Effects of e-commerce on local labor markets

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Abstract

E-commerce has experienced extraordinary growth in recent years. This paper studies the effects of e-commerce on local labor markets resulting from the enactment of state legislation, the Amazon Tax, which reduced the price advantage of out-of-state e-commerce retailers. I find declines in employment (9.6%) and wages (7.8%) in last-mile transportation and warehousing, as well as declines in local retail employment and number of establishments (1%). I find distinctive effects by retail sector: warehouse clubs and supercenters' employment increases (6.27%), while other brick-and-mortar retailers' employment decreases (2.32%). These effects are influenced by retail employment changes in urban areas. Additionally, I observe a two-part compositional change of retail employment in non-urban areas: an increase in the share of office and service occupations (7.14%) and decrease in the share of sales and related occupations (4.79%). Finally, through a general equilibrium model, I study the conditions that predict these empirical results.

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Introduction

In the last decade, there has been an increase in the presence of online retailers (Amazon.com, eBay.com, Alibaba.com, Zappos, Newegg, Safeway, etc) which had led to the rapid growth of e-commerce transactions from 4.2% of total sales in the first quarter of 2010 to 10.5% of total sales in the first quarter of 2019 in the United States.[1]. Given that retail is a key local economic activity and that the retail workforce represents 11% of the total workforce in the US, it is paramount to understand the effects of e-commerce on local labor markets. Gebeloff and Russell (2017), Kane and Tomer (2017) and Tomer and Kane (2021) suggest the expansion of e-commerce may harm retail workforce, especially outside of metropolitan areas. On the other hand, Hortaçsu and Syverson (2015) casts doubt on e-commerce driving force due to its smaller size compared to Warehouse Clubs and Supercenters, while Mandel (2017) associates e-commerce with job creation and wage growth. In this paper, I evaluate the effects of e-commerce on local labor markets of related industries through the enactment of the Amazon Tax, a state legislation that removes a price advantage for out-of-state online retailers.

The main identification challenge to evaluate the effects of e-commerce introduction in local labor markets is that e-commerce sales grow everywhere at a pace given by local economic conditions. Hence, it may not be possible to distinguish between e-commerce exposure and local economic conditions to differentiate treated and control areas. I exploit the fact that out-of-state e-commerce retailers have had a price advantage which dissipates when the Amazon Tax legislation is enacted to identify the effects of e-commerce on local labor markets. The price advantage originates in out-of-state e-commerce retailers not being required to collect state sales taxes for more than two decades. Starting in 2008, to recover tax revenue losses, state governments enacted legislation, which is known as the Amazon Tax.[2]

Using employment and establishment counts from County Business Patterns as well as wages and occupation's employment shares from the American Community Survey, I examine the effects of the Amazon Tax enactment in four states in 2013. I use a difference-in-differences design, exploiting the exogenous variation provided by the year of enactment of the Amazon Tax to evaluate the changes in incentives for both in-state brick-and-mortar and e-commerce retailers. First, I identify effects in employment rates and number of establishments for retail and warehousing and transportation sectors at commuting zones. I find that after the Amazon Tax is enacted, local employment in transportation and warehousing decrease on average by 34.8 employees per 100,000 working age population per year, which represents a 9.6 percent decrease from its average pre-period mean. More-

[1] See Figure 1

[2] State governments also signed voluntary collection agreements with major e-commerce retailers, like Amazon.com, Inc (Amazon) whose sales account for 50% of online retail sales by 2018 Berg et al. (2019)

over, I observe an average decline in retail employment in commuting zones in states that enacted the Amazon Tax on average of 74.6 retail employees per 100,000 working age population per year compared with retail employment in commuting zones that did not enact the Amazon Tax. This decline represents more than 1 percent of the average retail employment in commuting zones before the year of enactment. However, I find a differential effect for warehouse clubs and supercenters and the remaining brick-and-mortar retailers. After the Amazon Tax is enacted, employment in warehouse clubs and supercenters increased on average by 6.27 percent each year in commuting zones in treated states, while employment in other brick-and-mortar retailers decreased on average by 2.32 percent from its baseline pre-period mean. All observed effects on employment are driven by urban commuting zones.

I also find there is a small decrease in the number of establishments of a yearly average of 3.74 fewer establishments per 100,000 population in urban commuting zones, which represents a decline of 0.98 percent from the baseline mean. Moreover, I do not observe a statistically significative change in the number of establishments in the transportation and warehousing sector.

As the price advantage is removed, now retailers have incentives to reorganize their labor structure to regain market share from e-commerce retailers. In light of the new incentives, and following the same methodology, I evaluate possible changes in wages and the occupational structure of the retail sector using the American Community Survey (ACS). I find that after the Amazon Tax is enacted there is a decrease in annual wages and hourly wages of employees in transportation and warehousing of 8.3% and 7.78% respectively. Finally, while I do not find statistically significant changes in retail occupational shares of all commuting zones, I observe that in non-urban commuting zones the sales and related occupational share in retail decreased on average by 2.5 percentage points, and office and service occupational share in retail increased on average by 1.52 percentage points after the Amazon Tax enactment.

Hence, when out-of-state e-commerce retailer price advantage is reduced, last-mile transportation and warehousing employment and wages decline. Additionally, in urban commuting zones the competition between warehouse clubs and supercenters and general brick-and-mortar intensifies, leading to an increase in employment for the first sector and a decrease in employment for the second sector, which add to a decline of overall retail employment. Last but not least, while retail employment does not change in non-urban areas, its composition does. The increase in office and service occupations and the decline in sales and related occupations suggest that retailers could be turning to a hybrid production model.

To investigate the potential channels leading to these effects, I also provide a conceptual framework. Through a four-sector general equilibrium model analysis, I find that the empirical results could be explained by three conditions. First, the consumers' elasticity of substitution between ware-

house clubs and supercenter retail and e-commerce retail is bounded by the consumers' elasticities of substitution between other brick-and-mortar retail and the previous types of retail. Second, workers' elasticity of substitution between being employed at warehouse clubs and supercenter retail and being employed at last-mile transportation and warehousing is bounded by the workers' elasticities of substitution between being employed at other brick-and-mortar retail and being employed in the previous sectors. Lastly, the relative difference in consumption preferences for different types of retail has to be larger than the relative difference in labor preferences for working in different retail sectors or last-mile transportation and warehousing.

This paper contributes to a growing literature that explores the role of e-commerce in the economy with a new identification strategy. By exploiting the enactment of the Amazon Tax as source of exogenous variation, this paper evaluates how the removal of a price advantage changes incentives for both e-commerce and brick-and-mortar retailers which may lead to changes in the retail market structure. In that sense, this paper extends the literature evaluating e-commerce effects on market structure, competition, prices, entrance and exit, and spatial distribution (Goldmanis et al., 2010; Bar-isaac et al., 2012; Cavallo, 2017; Vitt, 2020; Pozzi, 2013; Wu, 2020; Fang and Policy, 2020). As this literature is mostly descriptive and theoretical, by incorporating the Amazon Tax as the identification strategy, this paper is the first to explore e-commerce causal effects.

Furthermore, this paper adds to the understudied literature on the effects of e-commerce on labor markets. Chun (2019) explores how online spending affects local retail employment. By instrumenting the geographic variation in online spending with the age distribution and online penetration rates, Chun (2019) finds a reduction in retail employment. However, this work does not take into account for unobserved economic conditions that may affect online penetration rates at the same time than employment. In the same line of research, but with a different approach, Chava et al. (2018) explores the changes in employment status and wages of employees at brick-and-mortar retailers when fulfillment centers from a major e-commerce retailer are established in the same county. They find a reduction not only in employment, but also in wages of hourly workers due to a reduction in hours employed. One major drawback of this approach is that it does not take into account that once a fulfillment center is introduced in a neighbour county in the same state, the e-commerce retailer may be required to collect sales tax for all the counties in that state. Hence, spillover effects over same-state counties may lead to a violation of the stable unit treatment value assumption conditions, since counties considered as controls may also be treated. While both studies introduce innovative strategies to evaluate e-commerce effects in employment, both strategies rely on economic retail market conditions. My contributions to this literature are twofold: identification and exploring mechanisms. I contribute in regards to the identification by exploiting the enactment of sales tax legislation, the Amazon Tax, as a new source of variation. On the other hand, I contribute to the

analysis of local labor market effects of e-commerce by exploring changes in the way retail is done, through the occupational requirement.

Lastly, this paper contributes to the literature that studies the effects of the Amazon Tax. Baugh et al. (2018) finds that the Amazon Tax reduces online sales, while Afonso (2019) shows that it increases tax revenue. Kaçamak and Wilking (2020) shows that the Amazon Tax leads to the presence of a pass-through to consumers as well as to a reduction in online expenditure. This paper is the first to evaluate the Amazon Tax effects on the local retail labor market and explore the mechanisms behind these changes with a general equilibrium model.

In the next section, I explore the institutional background regarding the changes in the retail sector and retail labor market as well as the history of the Amazon Tax. In the third section I describe the data and empirical strategy. In the fourth section I present the main results. In the fifth section I introduce a conceptual framework that investigate the potential channels leading to the observed effects. Finally, the last section summarizes the conclusions.

Institutional Background

The retail sector and the retail labor market

The retail industry is present in almost all the local markets in the United States.[3]. Also, retail has experienced three main changes over the last thirty years. First, the decline of small family owned stores, also known as Mom-and-pop stores, due to the entrance of big-box stores, as warehouse clubs and supercenters, has been widely studied as the "Wal-mart effect". Second, department stores have been experiencing a sharp decline in their number of establishments, that the media has denominated as "Retail apocalypse". Finally, the development of new technologies has made not only possible but also safe to buy online with the emergence of e-commerce retailers.

In this section I document changes in retail and in the retail labor market using data from the American Community Survey, the Annual Retail Trade Survey and the Occupational Employment and Wages Survey. The North American Industry Classification System (NAICS) identifies as e-commerce retailers as those retailers that do not have a store, perform most of their sales online, and are included into "Electronic Shopping and Mail Order Housing (NAICS 4541)". The remaining retailers, also known as brick-and-mortar retailers, may also sell online, but are classified according to their primary business activity.

Before exploring labor market outcomes, it is paramount to observe that the retail labor market is highly responsive to changes in retail sales. Figure 2 presents e-commerce and brick-and-mortar

[3]According to County Business Patterns data 99.81 % of the U.S. counties had at least one retail establishment in 2003.

retail trends for both employment, measured as employees in hundred thousands, and total sales, measured as sales in hundred thousands in 2014 us dollars. There is a high correlation between sales and employment in both sectors up to 2017.

While the origins of e-commerce can be traced to early 1980s, it was not until mid 1990s with the launching of the first web browsers that companies started developing e-commerce platforms. Moreover, the first e-commerce companies like Book Stacks Unlimited and Amazon.com, Inc. were focusing on the online book market. Figure 3 shows the share of online sales with respect to total sales for e-commerce (NAICS 4541). Online sales reach more than half of the total sales of the sector in the year 2009, reaching up to 80% in the year 2018. Not only online sales had an immense growth in the e-commerce sector, but also the share of the e-commerce sector as part of retail experienced an a vast growth. In 2005 the Electronic Shopping and Mail-Order Houses (NAICS 4541) sector represented 5% of the total retail sales, but in 2016 e-commerce retailers represented more than 10% of total retail sales. An additional way to observe the increasing importance of e-commerce is through the growth rate of sales. Figure 1 shows that, for the period 2005-2017, the growth rate of sales of e-commerce retailers is several times the growth rate of sales of brick-and-mortar retailers.

Despite employment and sales being highly correlated for e-commerce and brick-and-mortar retailers, e-commerce retailers employs fewer employees and a different occupational structure than brick-and-mortar retailers for the same amount of sales. Figure 4 shows the number of employees per 100,000 usd in sales for both sectors for years 2000-2018. While in 2005 e-commerce retailers required 1.19 employees per 1 usd in sales, brick-and-mortar retailers required 2.98 times the number of employees that e-commerce retailers. By the year 2017, that difference has grown to 3.48 times. Not only does e-commerce employs fewer employees in its own sector that brick-and-mortar retail as well as relies on employees from last-mile warehousing and transportation sector, but also e-commerce and brick-and-mortar retail require different types of employees. Figure 6 Panel A presents the occupational structure in retail, grouped for the main three sectors, in the year 2007 using OEWS data. Both E-commerce (NAICS 4541) and Warehouse clubs and supercenters (NAICS 4529) employ more employees from office and service occupations that general brick-and-mortar sectors.[4] However, in order to sell goods, e-commerce retailers employ less employees of sales and related occupations and requires from the last-mile transportation and warehousing sector (NAICS 49). Figure 5 shows how the growth rate of e-commerce retail sales is highly correlated to the growth rate of employment in last-mile transportation and warehousing in the period studied.

Finally, there is also evidence that the retail sector is moving to a hybrid retail model: an increase in brick-and-mortar online sales as well as changes in the retail occupational structure. First,

[4] I split retailers into warehouse clubs and supercenters (NAICS 4529), e-commerce retailers (NAICS 4541) and other general brick-and-mortar retailers (remaining NAICS)

the shares of online sales from brick-and-mortar retailers have more than double between 2005 and 2016. Even when those shares remain small, the changes preempt the COVID-19 pandemic.[5] Second, the occupational structure of the retail sector also has experienced several changes. Figure 6 Panel B presents the changes in occupational shares for the 5 major occupational groups in retail with respect to the corresponding shares in 2005. The retail sector in 2005 represents around 10% of the total employed population, and the share of sales and related occupation is 53% of the retail employees. Hence, a reduction in the share of sales and related occupations in retail of 5% from 2005 to 2017 represents 1% less employees in sales and related occupations, or more than 1M employees not working in sales and related occupations anymore. Together, this evidence suggests that brick-and-mortar may have made some adjustments to sell online and adopt a hybrid model.

