control variables, and myriad retail real estate factors, I was able to run a series of regression tests that provided quantitative data to fill in the gaps of previous research.

Via OLS estimation, it has been found that e-commerce sales do have an impact on retail real estate to some degree. There are not effects on every factor of the retail real estate market tested, but there is evidence of correlation amongst some of the regression tests run. Many of these correlations are negligible, but nonetheless it is important to see how these correlations impact the real estate market and the intuitive reasoning behind these correlations.

On the country level, returns of the NCREIF property index and percent change in commercial real estate prices for the U.S. are negatively impacted by total e-commerce sales. This negative correlation shows that online retail sales are hurting the retail real estate industry both privately and publicly. A decline in the NCREIF property index indicates that private investments in the commercial real estate space have decreased as e-commerce sales have increased. Growing e-commerce sales causing commercial real estate prices to suffer indicates that physical retail space is in lower demand as an effect of increasing online sales. This notion is furthered in my regression testing at the city level. On a city level, asking rent amongst the cities studied is negatively impacted by total e-commerce sales. As e-commerce sales rise, asking rents lower in cities across the country, likely as an effect of fewer people shopping at brick and mortar locations and the demand for these locations decreasing.

These findings are important as they help to provide some answers to much of the past literature written on the topic. It is evident that total e-commerce retail sales are increasing rapidly and that they are steadily growing their share of the total retail sales in the United States. The results from my regression testing show that this increase in sales has negatively impacted the retail real estate industry as a whole. It is detrimental to the country, and individual cities, to have increased vacancies in their retail spaces and decreased pricing for these spaces. Potential policy implications may need to be implemented to offset the decrease in demand. Policies may

include cities looking to shift away from retail space in favor of more residential houses and multipurpose public spaces. The government can also look to increase taxes on e-commerce sales as a way to level the playing field.

Much of my findings were hypothesized by previous researchers based on their early surveys and studies of the changing retail landscape, but the ability to provide quantitative data to support my hypothesis, and the hypotheses of the other researchers, is tremendous. Even with these new findings, these is still room for further investigations into this topic.

It is possible that this lower demand for physical retail space, and therefore a lowering in the prices for this space, will negatively impact communities in the future. Although businesses may not suffer from receiving their sales online instead of in physical stores, the cities and communities where these stores are located might suffer from their decreasing foot traffic. As discussed in the introduction to this paper, many retailers rely on each other to draw in customers (Richter 2017). When one business does well it can benefit others around it simply by drawing people to the area who are prepared to shop and spend money on retail items. I have seen that retail space can be negatively impacted by e-commerce sales, but it would be interesting to see exactly which businesses are being impacted the most. Further research can be had into which specific sectors are being impacted the most as well as which specific companies. This information can be used to determine the differences between retail setups and whether being an individually located retailer on a downtown city block is likely to be more or less effected by e-commerce sales than a retailer located in a shopping center and mall. Investigations into how retail is organized can provide lots of information into the direction retail is headed and how they should be organized in order to better their chances of surviving as a brick and mortar store.

One my concerns with this paper is the limited amount of data used at the city level. Although I found my collection of 66 cities to be sufficient, I wish that I could have looked at the data for more than just the last five years. Following this data from 2000, rather than 2014, can provide a better picture of how cities have been impacted. It would also be interesting to see if there are any characteristics of these cities that make their retail sectors more or less likely to be impacted by the growth e-commerce sales. This can likely be investigated using information on demographics of each city. Further research can also generally improve the variables used in my research. Different retail real estate variables can be investigated, and further dependent variables can be added to show different aspects of e-commerce sales and possibly other important control variables.

It is fulfilling to see this research add quantitative data that fills the gaps and supports the investigations of other great researchers. As time moves on and technology continues to consume our daily lives it seems inevitable that the online retail industry will continue to prosper. As e-commerce retail sales continue to grow, it can be assumed that retail real estate will continue to suffer. Further research will be needed to investigate the everchanging retail landscape further.

VII. Tables

Table 1- Country Level Summary Statistics				
	Mean	Standard Deviation	Min	Max
Total Retail Space Vacated in U.S. (in million SF)	82.216	38.609	24.5	165.5
Value of U.S. Construction Put in Place (in billion U.S. dollars)	66.491	14.991	40.1	89.68
Returns of the NCREIF Property Index (in %)	2.071	3.021	-8.29	5.43
Change in Commercial Real Estate Prices for United States (in %)	8.058	11.25	-28.3	19.9
E-commerce Sales (in million U.S. dollars)	46117.95	34534.07	5691	122526
E-commerce Sales as a Percent of Total Retail Sales (in %)	4.247	2.587	0.80	9.4
Stock Market Price	1479.792	480.288	879.82	2683.73
Unemployment Rate (in %)	6	1.766	4	9.8
Inflation Rate (in %)	2.184	1.106	-0.4	3.8
Treasury Bond Rate (in %)	3.346	1.108	1.76	5.11
Poverty Rate (In %)	13.18	1.25	11.30	15.10
Violent Crime Rate (Per 100,000 pop)	438.49	53.99	361.6	523

Table 2- Country Level Dependent Variables by Year				
Year	Total Retail Space Vacated in U.S. (in million SF)	Value of U.S. Construction Put in Place (in billion U.S. dollars)	Returns of the NCREIF Property Index (in %)	Change in Commercial Real Estate Prices for United States (in %)
2000	154.9	67.49	3.33	12.1
2001	165.5	63.2	0.67	11.4
2002	103.3	62.52	1.67	13.6
2003	88.9	61.53	2.76	14.9
2004	57.8	67.06	4.66	16.2
2005	88.4	70.24	5.43	15.0
2006	58.9	76.71	4.51	13.8
2007	55.3	89.68	3.21	13.5
2008	132.2	86.21	-8.29	5.7
2009	71.2	54.74	-2.11	-12.9
2010	68.7	40.1	4.62	-28.3
2011	56	42.82	2.96	19.9
2012	33.5	47.34	2.54	4.8
2013	24.5	53.16	2.53	7.3
2014	62	62.84	3.04	13.6
2015	41.4	65.9	2.91	14.1
2016	97.8	76.58	1.73	5.9
2017	98.5	86.95	1.8	6.1
2018	103.3	88.26	1.37	6.4

Table 3 –City Level Summary Statistics by Year					
Variable	2014	2015	2016	2017	2018
Net Absorption (in million SF)	442212.642 (1733999.58)	323076.418 (1326787.21)	259242.806 (1063409.89)	425216 (1730517.29)	183609.97 (785418.463)
Vacancy Rate (in %)	0.083 (0.022)	0.077 (0.022)	0.074 (0.026)	0.066 (0.018)	0.063 (0.016)
Asking Rent (in $)	24.287 (6.307)	21.432 (7.364)	20.377 (6.877)	16.496 (5.539)	17.138 (5.538)