In order to explain these changes in the retail sector and in the retail labor market first and foremost I consider the evolution of retail competition. The first indicator of the type of competition is that prices from websites and physical stores are similar in US 69% of the time Cavallo (2017). However, Cavallo (2017) analysis of US prices does not include tax rates or contemplate tax rates differences due to state legislation. As out-of-state online retailers are exempt from collecting sales taxes, they have a price advantage over brick-and-mortar retailers. With a sufficient price advantage, more consumers may choose buying online. Hence, the price advantage could have accelerated the growth of e-commerce and could have lead the changes in the retail labor market. Leveling the playing field, as out-of-state e-commerce retailers are being required to collect sales taxes by new state legislation, results a reduction of out-of-state online sales documented by (Baugh et al., 2018; Einav et al., 2014). In the next sections, I introduce the details of what the legislation change entailed, to later focus on the effects of the Amazon Tax on local labor markets.

Amazon Tax

The enactment of the Amazon Tax legislation by state governments establishes that out-of-state retailers are required to collect state sales taxes for purchases realized in-state. This paper studies the effect the Amazon Tax legislation has over the local labor market.

To provide some context, consumers across US are responsible for paying sales taxes from out-of-state purchases, also known as "use taxes". Use taxes are set to discourage circumventing sales taxes through out-of-state consumption. Consumers are required to remit use taxes on the income tax returns annually. However, Manzi (2010) finds that only 27 states that have sales and income taxes include a line on the income tax return to report use tax. Furthermore, he finds that more than 89% of the of income tax returns of those states do not report any use tax. Low compliance on use tax

[5] See Figure 7

reporting could be explained due to use taxes not being collected at the time of the purchase and consumers relying on retailers to collect sales taxes.[6]

Moreover, in the 1992 case *Quill v. North Dakota*, the US Supreme Court ruled that out-of-state retailers cannot be required to collect state sales taxes due to lack of nexus (physical presence) in the state. The reason sustained by the Court was that otherwise collecting sales taxes would impermissibly burden interstate commerce due to many diverse taxing jurisdictions.[7] Hence, since 1992, the US Supreme Court ruling gave a price advantage to out-of-state online retailers over brick-and-mortar retailers. Furthermore, several researchers estimate and forecast revenue losses from uncollected state sales taxes due to e-commerce. Bruce and Fox (2001) estimates these losses were $7B in 2001 and forecasts those losses to be $29.17B in 2011 (2.83% of total sales tax collection). As estimates and forecasts have been updated the revenue losses have increased.[8]

As state government's concerns increased, in 2008, the state of New York enacted the first legislation that changed the definition of nexus to require sales tax collection from out-of-state retailers. The definition of nexus as physical presence was replaced by "having a constitutionally sufficient connection between the state and business". The new legislation considers retailers that have affiliates, associates or subsidiaries in-state to have a sufficient connection with the state, and hence being required to collect sales taxes.[9]

In the following years, 28 states have implemented sales taxes on out-of-state e-commerce sales by making the definition of nexus broader. These legislation changes, also known as the "Amazon Tax", have been associated to increases in sales tax collection and declines in consumption. Afonso (2019) finds that the Amazon Tax increases local sales tax revenue while comparing tax revenue collection in North Dakota counties with South Dakota counties after North Dakota enacted the Amazon Tax. Moreover, he finds that the policy change benefits more urban jurisdictions than rural or tourism-rich jurisdictions due to the urban jurisdiction also collecting local sales taxes. Additionally, Baugh et al. (2018) estimates a reduction of Amazon purchases by 9.4% due to Amazon sales tax collection.

[6] Since the difference between sales taxes and use taxes relies on the location of the retailer, on the remaining of the paper, I will use sales taxes and use taxes interchangeably.

[7] Lunder and Pettit (2014)

[8] Bruce and Fox (2004) estimate the losses as $15.5B in 2003 and forecast them as $21.5B in 2008. Bruce et al. (2009) update the estimates to $23.39B in 2008 and the forecast to $30.67B in 2011 with an high growth sales scenario of $40.82B for the same year. Additionally, Omar et al. (2008) estimates that the revenue losses would rise to $62.1B by 2011.

[9] A previous attempt to increase and simplify sales tax collection, in 2005, 13 state governments signed the Streamline Sales and Use Tax Agreement (SSUTA), while 10 additional states were incorporated as full members at a later date. The agreement is meant to ease the registration process for businesses operating in multiple sales tax-levying states, as well as set common sales tax-related definitions and rules, simplifying rate structures. The agreement also provides exemptions for smaller remote sellers from tax collection responsibilities, even though they were already exempt from collecting due to *Quill*. Finally, the agreement proposes providing all participating remote sellers free tax software. Nevertheless, as the definition of nexus requires physical presence, in SSUTA states, out-of-state retailers collect tax voluntarily. Hence, the effect of SSUTA on tax revenue collection is not clear.

These findings are supported by Kaçamak and Wilking (2020), which shows that consumers face higher prices and reduced their online expenditure.

Previous papers focus on the year in which Amazon.com, Inc. (Amazon) starts collecting sales taxes, which entails Amazon decision and may lead to endogeneity issues. The timing of Amazon's decision to start collecting sales taxes may be correlated with local economic conditions that also affect other retailers decisions. As previous papers are focusing on consumer behavior, relying on Amazon Tax collection does not bring the same endogeneity issues. Instead, I focus on the Amazon Tax enactment dates from state legislation. By focusing on the enactment of the legislation, I intend to avoid any type of anticipation that retailers and consumers may face.

the Amazon Tax definition of nexus only allowed state governments to collect sales taxes from out-of-state retailers that were selling their own goods. However, some online retailers, like Amazon, act both as retailers and marketplace. In a further effort to reduce tax revenue losses, state governments enacted new legislation in the years 2017 and 2018, broadening again the definition of nexus to include marketplace collection. Hence, I restrict my analysis to the period 2005-2016.

Finally, in the 2018 case *South Dakota v. Wayfair, Inc*, the US Supreme Court overruled *Quill* stating not only that physical presence was no longer needed, but also highlights " the inherently unfair competitive advantage of online retailers over retailers with a physical presence in a state and the economic distortions caused by businesses who intentionally avoid any physical presence in a state." (Newmark et al., 2019). In other words, *Wayfair* ruling supports the idea that before the enactment of the Amazon Tax, out-of-state retailers had a price advantage over brick-and-mortar retailers. Removing the price advantage through sales tax collection affected consumption patterns and helped the states recover tax revenue losses, however, it is unclear how it affected local business in particular and local labor markets in general.

Data Sources and Empirical Strategy

Data and Sample

I use the variation in state the Amazon Tax enactment to evaluate the effects of E-commerce on local labor markets. I combine information from a number of sources regarding employment, number of establishments, occupational shares and wages, for the years 2010-2016.

I define a local labor market as a commuting zone-state unit of observation. Following Dorne (2009), identifying local labor markets using commuting zones presents two advantages: the large coverage of US, and that, instead of being based on state borders or population, commuting zones rely principally on economic geography. However, from the 722 commuting zones, 18% cross state

borders, hindering the distinction between treated and control areas due to the Amazon Tax legislation being enacted by states. Therefore, I split commuting zones that cross state borders to define the units of observation. One advantage of splitting commuting zones by states is that the partition of a commuting zone in an untreated state is a good comparison of the partition of the same commuting zone in a treated state. However, if the local markets are integrated, spillovers may occur, leading to the violation of stable unit treatment value assumption (SUTVA). As a robustness check, I exclude commuting zones that cross state borders from the analysis.[10]

To evaluate the effects of e-commerce on establishments and employment over time I use data from County Business Patterns (CBP). CBP data is elaborated by the U.S. Census Bureau from the Business Register (BR), which combines several data sources as the Economic Census, Annual Survey of Manufactures and Current Business Surveys, and IRS administrative records. CBP county annual data includes the number of establishments, employment during the week of March 12, first quarter payroll, and annual payroll of each 6-digit industry. To preserve the confidentiality of individual employers, U.S. Census Bureau suppressed the number of employees for the majority of county-industry cells. Accordingly, a flag is provided indicating the bin in which the suppressed number belongs to. Bartik et al. (2018) and Eckert et al. (2021) both overcome the suppression by developing linear programming methods that impute the suppressed values. I use Eckert et al. (2021) imputed version, since not only harmonize industry codes to NAICS 2012, but also bridge county codes making them consistent through the entire panel. Eckert et al. (2021) impute 1975-2016 CBP employment values with an algorithm relies on linear programming. The algorithm minimizes the distance to the midpoint of the flagged bin, conditional on being inside the interval and all values adding to the parent category both by industry and geography. The algorithm also accounts for inconsistent bounds due to possible errors either in the employment of disclosed cells or in the employment bounds of the suppressed cells.

In 2017, the U.S. Census Bureau changed the disclosure rule for cells with less than 3 establishments, removing flags—rendering all algorithms inadequate to impute 2017 and 2018 employment values. Therefore, I restrict my analysis of CBP to the period 2010-2016.

I combine the data on number of establishments and employment with population and working age population data from Census Intercensal Population Estimates for the periods 2000-2010 and 2010-2020. The Census Intercensal Population Estimates is a product from the U.S. Census Bureau, which reconcile the postcensal population and housing units estimates with the census counts at the county, state and national level. The annual population county estimates account for births, deaths and migration patterns and are constructed using the Das Gupta method, confirming that the sum of county estimates amounts to the national level. Finally, I collapse the data to commuting zone -

[10] Results are robust to excluding commuting zones that cross state borders from the sample

state level using crosswalks from CBP county 2000 and CBP county 2010 definitions provided by Autor, Dorn and Hanson (2013).

To evaluate changes in wages and the occupational structure, I rely on data from the IPUMS-USA version of the American Community Survey (ACS). ACS data was collected yearly starting in 2005. The dataset consists of a yearly 1-in-100 nationally representative sample and contains questions regarding employment status, occupation and pre-taxes wages and salaries received in the previous calendar year (annual income wages). I deflate wages and salaries to 2014 usd and measure changes in the occupational structure through changes in occupational shares. I harmonize occupational codes to the 2010 Standard Occupational Classification System (SOC). I focus on annual income wages of employees in retail (NAICS 44) and last mile transportation and warehousing (NAICS 49) as well as occupational shares of sales and related occupations (SOC 41-) and transportation and material moving occupations (SOC 53-) employees. The smallest identifiable geographical unit in ACS data is the Public-Use Microdata Area (PUMA) defined by the Census Bureau every 10 years. To evaluate the effects on local labor markets, I collapse the data at commuting zones - state, using crosswalks from PUMA 2000 and PUMA 2010 definitions to commuting zone definition from Autor and Dorn (2013) and Autor, Dorn and Hanson (2019).

Additionally, given that the Amazon Tax effects in the labor market may be mediated by consumption, as a robustness check I control for predictors of changes in consumption and e-commerce consumption. To predict for changes in consumption, I rely on the median household income estimates from the Small Area Income and Poverty Estimates (SAIPE) Program. The SAIPE Program is conducted by the US Census Bureau, which combines data from administrative records, survey data and population estimates to produce median household income estimates at the county level. To predict changes in e-commerce consumption patterns, I collect location records of Amazon.com, Inc fulfillment centers provided by MWPVL International.[11] The main reasons to use Amazon locations as predictor of e-commerce consumption patters are twofold: Amazon is one of the biggest e-commerce retailer in the period studied, and, Amazon sets locations such that it minimizes shipping costs according to consumption patterns.[12] I complement data on the location of Amazon.com, Inc. fulfillment centers from MWPVL International with information on closed fulfillment centers from newspaper articles.[13]

[11] MWPVL International is a firm which provides services on supply chain and logistics network strategy. As part of their research analysis of the current Amazon.com logistics network they collected Amazon.com fulfillment center's locations.

[12] See Houde et al. (2017)

[13] Results are robust to the inclusion of time-varying controls, however, these specifications may incorporate additional bias as these controls may also be affected by the enactment of the Amazon Tax.

Identification

In order to estimate the effect of e-commerce on local labor markets, I exploit the idea that the e-commerce growth was fueled by the price advantage that out-of-state e-commerce retailers had over in-state retailers. Hence, I define the treatment as the enactment of an the Amazon Tax by the state government. While previous literature evaluating the effects of the Amazon Tax define treatment when Amazon starts collecting sales taxes, by focus on the enactment of legislation I avoid any possible anticipation.

I consider commuting zones in states that enacted an the Amazon Tax in 2013 as treated observations, while commuting zones in states that did not enacted an the Amazon Tax before 2016 are in the control group (never treated). Additionally, I exclude from the sample those commuting zones in states that signed voluntary collection agreements(VCA) and where Amazon was not collecting sales taxes before 2008. The main reason for these exclusions is that while the enactment of new legislation can be considered exogenous, voluntary collection agreements and amazon deciding to collect sales taxes before any legislation changes involve negotiation between state officials and Amazon, Inc, leading to not only possible endogeneity but also anticipation from other actors. Table 1 presents a list of states that are in treated and control groups, while Figure 11 shows in which years states enacted such legislation.

In an ideal experiment, state government would randomly enact the Amazon Tax to reduce such price advantage, leading to local labor markets in treated states and in control states to be statistically identical in observable and unobservable characteristics. Not only that is not the case, but treated and control states exhibit differences in observable characteristics. Table 2 shows a comparison of some observable characteristics in treated and control states before the first year of treatment (2005-2007). States that enacted the Amazon Tax have higher sales tax rates, lower household income, and higher rate of older and more educated population. Moreover, states that enacted the Amazon Tax exhibit a different industry composition that states that did not enact the Amazon Tax.

In the absence of random assignment, the difference-in-difference (DID) approach estimates the policy effects in a quasi-experimental setting by comparing the outcome of a treated and control units before and after the enactment of the Amazon Tax. While DID approach does not require that treated and control units are similar in characteristics, it does rely on the assumption that the outcome of treated and control units present parallel trends. Hence, by assuming parallel trends, in the absence of the treatment, treated units would have exhibit same trends as control units. Then, the main identification assumption is that commuting zones in states where the legislation was enacted and commuting zones in states which did not enact the Amazon Tax exhibit parallel trends in employment, wages, number of establishments and occupational shares that would have continue in the absence of the treatment.

To evaluate the validity of the parallel trend assumption, first I visually compare outcomes' averages between treated and control commuting zones (CZ) in the pre-period. Figures 8, 9 and 10 show the comparisons for employment/working age population, wages and establishment/population by industry and retail occupational shares corresponding to CZ treated in 2013 and never treated CZ. With the exception of establishments per population in retail, the remaining outcomes do not exhibit parallel pre-trends.

A more formal traditional approach to evaluate the parallel trend assumption consists on testing the significance of the lead coefficients in an even study, which I evaluate together with the results in the next section.

Finally, I assume that there are no spillover effects between commuting zones. One possible threat to this assumption is that in commuting zones located at state borders, the enactment of the Amazon Tax in a particular state affects not only the employment of the commuting zones in that state, but also employment in neighbouring commuting zones out of that state. Additionally, commuting zones that are located in more than one state may face a threat to the assumption if the market is integrated leading to effects in the area located in the non treated state. In order to evaluate these threats to the stable unit treatment value assumption (SUTVA), I exclude from the specification all commuting zones in state borders as well as commuting zones that cross state borders as robustness check.[14]

Econometric Specification

In order to analyze the effects of removing a price advantage for out-of-state e-commerce retailers, I implement the Event Study Difference-in-Differences methodology.

With County Business Patterns (CBP) data, I estimate the following equations:

$$Y_{cy} = \sum_k \psi_k D_{sy}^k + \alpha_c + \gamma_y + \epsilon_{cy}$$

$$Y_{cy} = \alpha_c + \gamma_y + \delta D_{sy} + \epsilon_{cy}$$

with $D_{sy}^k = I[y - e_y = k]$ being a dummy variable equal to one if state s at year y the Amazon Tax has been enacted. I focus on two main outcome variables, the ratio of employment over working age population in a commuting zone c at time y, $\frac{Emp_{cy}}{Pop_{cy}} \times 100000$, and the ratio of the number of establishments over total population, $\frac{Est_{cy}}{Pop_{cy}} \times 100000$ for both retail and transportation and warehousing sectors.

[14] All results are robust to the exclusion of commuting zones that cross state borders from the sample

With American Community Survey (ACS) data, I estimate the following equations:

$$Y_{cy} = \sum_k \phi_k D_{sy}^k + \delta_c + \theta_y + \nu_{cy}$$

$$Y_{cy} = \alpha_c + \gamma_y + \delta D_{sy} + \epsilon_{cy}$$

with $D_{sy}^k = I[y - e_y = k]$ being a dummy variable equal to one if state s at year y the Amazon Tax is enacted. The outcome variables are logarithm of annual income wages of retail and transportation and warehousing employees, as well as the shares of employment on occupations i in commuting zone c at year y, $Y_{cyi} = \frac{Emp_{cyi}}{Emp_{cy}}$. I focus on sales occupations, office and service occupations, and transportation, construction and production occupations, and managerial and professional occupations, following the Standard Occupational Classification System.

In both cases, I include commuting zone and year fixed effects as well as weights by population in 2005. Also, as the treatment takes place at the state level, I cluster standard errors at the state.

Since the removal of a price advantage changed consumption patterns affecting brick-and-mortar and e-commerce retailers, I focus on two industries: retail (NAICS 44) and it's main substitute related with e-commerce retail, last mile transportation and warehousing (NAICS 49). Notice that my definition of transportation and warehousing (NAICS 49) does not include freight or transportation of passengers, only postal services and courier messengers. For the aforementioned industries, I evaluate the following labor market outcomes Y: employment per working age population, number of establishments per population and wages. Additionally, to evaluate changes in the local occupational structure, I focus on changes in the shares of retail employment for transportation and material moving occupations, production and construction occupations (SOC 53-, 51-, 45-, 47- and 29-), office and service occupations (SOC 43-, and 3X-), sales and related occupations (SOC 41-), and managerial and professional occupations (SOC 1X- and 2X-)

In the following sections I present the results evaluating the difference-in-differences of commuting zones in states that enacted the Amazon Tax in 2013. By focusing only on one group-time ATT, I circumvent the bias in ATT estimates due to differential timing. Moreover, as the pre-treatment period covers the period after the Great Recession, the comparison considers commuting zones that were already affected in the same way, without contamination from the Great Recession effects itself. Finally, since CBP data from years after 2017 cannot be imputed due to disclosure rules changes, and the Marketplace legislation was also enacted in 2017, looking at commuting zones treated in 2013 allows me to evaluate the ATT with a 3 year post-period window.

Results

Employment Effects

Among the concerns regarding the growth in e-commerce and the competition it presents for traditional brick-and-mortar retailers is that e-commerce retail requires fewer local retail employees. Moreover, as e-commerce retail depends on transportation and warehousing, the growth in e-commerce should be accompanied with an increase in employment in the transportation and warehousing sector. As the enactment of the Amazon Tax may reduce the incentives for e-commerce retail entrance while increasing the incentives for traditional retailers to switch to an hybrid model, as click-and-brick, I start the analysis by evaluating changes in employment in general as well as employment for both retail and last mile transportation and warehousing sectors.

First, I evaluate the parallel trend assumption visually by observing the pre-period event study coefficients. Figure 12 presents the event study estimates corresponding to employment/working age population for main sectors: overall, transportation and warehousing, retail, warehouse clubs and supercenters, and general brick-and-mortar. I observe that in all cases there is no evidence of pre-trends, however, the pre-period estimates are noisy.

Table 3 presents the difference-in-differences estimates of the enactment of the Amazon Tax. Panel A presents the estimates for the entire sample, while panel B and C presents the estimates for urban commuting zones and non-urban commuting zones respectively.

I find that the difference in employment per 100,000 working population after the enactment of the Amazon Tax, when compared with prior to it was 326.5 higher among those commuting zones in states that enacted the Amazon Tax than those commuting zones in states without the Amazon Tax enactment.

Moreover, I find that in the transportation and warehousing sector, there is a decrease in employment of 34.82 employees per 100,000 working age population in commuting zones in states that enacted the Amazon Tax compared to commuting zones in states that did not enacted the Amazon Tax. This effect represents a 9.57% decrease from the pre-period baseline mean.

Additionally, I find that in the retail sector, there is also a decrease in employment of 74.56 employees per 100,000 working age population after the enactment of the Amazon Tax in commuting zones in treated states versus commuting zones in states without the enactment of the Amazon Tax. The decline in retail employment represents 1.01% of its pre-period baseline mean.

However, when I differentiate between warehouse clubs and supercenters and other brick-and-mortar retailers, I find that the decrease in employment is driven by a decrease in employment of other brick-and-mortar retailers of 2.32% of its baseline mean, while employment in warehouse clubs and supercenters increases by 6.27% with respect of its baseline mean, after the enactment of the

Amazon Tax.

Panels B and C show that the changes in retail employment in all sub-sectors are driven by changes in retail employment in urban commuting zones, while retail employment in non-urban areas exhibit no statistically and economically significative changes.

Wages Effects

The expansion of e-commerce may have additional consequences on retail and transportation and warehousing employees. Several claims have been made on how e-commerce can harm employees in the retail sector. (Chava et al., 2018) finds that after Amazon opens a fulfillment center income related wages of brick-and-mortar employees decrease, mostly due to a reduction in working hours. Since the enactment of the Amazon Tax creates incentives not only for Amazon and other e-commerce retailers to set locations in the state, but also for brick-and-mortar retailers to convert to an hybrid system, the effects on wages may go in both directions. In this section, I explore what are the effects of the enactment of the Amazon Tax on income wages and hours worked.

First, I evaluate the parallel trend assumption visually by observing the pre-period event study coefficients. Figure 14 presents the event study estimates corresponding to the logarithm of annual income wages for main sectors: overall, transportation and warehousing and retail. I observe that in all cases there is no evidence of pre-trends, however, the pre-period estimates are noisy.

Table 4 presents the difference-in-differences estimates of the enactment of the Amazon Tax. Panel A presents the estimates for the entire sample, while panel B and C presents the estimates for urban commuting zones and non-urban commuting zones respectively.

I find that the difference in annual income wages of retail employees after the enactment of the Amazon Tax, when compared with prior to it is 1.19 percent lower among those commuting zones in states that enacted the Amazon Tax than those commuting zones in states without the Amazon Tax enactment, while the hourly wages of retail employees is 1.32 percent lower. Both declines in hourly and annual wages of retail employees are not statistically significant.

Moreover, I find that in the transportation and warehousing sector, there is a decrease of 8.3 percent of annual wages and 7.7 percent of hourly wages in commuting zones in states that enacted the Amazon Tax compared to commuting zones in states that did not enacted the Amazon Tax. These effects are both statistically significative at 1% and 5% respectively.

Panels B and C show that the changes in wages of transportation and warehousing employees are driven by changes in wages for employees in urban commuting zones, while wages of transportation and warehousing employees in non-urban areas exhibit no statistically and economically significative changes.

Establishments Effects

One of the arguments to remove the price advantage that e-commerce retailers had over brick-and-mortar retailers is that brick-and-mortar establishments were closing at an alarming rate due to the disadvantage. Moreover, the media named this phenomenon "Retail Apocalypse", while politicians presented the Amazon Tax policies as a way to reduce brick-and-mortar establishments' closures. I evaluate the effect of the Amazon Tax enactment on the number of establishments in both retail and transportation and warehousing sectors.

First, I evaluate the parallel trend assumption visually by observing the pre-period event study coefficients. Figure 13 presents the event study estimates corresponding to number of establishments/population for main sectors: overall, transportation and warehousing, retail, warehouse clubs and supercenters, and general brick-and-mortar. I observe that in all cases there is no evidence of pre-trends, however, the pre-period estimates are noisy.

Table 4 presents the difference-in-differences estimates of the enactment of the Amazon Tax. Panel A presents the estimates for the entire sample, while panel B and C presents the estimates for urban commuting zones and non-urban commuting zones respectively.

I find that the difference in retail establishments per 100,000 people after the enactment of the Amazon Tax, when compared with prior to it was 1.97 lower among those commuting zones in states that enacted the Amazon Tax than those commuting zones in states without the Amazon Tax enactment.

Moreover, I find that in the transportation and warehousing sector, there is a decrease of 0.18 establishments per 100,000 people in commuting zones in states that enacted the Amazon Tax compared to commuting zones in states that did not enacted the Amazon Tax. This effect represents a 1.88% decrease from the pre-period baseline mean, however it is not statistically significative.

Additionally, when I differentiate between warehouse clubs and supercenters and other brick-and-mortar retailers, I find that the decrease in retail establishments is driven by a decrease in the number of establishments of other brick-and-mortar retailers of 0.53% of its baseline mean, while the number of establishments in warehouse clubs and supercenters increases by 3.14% with respect of its baseline mean, after the enactment of the Amazon Tax. Only the increase in the number of establishments in warehouse clubs and supercenters is statistically significant.

Panels B and C show that the changes in retail establishments in all sub-sectors are driven by changes in retail establishments in urban commuting zones, while retail establishments in non-urban areas exhibit no statistically and economically significative changes.

Occupational Structure Effects

Given that e-commerce retail and brick-and-mortar retail require employees on different occupations, with different skills, in this section I explore what are the effects of the Amazon Tax enactment on the retail occupational shares of four categories of main occupations of retail: transportation and material moving occupations, production and construction occupations (SOC 53-, 51-, 45-, 47- and 29-), office and service occupations (SOC 43-, and 3X-), sales and related occupations (SOC 41-), and managerial and professional occupations (SOC 1X- and 2X-).

First, I evaluate the parallel trend assumption visually by observing the pre-period event study coefficients. Figure 15 presents the event study estimates corresponding to retail occupational shares. I observe that in all cases there is no evidence of pre-trends, however, the pre-period estimates are noisy.

Table 6 presents the difference-in-differences estimates of the enactment of the Amazon Tax. Panel A presents the estimates for the entire sample, while panel B and C presents the estimates for urban commuting zones and non-urban commuting zones respectively.

I find that the difference in the retail share of sales occupations after the enactment of the Amazon Tax, when compared with prior to it was 0.397 percentage points lower among those commuting zones in states that enacted the Amazon Tax than those commuting zones in states without the Amazon Tax enactment.

Moreover, I find that the retail share of managerial and professional occupations faces an increase of 0.29 percentage points in commuting zones in states that enacted the Amazon Tax compared to commuting zones in states that did not enacted the Amazon Tax. This effect represents a 3.23% increase from the pre-period baseline mean.