Table 4 - City Level Summary Statistics by City			
City	Net Absorption (in million SF)	Vacancy Rate (in %)	Asking Rent (in $)
Albuquerque	41285.6 (99784.02)	0.077 (0.008)	17.542 (3.973)
Atlanta	472258.2 (289219.5)	0.087 (0.015)	16.574 (3.622)
Austin	137235.2 (197777.3)	0.054 (0.009)	25.288 (3.631)
Bakersfield	8136.6 (127576.1)	0.089 (0.006)	17.488 (2.843)
Baltimore	68538.8 (133293.2)	0.055 (0.001)	26.738 (7.311)
Birmingham	38445.4 (153625.3)	0.0972 (0.018)	13.444 (4.581)
Boise	44551.6 (75614.86)	0.073 (0.006)	15.12 (2.925)
Boston	173160.2 (287992.8)	0.038 (0.005)	22.604 (3.262)
Buffalo	26932 (40208.69)	0.0656 (0.012)	12.72 (1.36)
Charleston	74117.4 (47618.12)	0.057 (0.017)	20.688 (1.834)
Charlotte	399023.2 (134029.8)	0.063 (0.008)	18.534 (4.115)
Chicago	587958.8 (256124.4)	0.103 (0.007)	18.492 (3.349)
Cincinnati	321559.6 (215860.6)	0.095 (0.012)	13.274 (1.587)
Cleveland	166262.6 (253234.2)	0.086 (0.015)	13.344 (2.667)
Columbus	207445.2 (241821.1)	0.066 (0.017)	13.574 (2.042)
Dallas	823814.2 (199929.1)	0.079 (0.013)	19.02 (3.001)
Denver	300957.4 (194756.8)	0.071 (0.005)	19.02 (3.001)
Des Moines	24231.8 (66134.94)	0.006 (0.013)	14.396 (2.927)
Detroit	258128.6 (100949.4)	0.101 (0.015)	15.744 (3.447)
Fort Lauderdale	236158 (105644.4)	0.061 (0.013)	23.964 (3.670)
Hampton Roads	143787.6 (268511.2)	0.073 (0.005)	17.146 (3.047)
Hawaii	30105.6	0.047	43.526

	(18094.46)	(0.011)	(7.72)
Houston	408221.4 (212055.3)	0.069 (0.004)	20.488 (4.108)
Indianapolis	-48800.6 (105386.9)	0.081 (0.009)	16.41 (3.932)
Inland Empire	350373.3 (259773.8)	0.092 (0.008)	20.98 (2.317)
Jacksonville	212339 (139575.8)	0.084 (0.018)	16.322 (2.812)
Kansas City	126737.4 (206530.8)	0.09 (0.013)	15.982 (2.733)
Knoxville	56291.6 (105269.7)	0.068 (0.019)	14.798 (1.049)
Las Vegas	203213.4 (275618.5)	0.119 (0.049)	20.062 (4.587)
Little Rock	-13685.8 (87630.78)	0.062 (0.012)	15.856 (3.106)
Los Angeles	244719.6 (368292.4)	0.055 (0.009)	30.474 (3.687)
Louisville	-14496.2 (126402.2)	0.054 (0.005)	15.344 (3.374)
Memphis	164039 (254389.6)	0.088 (0.017)	14.432 (4.501)
Miami	249965.8 (177347.5)	0.045 (0.015)	34.142 (6.365)
Milwaukee	2743.2 (137122.8)	0.095 (0.007)	15.454 (4.012)
Minneapolis	175745.2 (223763.6)	0.064 (0.012)	17.058 (2.488)
Mobile	30670.2 (86861.4)	0.105 (0.013)	12.972 (4.082)
Nashville	96251.2 (125892.1)	0.056 (0.017)	20.858 (5.253)
New Orleans	1816.6 (90144)	0.071 (0.017)	19.632 (6.458)
New York City Metro (Greater Tri-State)	637088.2 (297086.6)	0.063 (0.003)	27.186 (3.780)
Oakland/East Bay	286905 (174145.7)	0.051 (0.004)	27.436 (4.025)
Oklahoma City	-5778.2 (78911.91)	0.089 (0.004)	14.686 (2.285)
Omaha	5432.6 (46443.92)	0.083 (0.009)	15.458 (2.947)
Orange County	101487 (190465.1)	0.049 (0.005)	30.348 (4.392)