Additionally, I find that in the retail sector, there is also a decrease the share of transportation, construction and production occupations as well as an increase in the share of office and service related occupations after the enactment of the Amazon Tax in commuting zones in treated states versus commuting zones in states without the enactment of the Amazon Tax. The decline in the share of transportation, construction and production occupations represents 0.09% of its pre-period baseline mean, while the increase in the share of office and services related occupations represents 0.58% of its pre-period baseline mean.

However, neither of the aforementioned effects are statistically significative.

Panels B and C show that the changes in retail transportation, construction and production share are driven by changes in urban commuting zones, while changes in the retail occupational shares of office and services and sales occupations are driven by non-urban areas. Moreover, these last changes represent an increase of 7.14 percent of the pre-period baseline mean of office and services occupational shares and a decrease of 4.79 percent of the pre-period baseline mean of sales occu-

pational shares respectively in non-urban areas. Both these effects are statistically and economically significative changes.

Discussion of Effects of E-commerce

Theoretical framework

Although the primary contribution of this paper is empirical, in this section I provide some structure for thinking about the effects of e-commerce on local labor markets when a price advantage is reduced or removed.

I observe suggestive evidence of a decline of the number of retail establishments, as well as a decline in retail employment, mostly explained by a decline in urban retail employment. In urban areas I also find a decline in employment at department stores and an increase in employment at warehouse clubs and supercenters, as well as a decline in wages of transportation and warehousing employees. In non-urban areas I find a decline in the retail share of sales and related occupations.

I evaluate these results in the context of the enactment of the Amazon Tax, which force out-of-state online retailers to collect sales taxes removing their price advantage over different types of brick-and-mortar retailers.

In the following subsections I present a four-sector general equilibrium model in which I evaluate an increase in the tax rate corresponding to out-of-state e-commerce retail sales. I also show under which conditions the empirical results hold, and explore the fundamentals behind those conditions by discussing consumers' substitution and workers' substitution.

The Basic Model

In this section I present a four-sector general equilibrium model with one factor of production (labor, L). The four sectors I consider are: general brick-and-mortar retail (B), warehouse clubs and supercenters (S), out-of-state e-commerce retail (E) and transportation and warehousing (T). The production of the three types of retail (B, S, E) occurs in a constant returns to scale environment:

$$B = L_B, \qquad S = L_S, \qquad E = T = L_T \tag{I}$$

Additionally, out-of-state e-commerce retail is produced in-state with transportation and warehousing services (W), which in turn are produced with labor. To simplify notation I label $L_T = L_E$.

In this setup, labor has a fixed total supply, but workers can freely move between sectors (with no unemployment). Thus:

$$L_B + L_S + L_E = \bar{L} \tag{II}$$

In each sector, labor is paid the value of its marginal product in competitive markets (zero profit condition)[15]:

$$p_B B = w_B L_B, \qquad p_S S = w_S L_S, \qquad p_E E = w_E L_E \tag{III}$$

Workers' decision regarding how much labor they want to allocate in each sector is given by their corresponding wages, w_B, w_S, w_E and their indirect utility $V(w_B, w_S, w_E)$, which is reflected in the elasticities of substitution:

$$\eta_1 = \frac{\frac{d(L_S/L_B)}{L_S/L_B}}{\frac{d(w_B/w_S)}{w_B/w_S}}, \qquad \eta_2 = \frac{\frac{d(L_E/L_B)}{L_E/L_B}}{\frac{d(w_B/w_E)}{w_B/w_E}}, \qquad \eta_3 = \frac{\frac{d(L_S/L_E)}{L_S/L_E}}{\frac{d(w_E/w_S)}{w_E/w_S}} \tag{IV}$$

I assume that workers preferences for working in the different sectors are well-behaved (complete, transitive, monotonic and convex), hence $\eta_1 > 0, \eta_2 > 0$ and $\eta_3 > 0$

Finally, consumers maximize their utility $U(B, S, E)$. Consumer's preferences are characterized by the elasticity of substitution (in demand) between B, S and E ($\sigma_1, \sigma_2, \sigma_3$):

$$\sigma_1 = \frac{\frac{d(S/B)}{S/B}}{\frac{d(p_B(1+\tau_B)/p_S(1+\tau_S))}{p_B(1+\tau_B)/p_S(1+\tau_S)}}, \qquad \sigma_2 = \frac{\frac{d(E/B)}{E/B}}{\frac{d(p_B(1+\tau_B)/p_E(1+\tau_E))}{p_B(1+\tau_B)/p_E(1+\tau_E)}}, \qquad \sigma_3 = \frac{\frac{d(S/E)}{S/E}}{\frac{d(p_E(1+\tau_E)/p_S(1+\tau_S))}{p_E(1+\tau_E)/p_S(1+\tau_S)}} \tag{V}$$

where the consumer price for $i = B, S, E$ is $p_i(1 + \tau_i)$ and τ_i is an *ad valorem* tax on i. I assume that consumers' preferences are well-behaved (complete, transitive, monotonic and convex), and they see retail from different sectors as substitutes, hence $\sigma_1 > 0, \sigma_2 > 0$ and $\sigma_3 > 0$

The consumer budget constraint here is implied by the assumption that the tax revenues are rebated lump sum to consumers and equations in (III).

In this economy, with pre-existing tax rates τ_B, τ_S and τ_E, I evaluate the effect of a small increase in the tax rate of out-of-state e-commerce retail (E).

Solving for equilibrium effects

In this subsection, I present the equations of change of the model following the log-linearization method of Jones (1965). Totally differentiating the production functions from equations in (I):

[15] While these markets rarely behave as perfectly competitive markets, this simplifying assumption allows me to focus in the competition across channels instead of the competition within each channel

$$\widehat{B} = \widehat{L_B} \tag{1}$$

$$\widehat{S} = \widehat{L_S} \tag{2}$$

$$\widehat{E} = \widehat{L_E} \tag{3}$$

Where $\widehat{i}$ is the proportional change of $i = B, S, E$, $\widehat{i} \equiv di/i$, and $\widehat{L_i}$ is the proportional change of labor in sector $i = B, S, E$, $\widehat{L_i} \equiv dL_i/L_i$

From differentiating the resource constraint:

$$\lambda_X \widehat{L_X} + \lambda_Y \widehat{L_Y} + \lambda_Z \widehat{L_Z} = 0 \tag{4}$$

Here, the fraction of labor supplied used in the production of retail is given by λ_i for $i = B, S, E$, with $\lambda_i = \frac{L_i}{\hat{L}}$. As before, $\widehat{L_i} \equiv \frac{dL_i}{L_i}$ is the proportional change in L_i.

I totally differentiate the equations in (III)to obtain:

$$\widehat{p_B} + \widehat{B} = \widehat{w_B} + \widehat{L_B} \tag{5}$$

$$\widehat{p_S} + \widehat{S} = \widehat{w_S} + \widehat{L_S} \tag{6}$$

$$\widehat{p_E} + \widehat{E} = \widehat{w_E} + \widehat{L_E} \tag{7}$$

From the definition of workers' elasticity of substitution between sectors:

$$\widehat{L_B} - \widehat{L_S} = \eta_1 \left(\widehat{w_S} - \widehat{w_B}\right) \tag{8}$$

$$\widehat{L_B} - \widehat{L_E} = \eta_2 \left(\widehat{w_E} - \widehat{w_B}\right) \tag{9}$$

$$\widehat{L_E} - \widehat{L_S} = \eta_3 \left(\widehat{w_S} - \widehat{w_E}\right) \tag{10}$$

Finally, from the definition of consumer' elasticity of substitution for types of retail(B, S, E):

$$\widehat{B} - \widehat{S} = \sigma_1 \left(\widehat{p_S} + \widehat{\tau_S} - \widehat{p_B} - \widehat{\tau_B}\right) \tag{11}$$

$$\widehat{B} - \widehat{E} = \sigma_2 \left(\widehat{p_E} + \widehat{\tau_E} - \widehat{p_B} - \widehat{\tau_B}\right) \tag{12}$$

$$\widehat{E} - \widehat{S} = \sigma_3 \left(\widehat{p_S} + \widehat{\tau_S} - \widehat{p_E} - \widehat{\tau_E}\right) \tag{13}$$

With $\widehat{\tau_i} = \frac{d\tau_i}{1+\tau_i}$

This model is characterized by the assumptions of perfect competition, perfect mobility, perfect information and perfect certainty, and defined by equations (1)-(18).

Effects of the Amazon Tax

I solve for the effects of an increase in the ad valorem tax rate on sales of out-of-state e-commerce retail, sector E, while the remaining tax rates do not change, $\widehat{\tau_B} = 0$,$\widehat{\tau_S} = 0$. Since I focus on real behavior, I choose S as numeraire, hence $\widehat{p_S} = 0$. The general solutions are:[16]

$$\widehat{w_S} = \widehat{p_S} = 0 \tag{14a}$$

$$\widehat{w_E} = \widehat{p_E} = \widehat{w_T} = \widehat{p_T} = -A\widehat{\tau_E} \tag{14b}$$

$$\widehat{w_B} = \widehat{p_B} = -A\epsilon_L\widehat{\tau_E} \tag{14c}$$

$$\widehat{L_E} = \widehat{E} = \widehat{L_T} = \widehat{T} = \underbrace{[\lambda_S\sigma_1\epsilon_U A}_{\text{Indirect Effect}} + \underbrace{(\lambda_E - 1)\sigma_2(\epsilon_U - 1)A]}_{\text{Direct Effect}}\widehat{\tau_E} \tag{14d}$$

$$\widehat{L_B} = \widehat{L_B} = [\lambda_S\sigma_1\epsilon_U A + \lambda_E\sigma_2(\epsilon_U - 1)A]\,\widehat{\tau_E} \tag{14e}$$

$$\widehat{L_S} = \widehat{L_S} = [(\lambda_S - 1)\sigma_1\epsilon_U A + \lambda_E\sigma_2(\epsilon_U - 1)A]\,\widehat{\tau_E} \tag{14f}$$

where ϵ_U and ϵ_L are the relative differences in preferences for consumers and workers respectively: $\epsilon_U = \frac{\sigma_3 - \sigma_2}{\sigma_1 - \sigma_2}$ and $\epsilon_L = \frac{\eta_3 - \eta_2}{\eta_1 - \eta_2}$, and $A \equiv \frac{1}{1 - \frac{\epsilon_L}{\epsilon_U}}$.

From (14a), wages in sector S do not change. The change of wages and price in sector E is proportional with respect to A, which measures the relation between relative differences in preferences for consumption and labor, from (14b).

The effects of increasing the tax rate on sales of E on the production of both B, S and E and their respective labor requirements can be split in two effects, Direct effects, and Indirect effects. The Direct effect reflects the trade-off that the consumer faces when substituting between general brick-and-mortar retail (B) and out-of-state e-commerce retail(E). The Direct Effect from both (14d), (14e) and (14f) consists of an effect given by the elasticity of substitution σ_2 between consumption of B and E, which is in turn weighted by a function of share of labor used in the production of E and the ratio of elasticity differences for consumption (ϵ_U) and A, the relation between relative differences in preferences for consumption and labor.

The Indirect effect reflects the trade-off that the consumer faces when substituting across brick-and-mortar retailers, that is between general brick-and-mortar retail (B) and warehouse clubs and

[16] See Appendix for derivations

supercenters (S). The Indirect Effect from both (14d), (14e) and (14f) consists of an effect given by the elasticity of substitution σ_1 between consumption of B and S, which is in turn weighted by a function of share of labor used in the production of S and the ratio of elasticity differences for consumption (ϵ_U) and A, the relation between relative differences in preferences for consumption and labor.

Both the direct effect and the indirect effect are a result of changes in relative prices of e-commerce p_E, since they both include the change in prices and wages in sector E from equation (14b)

The following propositions show under which conditions a rise on the tax rate on sales of E leads to a rise or fall of the wages, and prices, of B and E

Proposition 1 *The wage, and price, of E will fall if an only if:*

$$\epsilon_L = \frac{\eta_3 - \eta_2}{\eta_1 - \eta_2} < \frac{\sigma_3 - \sigma_2}{\sigma_1 - \sigma_2} = \epsilon_U$$

That is, wages in transportation and warehousing will fall if and only if the relative differences in preferences for consumers, ϵ_U , is larger than the relative differences in preferences for workers, ϵ_L.

An example where this proposition holds is a case where consumers' elasticity of substitution between e-commerce retail and warehouse clubs and supercenter retail, σ_3, is larger than consumers' elasticities of substitution for both types of retail with respect of general brick-and-mortar retail, σ_2 and σ_1, while the workers' elasticities of substitutions are similar across the three sectors.

Proposition 2 *The wage, and price, of B will fall if an only if:*

$$\frac{1}{\epsilon_U} = \frac{\sigma_1 - \sigma_2}{\sigma_3 - \sigma_2} < \frac{\eta_1 - \eta_2}{\eta_3 - \eta_2} = \frac{1}{\epsilon_L}$$

Hence, wages in general brick-and-mortar retail will fall if and only if the inverse of relative differences in preferences for consumers, ϵ_U , is larger than the inverse of relative differences in preferences for workers, ϵ_L. Proposition 2 also holds with the previous example.

The following propositions show under which conditions a rise on the tax rate on out-of-state e-commerce sales, $\widehat{\tau_E} > 0$, leads to a rise or fall of the labor requirements of the three sectors.

Proposition 3 *Let ϵ_U and ϵ_L are the relative differences in preferences for consumers and workers respectively: $\epsilon_U = \frac{\sigma_3 - \sigma_2}{\sigma_1 - \sigma_2}$ and $\epsilon_L = \frac{\eta_3 - \eta_2}{\eta_1 - \eta_2}$, and $C = \frac{\lambda_S \sigma_1}{(\lambda_E - 1)\sigma_2}$. E-commerce consumption, E, as well as labor requirements in transportation and warehousing, L_W, will fall if an only if either one of these cases holds:*

Case I: $0 < \epsilon_L < \epsilon_U$ *and* $\epsilon_U < \frac{1}{1+C}$

Case II: $\epsilon_L < \epsilon_U$, $\epsilon_L < 0$ *and* $\epsilon_U > \frac{1}{1+C}$

Case III: $\epsilon_L > \epsilon_U$, $\epsilon_L > 0$ *and* $\epsilon_U > \frac{1}{1+C}$
Case IV: $0 > \epsilon_L > \epsilon_U$ *and* $\epsilon_U < \frac{1}{1+C}$

Under cases I and II, Propositions 1 and 2 also hold. The additional requirement for Proposition 3 to hold is given by the consumers' relative elasticity of substitution of general brick-and-mortar retail with respect to other retail sectors, σ_1/σ_2, weighted by the ratio of labor shares in warehouse clubs and supercenters and e-commerce retail, $\lambda_S/(\lambda_E - 1)$. Notice that as $\lambda_E - 1 < 0$, C is also negative. Hence, for case I to hold, it must be the case that $0 \leq |C| < 1$ and larger enough such that $\epsilon_U < \frac{1}{1+C}$.The underlying condition such that the absolute value of C is smaller than 1 is given by $\lambda_S/(1 - \lambda_E) < \sigma_1/\sigma_2$, where $\lambda_S/(1 - \lambda_E) = \lambda_S/(\lambda_S + \lambda_B) < 1$. An example in which case I may be true is if consumers' elasticity of substitution between general brick-and-mortar and warehouse clubs and supercenters is smaller than their elasticity of substitution between general brick-and-mortar and e-commerce retail. For case II to hold, it must be true that either $\leq |C| > 1$ or $\epsilon_U > \frac{1}{1+C}$; then a sufficient condition is that $\lambda_S/(1-\lambda_E) > \sigma_1/\sigma_2$ which holds with σ_1 sufficiently small.

Under cases III and IV, Propositions 1 and 2 don't hold, which implies that wages in transportation and warehousing and general brick-and-mortar retail increase when the tax on e-commerce increase. Moreover, case III and IV only require $\epsilon_U > \frac{1}{1+C}$ and $\epsilon_U < \frac{1}{1+C}$ respectively, without any boundary restriction for C.

Proposition 4 *Let* ϵ_U *and* ϵ_L *are the relative differences in preferences for consumers and workers respectively:* $\epsilon_U = \frac{\sigma_3 - \sigma_2}{\sigma_1 - \sigma_2}$ *and* $\epsilon_L = \frac{\eta_3 - \eta_2}{\eta_1 - \eta_2}$, *and* $D = \frac{(\lambda_S - 1)\sigma_1}{\lambda_E \sigma_2}$. *Retail warehouse clubs and supercenters consumption,* S, *as well as its labor requirements will rise if an only if either one of these cases holds:*
Case V: $0 < \epsilon_L < \epsilon_U$ *and* $\epsilon_U > \frac{1}{1+D}$
Case VI: $\epsilon_L < \epsilon_U$, $\epsilon_L < 0$ *and* $\epsilon_U < \frac{1}{1+D}$
Case VII: $\epsilon_L > \epsilon_U$, $\epsilon_L > 0$ *and* $\epsilon_U < \frac{1}{1+D}$
Case VIII: $0 > \epsilon_L > \epsilon_U$ *and* $\epsilon_U > \frac{1}{1+D}$

Under cases V and VI, Propositions 1 and 2 also hold. The additional requirement for Proposition 4 to hold is given by the consumers' relative elasticity of substitution of general brick-and-mortar retail with respect to other retail sectors, σ_1/σ_2, weighted by the ratio of labor shares in warehouse clubs and supercenters and e-commerce retail, $(\lambda_S - 1)/\lambda_E$. Notice that as $\lambda_S - 1 < 0$, D is also negative. Hence, for case V to hold, it can be true that either $\leq |D| > 1$ or $\epsilon_U > \frac{1}{1+D}$; then a sufficient condition is that $(1 - \lambda_S)/\lambda_E = (\lambda_B + \lambda_E)/\lambda_E > \sigma_1/\sigma_2$ which holds with σ_1 sufficiently small, since $(1 - \lambda_S)/\lambda_E > 1$. For case VI to hold, it must be the case that $0 \leq |D| < 1$ and larger enough such that $\epsilon_U < \frac{1}{1+D}$.The underlying condition such that the absolute value of D is smaller

than 1 is given by $(1-\lambda_S)/\lambda_E < \sigma_1/\sigma_2$, where $(1-\lambda_S)/\lambda_E = \lambda_E + \lambda_B/\lambda_E > 1$. An example in which case VI may be true is if consumers' elasticity of substitution between general brick-and-mortar and warehouse clubs and supercenters is smaller than their elasticity of substitution between general brick-and-mortar and e-commerce retail.

Under cases VII and VIII, Propositions 1 and 2 don't hold, which implies that wages in transportation and warehousing and general brick-and-mortar retail increase when the tax on e-commerce increase. Moreover, case VII and VIII only require $\epsilon_U < \frac{1}{1+D}$ and $\epsilon_U > \frac{1}{1+D}$ respectively, without any boundary restriction for D.

Proposition 5 *Let ϵ_U and ϵ_L are the relative differences in preferences for consumers and workers respectively: $\epsilon_U = \frac{\sigma_3-\sigma_2}{\sigma_1-\sigma_2}$ and $\epsilon_L = \frac{\eta_3-\eta_2}{\eta_1-\eta_2}$, and $F = \frac{\lambda_S\sigma_1}{\lambda_E\sigma_2}$. Retail consumption from general brick-and-mortar retailers, B, as well as their labor requirements will fall if an only if either one of these cases holds:*

Case IX: $\frac{1}{1+F} > \epsilon_U > \epsilon_L > 0$
Case X: $\epsilon_U > \frac{1}{1+F} > 0 > \epsilon_L$
Case XI: $\epsilon_L > \epsilon_U > \frac{1}{1+F} > 0$
Case XII: $0 > \epsilon_L > \epsilon_U$ *and* $\epsilon_U < \frac{1}{1+F}$

Under cases IX and X, Propositions 1 and 2 also hold. The additional requirement for Proposition 5 to hold is given by the consumers' relative elasticity of substitution of general brick-and-mortar retail with respect to other retail sectors, σ_1/σ_2, weighted by the ratio of labor shares in warehouse clubs and supercenters and e-commerce retail, λ_S/λ_E. Notice that as both λ_S and λ_E are shares of labor employed in each sector, $\lambda_S/\lambda_E > 0$, then F is also positive and $1/(1+F) < 1$. For case IX to hold, it must be true that $\epsilon_U < 1$; then a necessary condition is that either $\sigma_3 < \sigma_1$ with σ_2 sufficiently small or $\sigma_3 > \sigma_1$ with σ_2 sufficiently large. The opposite is true for cases X and XI.

Under cases XI and XII, Propositions 1 and 2 don't hold, which implies that wages in transportation and warehousing and general brick-and-mortar retail increase when the tax on e-commerce increase. Moreover, case XI and XII only require $\epsilon_U < \frac{1}{1+F}$ and $\epsilon_U > \frac{1}{1+F}$ respectively. Case XII requires then that $\epsilon_U < 1$, or equivalently either $\sigma_3 < \sigma_1$ with σ_2 sufficiently small or $\sigma_3 > \sigma_1$ with σ_2 sufficiently large, while case XI does not impose any additional boundary restriction for F.

Finally, the following proposition shows in which cases a rise on the tax rate on out-of-state e-commerce sales, $\widehat{\tau_E} > 0$, leads to the observed effects present in the empirical results: a fall of wages in transportation and warehousing and general brick-and-mortar retail, a fall in employment in transportation and warehousing and general brick-and-mortar retail, and an rise in employment in warehouse clubs and supercenters.

Proposition 6 *Let ϵ_U and ϵ_L are the relative differences in preferences for consumers and workers respectively: $\epsilon_U = \frac{\sigma_3-\sigma_2}{\sigma_1-\sigma_2}$ and $\epsilon_L = \frac{\eta_3-\eta_2}{\eta_1-\eta_2}$. Both the wages and employment in transportation and warehousing and general brick-and-mortar retail will fall $\widehat{w_T} = \widehat{w_E} < 0, \widehat{w_B} < 0$, $\widehat{L_T} = \widehat{L_E} < 0, \widehat{L_B} < 0$, while employment in warehouse clubs and supercenters will rise, $\widehat{L_S} > 0$, if an only if: $\frac{1}{1+\frac{\lambda_S\sigma_1}{\lambda_E\sigma_2}} > \epsilon_U > \epsilon_L > 0$, and $\frac{1-\lambda_E}{\lambda_S} > \frac{\sigma_1}{\sigma_2} > \frac{\lambda_E}{1-\lambda_S}$*

Under Proposition 6, Propositions 1-5 hold simultaneously. A necessary condition behind Proposition 6 are that either the consumer elasticity of substitution between general brick-and-mortar retail and e-commerce retail is larger than the consumer elasticity of substitution between warehouse clubs and supercenters retail and e-commerce retail, which in turn is larger to the consumer elasticity of substitution between general brick-and-mortar retail and warehouse clubs and supercenters retail, $\sigma_2 > \sigma_3 > \sigma_1$, or that the consumer elasticity of substitution between general brick-and-mortar retail and warehouse clubs and supercenters retail is larger than the consumer elasticity of substitution between warehouse clubs and supercenters retail and e-commerce retail, which in turn is larger to the consumer elasticity of substitution between general brick-and-mortar retail and e-commerce retail, $\sigma_1 > \sigma_3 > \sigma_2$. Hence, it must be the case that the consumer elasticity of substitution between warehouse clubs and supercenters retail and e-commerce retail is between the remaining consumer elasticities of substitution between brick-and-mortar retail and the other types or retail. Moreover, since $1 > \epsilon_L > 0$, workers' elasticity of substitution elasticity of substitution between working at warehouse clubs and supercenters retail and transportation and warehousing is between the remaining workers' elasticities of substitution between working at brick-and-mortar retail and at the other two sectors, either $\eta_2 > \eta_3 > \eta_1$ or $\eta_1 > \eta_3 > \eta_2$, is also a necessary condition of Proposition 6.

Then given that on average the increase in sales taxes was of 5.6%, for a decrease in wages of transportation and warehousing employees of 7.7%, it must be true that $\epsilon_U > 2.1\epsilon_L$.

Substitution in the retail market

In this section, I explore the determinants of the elasticities of substitution. As mentioned before, a consumer can either buy from a brick-and-mortar retailer, either a general brick-and-mortar or a warehouse club and supercenter, or buy online from an out-of-state e-commerce retailer. I assume consumers buy multiple goods, and for each good acquisition they decide over the three purchasing options.

Each purchasing option involves a cost $C_{ij} = h(\cdot)$ associated with the type of retailer j and how the consumer i perceives the purchase. The first difference in purchasing costs between buying from a brick-and-mortar retailer and buying from an e-commerce retailer comes from the searching time that consumers spend on selecting the product. Searching times, $t_j = g(\theta_j, \psi_j)$ are affected

by how well the retailer shows the product characteristics, θ_j, and how much variety,ψ_j, they offer. For example, through e-commerce, consumers face lower costs associated to accessing detailed information of the characteristics of the products, comparing across products, comparing prices across different sites and buying with a click in their computer or mobile device. On one hand, brick-and-mortar store offers limited product variety, however, by searching online the vast product variety can obfuscate the consumer. Moreover, brick-and-mortar retailers proximity to each other creates an environment where consumers can visit many stores and purchase all the goods in the same visit, similar to searching online and comparing many websites. Hence, distance to the store, d_j, is a key cost associated to purchases from brick-and-mortar retailers, such as the lack of proximity of some brick-and-mortar stores, like outlet malls, to consumers creates a challenge for consumers without transportation means. Besides, while delivery is not needed in brick-and-mortar stores, it is required at online purchases, adding waiting time, m_j, and shipping costs, s_j, to the associated purchasing costs. Additionally, pre-purchase interactions at brick-and-mortar stores reduce consumption costs related to measure, touch, smell, try and feel the products, which is not possible online. I consider this cost as experience related costs X, where $X = 0$ at the store and $X = 1$ online. Finally there are some learning costs, L_{ij} associated with purchasing in general. For instance, when buying in the store the consumer learns where the products are located, if those products are moved to different shelves the consumer will have to re-learn the products location. Furthermore, buying online requires developing certain skills as knowing how to browse the Internet and how to recognize safe sites and platforms from scams.

Consumers then maximize utility given by:

$$U_{ij} = v_i - p_j - C_{ij}$$

depending on how much their value the good v_i, the price they face at each purchasing option p_j, and the associated cost from the purchase, $C_{ij} = h(t_j, s_j, m_j, d_j, X_j, L_{ij})$.