Orlando	265407.8 (174829.9)	0.073 (0.011)	19.306 (2.146)
Palm Beach	138934.6 (140273.9)	0.066 (0.012)	23.516 (2.358)
Philadelphia	118886.4 (439851.9)	0.075 (0.007)	19.042 (3.129)
Phoenix	422109.8 (312448)	0.106 (0.014)	18.392 (4.058)
Pittsburgh	22891.6 (106598.7)	0.047 (0.004)	17.772 (4.601)
Portland	260151.6 (120515.4)	0.062 (0.010)	22.62 (3.255)
Providence	20648.8 (44078.77)	0.082 (0.016)	17.074 (5.128)
Raleigh/Durham	146783.8 (115225.4)	0.048 (0.012)	19.76 (1.959)
Reno	62558.2 (34284.09)	0.112 (0.027)	19.458 (4.949)
Richmond	68483.8 (75622.73)	0.081 (0.008)	17.834 (2.451)
Sacramento	393175.6 (260736.4)	0.096 (0.013)	20.586 (3.968)
Salt Lake City	108357.6 (259768)	0.06 (0.005)	18.358 (2.454)
San Antonio	39298.8 (165728.1)	0.069 (0.008)	17.99 (2.41)
San Diego	46614.2 (324390)	0.054 (0.009)	26.796 (3.942)
San Francisco Metro	157102.4 (92044.75)	0.043 (0.003)	24.898 (6.721)
San Jose	203493 (129908.8)	0.045 (0.005)	36.79 (5.496)
Seattle	215270.4 (159725.9)	0.06 (0.008)	24.32 (5.41)
St. Louis	24625.6 (222579.5)	0.084 (0.012)	14.462 (1.676)
Tampa	170301.2 (129015.4)	0.075 (0.010)	18.35 (4.093)
Tucson	17048 (67875.07)	0.087 (0.007)	18.808 (4.046)
Tulsa	52176.8 (71549.65)	0.078 (0.012)	13.274 (2.282)
Washington, DC	230583.6 (250716.2)	0.049 (0.003)	32.18 (4.168)

Table 5 – City Level Summary Statistics				
Variable	Mean	Standard Deviation	Min	Max
E-commerce Sales (in billion U.S. dollars)	46117.95	34534.07	5691	122526
E-commerce Sales as a Percent of Total Retail Sales (in %)	4.247	2.587	0.80	9.4
Stock Market Price	1479.792	480.288	879.82	2683.73
Unemployment Rate (in %)	6.00	1.766	4.00	9.80
Inflation Rate (in %)	2.184	1.106	-0.40	3.80
Poverty Rate (in%)	13.26	21.74	0.058	57
Crime Index (US Average =280.6)	474.23	185.03	106.60	968.70

Table 6- E-commerce Sales and E-commerce Sales as a Percentage of Total Retail Sales		
Observation Date	ECOMSA	ECOMPCTSA
2000-01-01	5691	0.8
2001-01-01	8135	1.1
2002-01-01	9904	1.3
2003-01-01	12738	1.6
2004-01-01	16697	2
2005-01-01	20801	2.3
2006-01-01	26417	2.7
2007-01-01	31728	3.2
2008-01-01	36017	3.6
2009-01-01	34132	3.8
2010-01-01	39289	4.2
2011-01-01	46936	4.7
2012-01-01	54788	5.1
2013-01-01	61985	5.6
2014-01-01	70425	6.2
2015-01-01	80500	6.9
2016-01-01	92145	7.8
2017-01-01	105387	8.4
2018-01-01	122526	9.4

Table 7- E-commerce Retail Sales % Change by Year	
Year	E-commerce Retail Sales % Change (t/t-1)
2001	30.043
2002	17.861
2003	22.248
2004	23.711
2005	19.730
2006	21.259
2007	16.739
2008	11.908
2009	-05.523
2010	13.126
2011	16.292
2012	14.332
2013	11.611
2014	11.984
2015	12.516
2016	12.638
2017	12.565
2018	13.988