As out-of-state e-commerce retailers do not collect sales taxes, consumers buying from them pay a price p, while consumers buying from general brick-and-mortar retailers pay the price $p(1 + \tau)$, with τ being the *ad valorem* sales tax. As warehouse clubs and supercenters usually offer discounts due to buying in bulk, consumers buying from them pay the price $p'(1+\tau)$. For simplicity, I assume $p < p'(1 + \tau) < p(1 + \tau)$ and that the associated purchasing cost at both brick-and-mortar retail options are the same (C_{is}).

Hence, in this setting, the elasticities of substitution between purchasing channels are functions of both the price advantage and consumers' purchasing associated costs. In that sense, as urban and rural areas have observable characteristics that lead to differences in both the type of price advantage

and the determinants of purchasing associated costs, I expect differences in consumers' substitution patterns. For example, urban areas not only have state sales taxes, they also have local sales taxes. Hence, in urban areas the price advantage is not removed when the Amazon Tax is enacted, only reduced, which may lead to a smaller substitution between e-commerce purchases and brick-and-mortar purchases by consumers. On the other hand, consumers in rural areas may face lower product variety, higher distance to the stores, waiting times, shipping costs, and learning costs due to lack of access to internet. While the first two imply higher associated costs for purchases from brick-and-mortar retailers, the last three imply higher associated costs for purchases from e-commerce retailers. Therefore, we may expect larger or smaller substitution from consumers depending which mechanisms prime.

Additionally, once the price advantage is removed, general brick-and-mortar retailers may have incentives to enter to the e-commerce retail market, given that now they compete with e-commerce retailers at the same prices, while e-commerce retailers may have incentives to locate closer to consumers, given that now they have to collect taxes everywhere.

Retail production and and substitution in the labor market

In the previous section, I assume that retailers in each sector produce retail with only labor. However, from the empirical analysis, the retail production functions require different combinations of tasks performed by employees from a variety of occupations (skills) according to the type of retail. Let's consider the main four occupational groups present in retail: sales employees L_{si}, professional and managerial employees L_{pi}, transportation, production and construction employees L_{ti}, office and service employees L_{oi} and let θ_{hi} be the share of each occupation h required for the production in sector $i = X, Y, Z$, and L_i be the vector of retail employment required to produce in such sector.

Notice that while out-of-state e-commerce retail requires only last mile transportation and warehousing services in the local labor market, when located in-state e-commerce retail also requires employees from the main four occupations. For the following analysis, I focus on in-state e-commerce requirements since general brick-and-mortar retailers may have incentives to enter into e-commerce retail market and out-of-state e-commerce retailers may have incentives to locate closer to consumers. To make the distinction clear, I label in-state e-commerce retail sector as O.

In line with the observations from the data, I assume that $L_Y > L_X > L_O$, that is e-commerce retailers require less employees than general brick-and-mortar retailers and warehouse clubs and supercenters. I also assume that general brick-and-mortar retailers require larger shares of sales and related occupations and smaller shares of the remaining occupations than e-commerce retailers, and that warehouse clubs and supercenters require a larger share of service and office occupations than general brick-and-mortar retailers, but smaller than e-commerce retailers. Finally, I assume that ware-

house clubs and supercenters require smaller shares of transportation, production and construction occupations and professional and managerial occupations than both general brick-and-mortar and e-commerce retailers. Hence:

$\theta_{sY} > \theta_{sX} > \theta_{sO}, \theta_{pO} > \theta_{pX} > \theta_{pY}, \theta_{oO} > \theta_{oY} > \theta_{oX}$ and $\theta_{tO} > \theta_{tX} > \theta_{tY}$.

Here, in-state e-commerce retail requirements for transportation and related occupations are here considering both in-house and out-sourced. Previously, I've chosen to consider that out-of-state e-commerce retailers outsource last mile transportation and warehousing instead of conducting this processes in-house as that was how major e-commerce retailers conduct the last mile transportation and warehousing during the period studied.

For the following analysis let's consider a labor market problem as a simplification of Bartik (2018). In this framework, in-state occupational wages are determined by the inverse labor-demand elasticity σ_h and a labor productivity shifter α_h such that the inverse-labor demand for a given occupation is $w_h = \alpha_h LD_h^{-\sigma_h}$, where the in-state labor demand LD_h for each occupation h be $LD_h = \sum_j l_{hj}$, with $j = X, Y, O$ representing the in-state retail sectors, general brick-and-mortar retail, warehouse clubs and supercenters and e-commerce retail.

In the baseline model, workers chose how much of their work is allocated to each sector. However, as sectors have different requirements over occupations, it is reasonable to assume that workers are in fact choosing over occupations. Hence, in this framework, each worker k has a bundle of skills, Θ_k, to perform several tasks. I assume all bundles can be place on a line such that different intervals belong to different occupations. For example, transportation and material moving occupations require less complex skills than sales and related occupations or professional occupations. While employees that require less complex skills can acquire additional skills and access to other occupations, skill acquisition is costly, since it requires human capital accumulation. Also, workers with more complex skills can perform occupations that require less complex skills, however as they are not the best match to those occupations, they face costs related to adaptation and lower wages.

In that sense, for given distributions of wages, skill bundles, initial occupation h_0 and vacancies, workers select themselves into occupations such that they maximize their indirect utility over occupation h:

$$v_{kh} = \ln(w_h) - s^H c_k^H \times 1(h \neq h_0)$$

Where w_h is the occupational wage, c_k^H is an idiosyncratic moving cost which is a function of the bundle of skills that the worker has $c_k^H(\Theta_k)$, and s^H is a measure of the importance of this cost. This setup is a particular case of Bartik (2018) in which workers do not move across locations (location moving cost is set to infinity).

The labor supply for each occupation will depend on the vector of wages w, the initial number of workers in each occupation N_{h0}, and a function $G(\cdot)$ that assigns probabilities of choosing each

occupation based on w and the distribution function of moving costs $F(c_i^H)$:

$$LS_h(w) = \sum_{h_0} N_{h_0} G(F(c_i^H), w)$$

The equilibrium in the labor market is characterized by the aggregate labor demand being equal to the aggregate labor supply for each occupation:

$$LD_h(w) = LS_h(w)$$

As the labor demand for each occupation is the sum of all retailers labor demands for such occupation, the labor demand in a given occupation will be affected by both the importance of each retailer in the total labor demand, previously defined as λ_j, as well as the shares that the occupation represents in each retailer labor demand, θ_{hj}.

As an increase in the sales tax rate for out-of-state e-commerce retailers reduces their demand of last mile transportation and warehousing services, that will lead to a decline of the labor demand and wages of transportation employees in that sector.

Moreover, if as response of the removal of the price advantage there is an increase in employment in warehouse clubs and supercenters and a decrease in employment of general brick-and-mortar retail, we may expect a decline in the labor demand of transportation and professional occupations, and an increase in the labor demand of sales and office occupations. Given the observed wages and occupational moving costs, transportation employees may be underqualified to work in sales or office occupations, while professional employees may be underqualified to work in sales or office occupations, leading to mismatches in the retail local labor market.

Finally, as general brick-and-mortar retailers now have incentives to start selling online, and out-of-state e-commerce retailers now have incentives to locate in the local economy, we may expect a decrease in the labor demand of sales occupations, and an increase in the labor demand of professional, office and transportation occupations. Given the observed wages and occupational moving costs, sales employees may be overqualified to work in transportation occupations, or underqualified to work in professional or office occupations, leading to mismatches in the retail local labor market.

Conclusion

In this paper, I present evidence of a non-neutral role of e-commerce on local labor markets. I find that the enactment of legislation requiring out-of-state e-commerce retailers to collect sales taxes, known as the Amazon Tax, lead to decreases in retail employment and number of establishments (1%), as well as in last-mile warehousing and transportation employment (9.57%) and wages (7.7%),

consistent with the findings of Chun (2019) and Chava et al. (2018). Moreover, I discover these effects are more pronounced in urban commuting zones, and they are explained by a decrease in employment of general brick-and-mortar retailers while employment of warehouse and supercenters increases.

Additionally, in non-urban commuting zones, I observe a change in the retail occupational structure consisting of an increase in the share of office and service related occupations (7.14%) and a decrease in the share of sales and related occupations (4.79%).

Finally, I show that the effects of e-commerce differ by sector and spatial dimension. Through a general equilibrium model, I connect the differential effects with different elasticities of substitution, which is consistent with Bar-isaac et al. (2012) and Vitt (2020).

These results suggest that even though e-commerce retail is only a small portion of the retail sector, it plays an important role in the local economy, in contrast to the conclusions of Hortaçsu and Syverson (2015). The differential effects in employment in warehouse clubs and supercenters and general brick-and-mortar retail may indicate that once e-commerce retail price advantage is removed the competition between the first two retail sectors could intensify, forcing general brick-and-mortar retailers to downsize or go out of business. On non-urban areas, the compositional changes in employment could imply that retailers may turn into a hybrid model anticipating internet usage growth.

Furthermore, the results may indicate the ineffectiveness of an increase in sales taxes, such as the enactment of the Amazon Tax, to slow down or stop the "Retail apocalypse". The inefficacy of this policy may be caused by erroneous perceptions of elasticities of substitution sizes. Additional research is needed regarding both consumers' and workers' preferences to better identify policies that protect retail employees from the changes caused by e-commerce growth.

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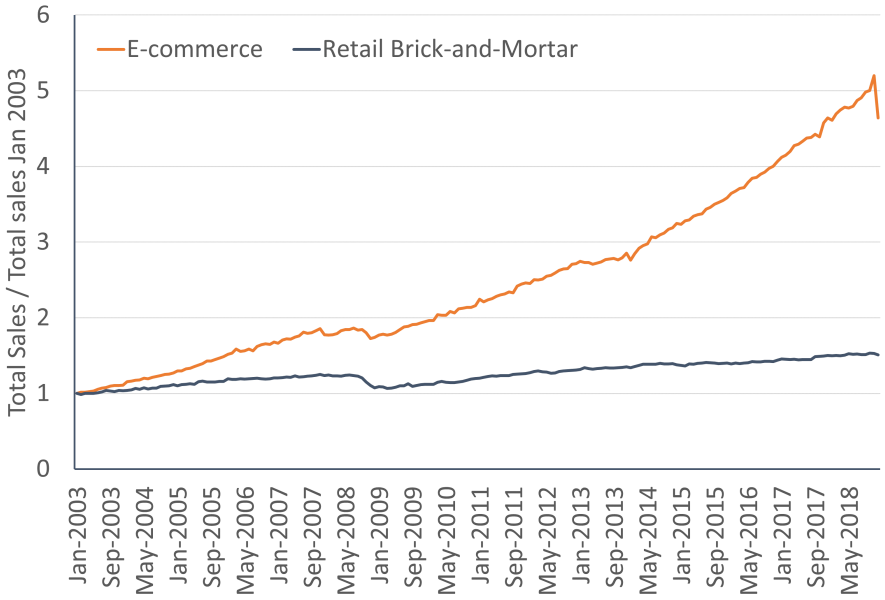
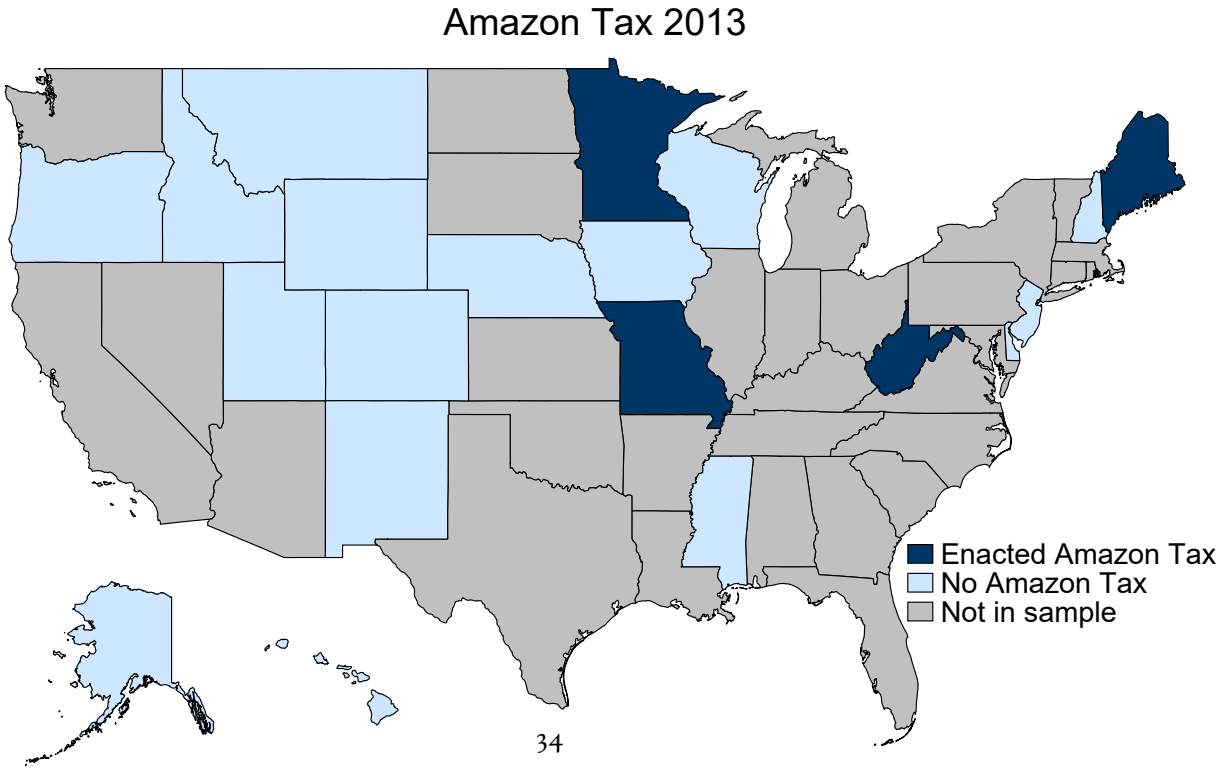
Figure 1: Sales growth e-commerce vs brick-and-mortar retailers



Notes: E-commerce share and brick-and-mortar share from total sales computed from Annual Retail Trade Survey years 2003-2017. E-commerce retailers here is short for electronic commerce and mail order houses industry (NAICS 4541), brick-and-mortar retailers are the remaining retailers.

Figures

Figure 11: States in sample



Notes: In dark blue states that enacted the Amazon Tax in 2013, in light blue states that never enacted the Amazon Tax, in gray states excluded from sample because: enacted the Amazon Tax in other years,signed voluntary collection agreements with Amazon,Amazon was already collecting sales taxes due to physical presence.

Tables

Table 1: States in sample: enactment of Amazon Tax 2013

Treated states	**Control states**		**Other states not in sample**	
Maine	Alaska	*Amazon Tax not in 2013*	*Voluntary Collection Agreement*	*With Amazon physical presence*
Minnesota	Delaware	Alabama	Arizona	Kansas
Missouri	District of Columbia	Arkansas	Florida	Kentucky
West Virginia	Hawaii	California	Indiana	North Dakota
	Idaho	Colorado	Maryland	
	Iowa	Connecticut	Massachussetts	
	Mississippi	Georgia	South Carolina	
	Montana	Illinois		
	Nebraska	Louisiana		
	New Hampshire	Michigan		
	New Mexico	Nevada		
	Oregon	New Jersey		
	Utah	New York		
	Wisconsin	North Carolina		
	Wyoming	Ohio		
		Oklahoma		
		Pennsylvania		
		Rhode Island		
		South Dakota		
		Tennessee		
		Texas		
		Vermont		
		Virginia		
		Washington		
		Wyoming		

Notes: Information compiled from State legislation, complemented with Baugh et al.(2018), Kaçamak and Wilkin(2020), and archived information from Amazon.com (Wayback Machine)

Appendix

I solve for the effects of an increase in the ad valorem tax rate on sales of out-of-state e-commerce retail, sector E, while the remaining tax rates do not change, $\widehat{\tau_B} = 0$,$\widehat{\tau_S} = 0$. Since I focus on real behavior, I choose S as numeraire, hence $\widehat{p_S} = 0$. Combining equations I, II, III and V, 1, 2, I find:

$$\hat{p_B} = \hat{w_B}, \hat{p_S} = \hat{w_S}, \hat{p_E} = \hat{w_E} \tag{15}$$

As $\hat{p_S} = 0$ due to S being the numeraire, hence:

$$\widehat{w_S} = \widehat{p_S} = 0 \tag{14a}$$

Combining equations 6,7 and 8, I obtain the expression:

$$\hat{p_B} = \frac{\sigma_3 - \sigma_2}{\sigma_1 - \sigma_2}(\hat{p_E} + \hat{\tau_E}) = \epsilon_U(\hat{p_E} + \hat{\tau_E}) \tag{16}$$

Combining equations 3,4 and 5, I obtain the expression:

$$\hat{p_B} = \frac{\eta_3 - \eta_2}{\eta_1 - \eta_2}\hat{p_E} = \epsilon_L\hat{p_E} \tag{17}$$

Combining expressions 15, 16 and 17, I find 14b and 14c

$$\widehat{w_E} = \widehat{p_E} = \widehat{w_T} = \widehat{p_T} = -A\widehat{\tau_E} \tag{14b}$$

$$\widehat{w_B} = \widehat{p_B} = -A\epsilon_L\widehat{\tau_E} \tag{14c}$$

Combining equation 6 with 14b and 14c, I obtain:

$$\hat{S} = \hat{B} + \frac{\sigma_1\epsilon_L\epsilon_U}{\epsilon_L - \epsilon_U}\hat{\tau_E} \tag{18}$$

Combining equation 7 with 14b and 14c, I obtain:

$$\hat{E} = \hat{B} + \frac{\sigma_2\epsilon_L(\epsilon_U - 1)}{\epsilon_L - \epsilon_U}\hat{\tau_E} \tag{19}$$

Combining expressions 18 and 19 with equation IV and I, I find:

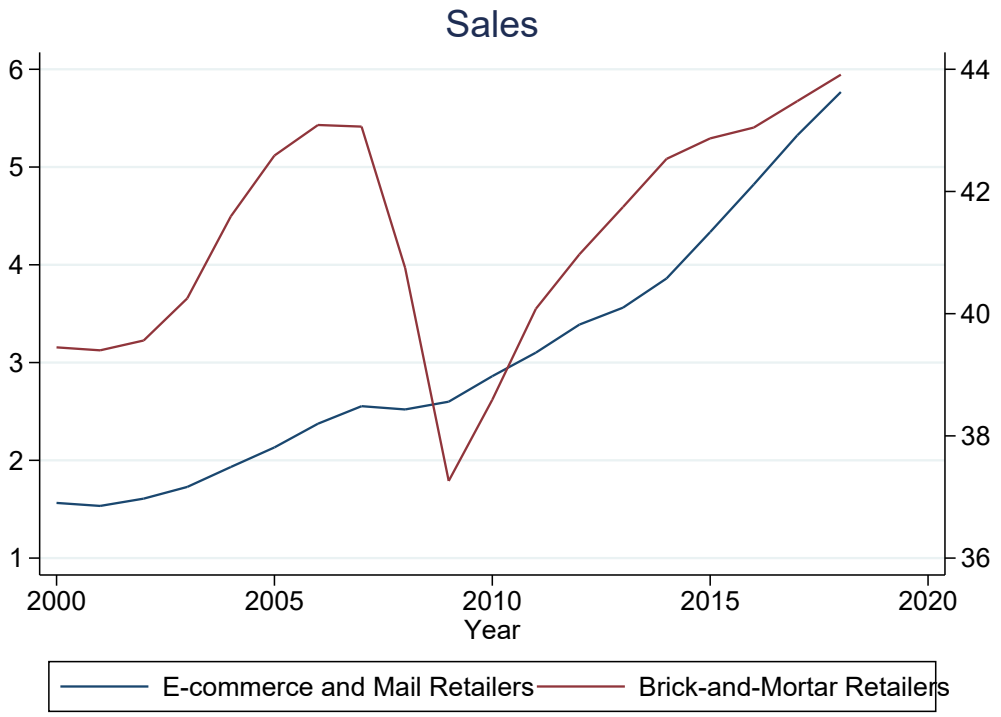
$$\widehat{L_B} = \widehat{L_B} = [\lambda_S\sigma_1\epsilon_U A + \lambda_E\sigma_2(\epsilon_U - 1)A]\,\widehat{\tau_E} \tag{14e}$$

Combining equation II, 14e and expression 18, I obtain

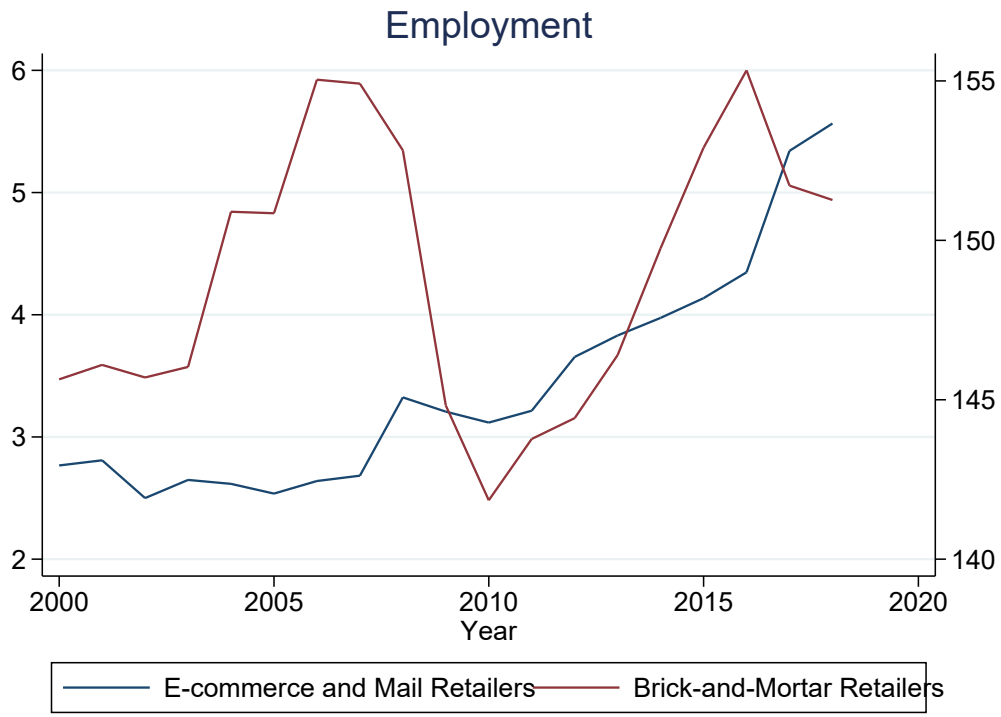
$$\widehat{L_S} = \widehat{L_S} = [(\lambda_S - 1)\sigma_1\epsilon_U A + \lambda_E\sigma_2(\epsilon_U - 1)A]\,\widehat{\tau_E} \tag{14f}$$

Finally, combining equations III, 14e and expression 19 I find

$$\widehat{L_E} = \widehat{E} = \widehat{L_T} = \widehat{T} = [\lambda_S\sigma_1\epsilon_U A + (\lambda_E - 1)\sigma_2(\epsilon_U - 1)A]\widehat{\tau_E} \tag{14d}$$



(a) Sales

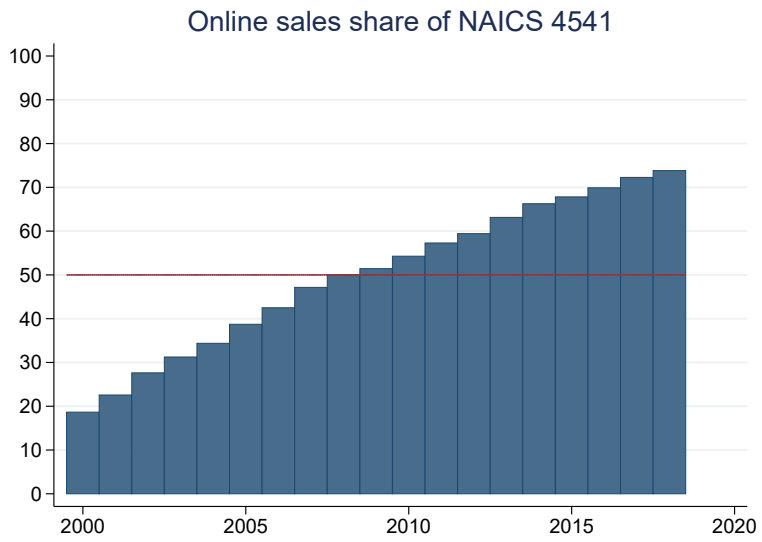


(b) Employment

Figure 2: Sales vs Employment in retail

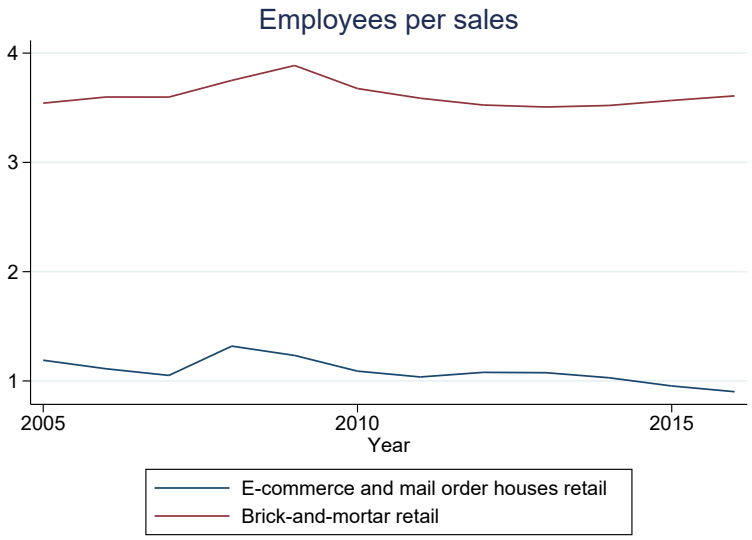
Notes: Total sales in millions computed from Annual Retail Trade Survey years 2005-2017. Employment in millions computed from County Business Patters data. Brick-and-mortar retailers are retailers that are not in the electronic commerce and mail order houses industry (NAICS 4541).