Table 8 – The Determinants of Retail Commercial Real Estate: Country Level				
Variables	Total Retail Space Vacated in U.S. (in million SF)	Value of U.S. Construction Put in Place (in billion U.S. dollars)	Returns of the NCREIF Property Index (in %)	Change in Commercial Real Estate Prices for United States (in %)
Total E-commerce Retail Sales	-0.0003 (0.0008)	0.0005*** (0.0001)	-0.0001* (0.0000)	-0.0005* (0.0003)
Stock Market Price	0.087 (0.052)	-0.019* (0.009)	0.002 (0.004)	-0.006 (0.016)
Unemployment Rate	6.774 (12.494)	-12.654*** (2.379)	2.384** (0.843)	-3.394 (3.765)
Inflation Rate	-1.166 (7.427)	1.708 (1.414)	0.822 (0.501)	2.907 (2.238)
Yield of 10-year Treasury Bond Rates	-10.867 (12.949)	-1.283 (2.466)	2.966*** (0.874)	-4.634 (3.902)
Poverty Rate	-6.338 (21.305)	8.871** (4.057)	-3.819** (1.438)	-8.023 (6.421)
Violent Crime Rate	0.894* (0.484)	0.233*** (0.092)	-0.142*** (0.033)	-0.404** (0.146)

Standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1.
How does each dependent variable impact important retail real estate factors in the United States?

Table 9 – The Determinants of Retail Commercial Real Estate: City Level			
Variables	Net Absorption (in million SF)	Vacancy Rate (in %)	Asking Rent (in $)
Total E-commerce Retail Sales	-9.898 (24.224)	-0.000 0.000	-0.001*** (0.000)
Stock Market Price	-301.251 (477.322)	0.000 0.000	0.034*** (0.006)
Unemployment Rate	-162,503.6 (296,014.1)	-0.011 (0.017)	-10.905*** (3.583)
Inflation Rate	320,483.6 (201,829.2)	0.003 (0.013)	4.539* (2.443)
Poverty Rate	8375.148** (3,708.541)	-0.000 0.000	-0.006 (0.045)
Crime Index	333.976 (288.996)	0.000 0.000	-0.005 (0.003)

Standard errors in parentheses
*** p<0.01, ** p<0.05, *p<0.1
How does each dependent variable impact important retail real estate factors across 66 individual cities nationwide?

VIII. Figures

Figure 1

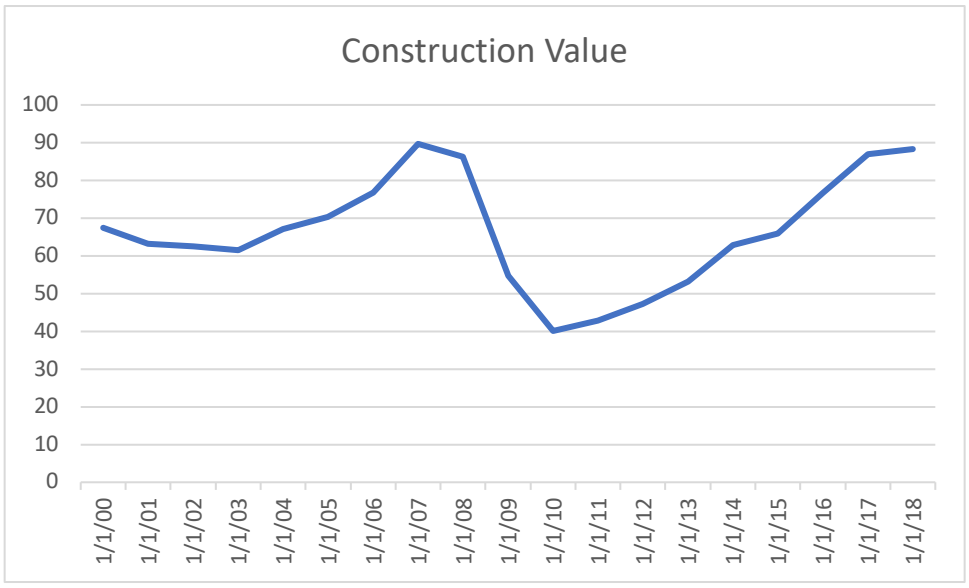

Figure 2

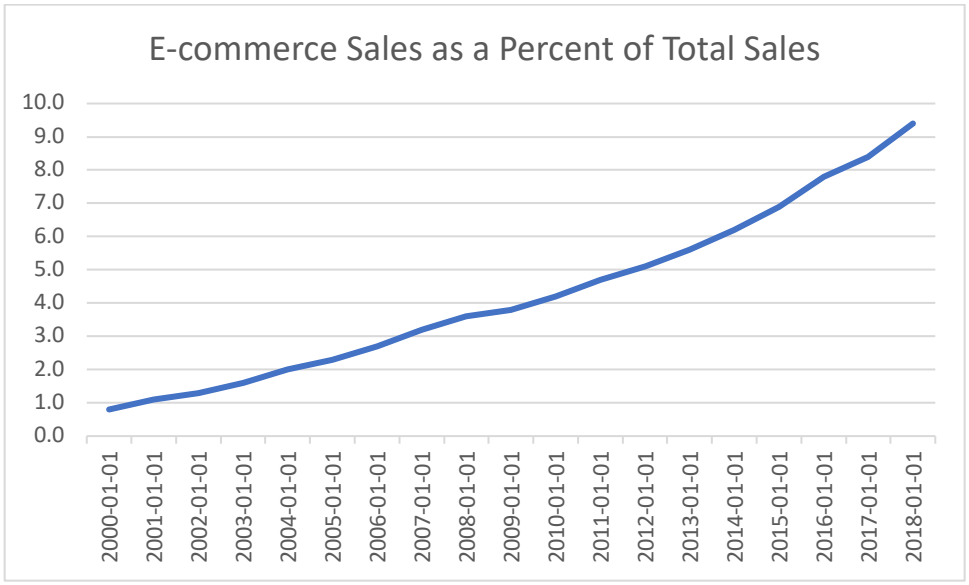

Figure 3

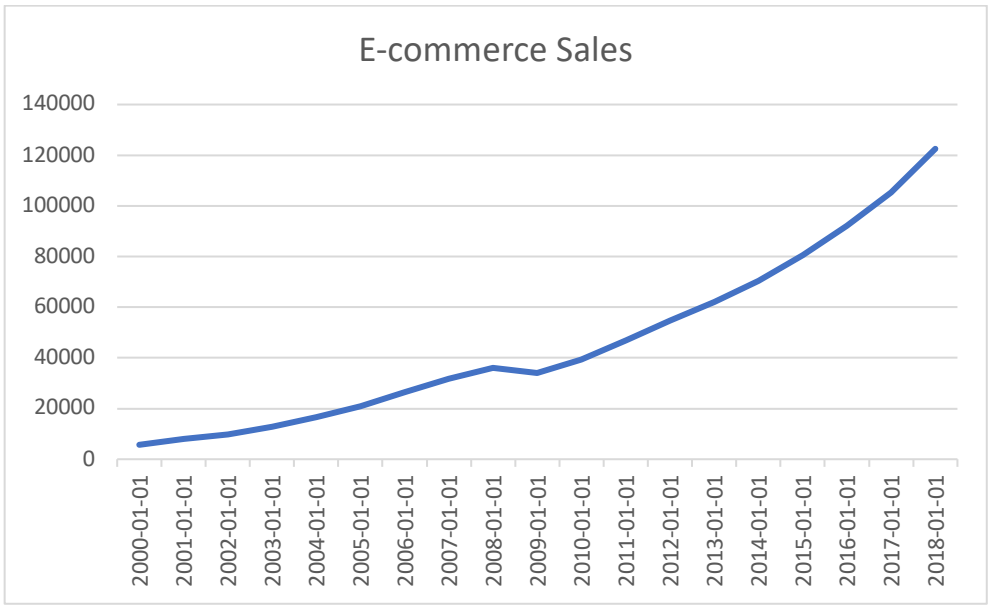

Figure 4

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ecompctsa	0.9940	1.0000

Figure 5

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