Figure 3: Online sales share from e-commerce retail sales



Notes: Online sales share from e-commerce total sales computed from Annual Retail Trade Survey years 2005-2017. E-commerce retailers here is short for electronic commerce and mail order houses industry (NAICS 4541)

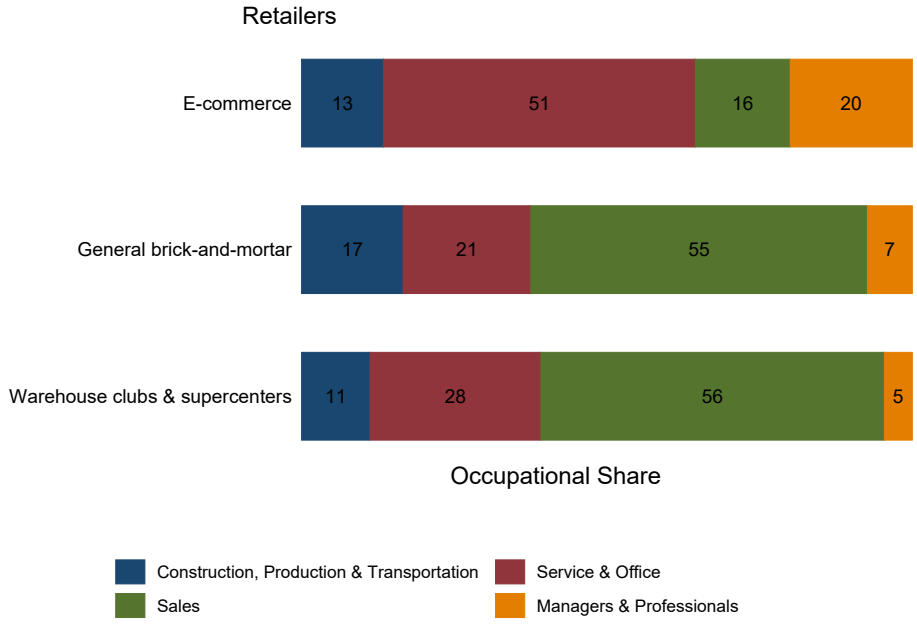
Figure 4: Employment per 100,000 M retail sales



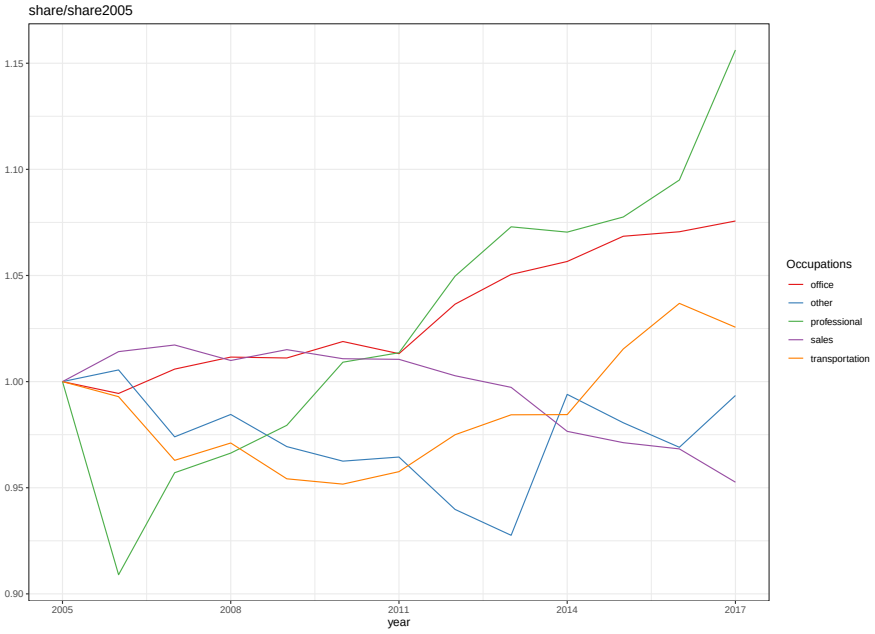
Notes: Total employment from County Business Patterns data. Total sales from Annual Retail Trade Survey years 2005-2017 deflated to 2014 usd.

Figure 5: Online retail sales growth vs warehousing and transportation employment growth

Notes: Warehousing and transportation employment growth rate computed from County Business Patterns data. Online retail sales growth rate computed from Annual Retail Trade Survey years 2005-2017.



(a) Retail Occupational Structure 2007

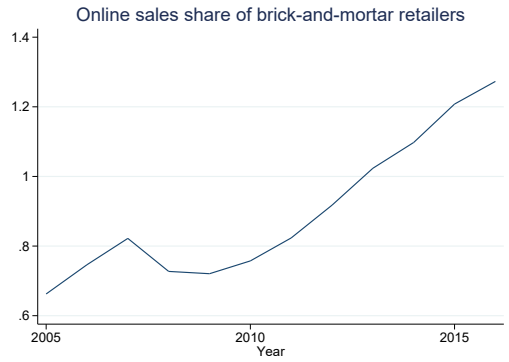


(b) Changes in the occupational structure of retail

Figure 6: Occupational Structure in Retail

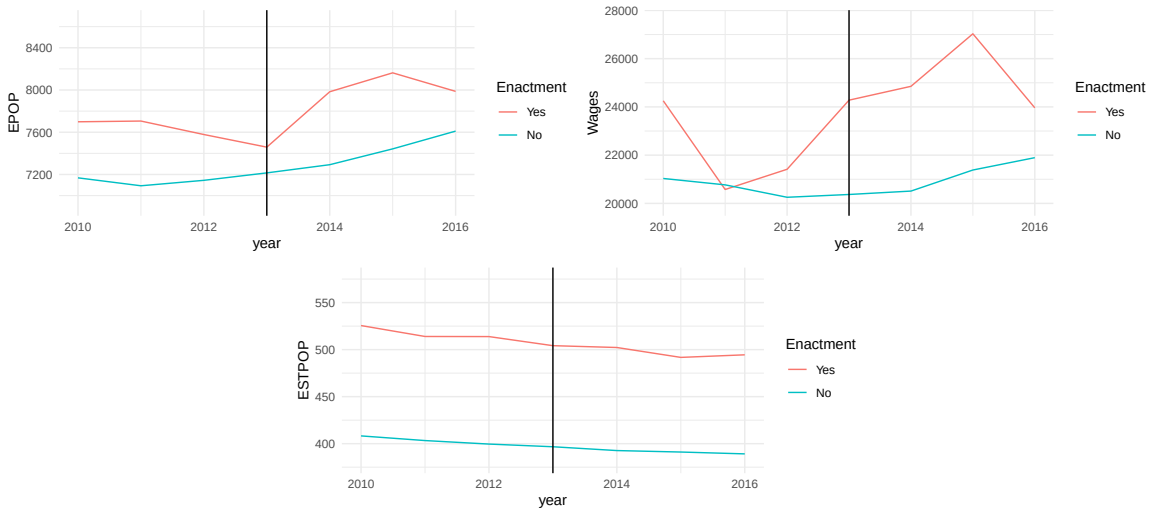
Notes: Panel A: Share of occupations by sub-industry from Occupational Employment and Wage Statistics (OEWS) May 2007. Industries: E-commerce (NAICS 4541), Warehouse Clubs and Supercenters (NAICS 4529), General Brick-and-mortar (NAICS 441, 442, 443, 444, 445, 446, 447, 448, 451, 4521, 453, 4542 and 4543). Panel B: Share of occupations from the American Community Survey years 2005-2017. The occupational share represents $Employment_{iR}/Employment_{R}$ where i is the occupational group and R is retail. Changes are measured with respect to 2005, as $share_{iR,t}/share_{iR,2005}$. Panel A and B occupational shares for major retail occupations: transportation and material moving occupations, production and construction occupations (SOC 53-, 51-, 45-, 47- and 29-), office and service occupations (SOC 43-, and 3X-), sales and related occupations (SOC 41-), and managerial and professional occupations (SOC 1X- and 2X-)

Figure 7: Online sales share from brick-and-mortar retail sales



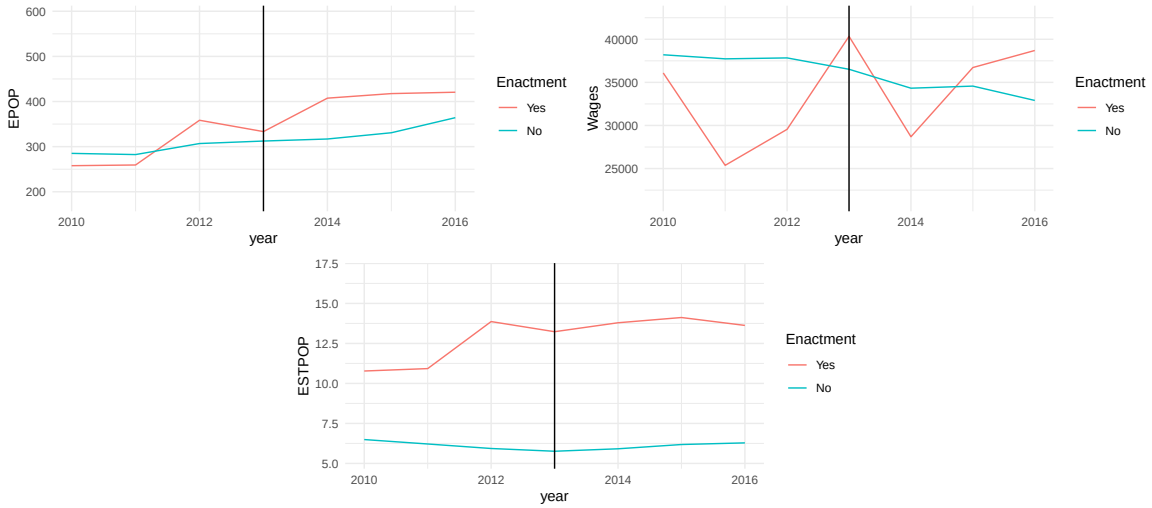
Notes: Online sales share from brick-and-mortar total sales computed from Annual Retail Trade Survey years 2005-2017. Brick-and-mortar retailers are retailers that are not in the electronic commerce and mail order houses industry (NAICS 4541)

Figure 8: Retail - Enactment of the Amazon Tax in 2013



Panel (a) Average Retail Employment/working age population*100,000 for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Working age population is population between ages 15 and 64 from Census Intercensal Population Estimates. Employment counts at the commuting zone level from County Business Patters. Panel (b) Average Retail Annual wages for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Average annual income wages of employees in Retail at the commuting zone level from yearly American Community Survey. Panel (c) Average Retail Establishments/Population*100,000 for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Population counts from Census Intercensal Population Estimates. Number of establishments at the commuting zone level from County Business Patters. Never Treated commuting zones exclude commuting zones of states that signed voluntary collection agreements or where Amazon.com, Inc was collecting sales tax due to physical presence.

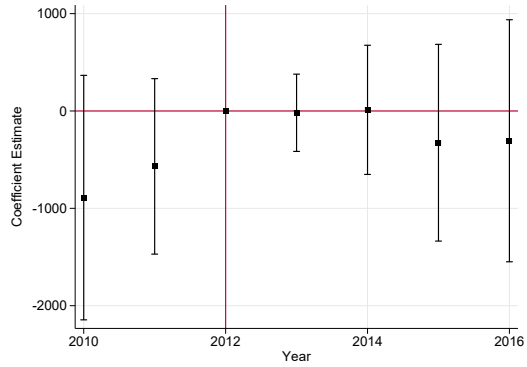
Figure 9: Last-mile transportation and warehousing - Enactment of the Amazon Tax in 2013



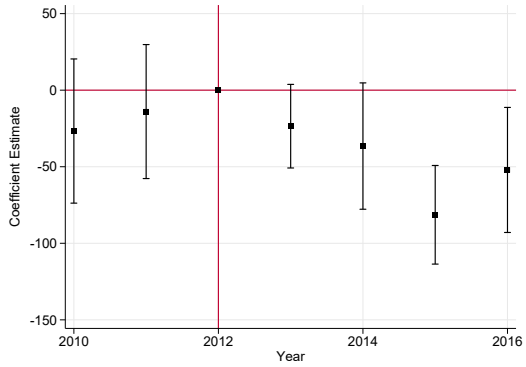
Panel (a) Average Transportation and Warehousing Employment/working age population*100,000 for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Working age population is population between ages 15 and 64 from Census Intercensal Population Estimates. Employment counts at the commuting zone level from County Business Patters. Panel (b) Average Transportation and Warehousing Annual wages for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Average annual income wages of employees in Transportation and Warehousing at the commuting zone level from yearly American Community Survey. Panel (c) Average Transportation and Warehousing Establishments/Population*100,000 for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Population counts from Census Intercensal Population Estimates. Number of establishments at the commuting zone level from County Business Patters. Never Treated commuting zones exclude commuting zones of states that signed voluntary collection agreements or where Amazon.com, Inc was collecting sales tax due to physical presence.

Figure 10: Employment Shares for commuting zones that enacted Amazon Tax in 2013

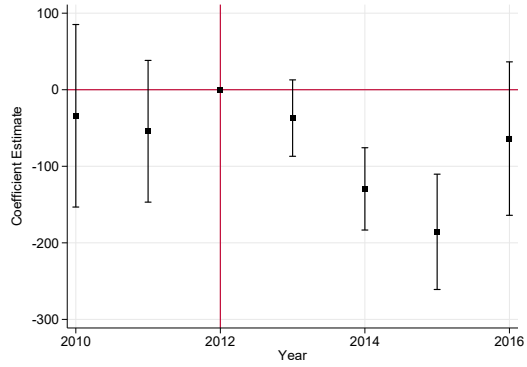
Panel (a) Average retail employment share of transportation, construction and production occupations for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Panel (b) Average retail employment share of office and service occupations for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Panel (c) Average retail employment share of sales and related occupations for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Panel (a) Average retail employment share of managerial and professional occupations for time-group treated commuting zones in 2013 vs Never Treated commuting zones. Employment counts by occupation and total employment at the commuting zone level from yearly American Community Survey. Never Treated commuting zones exclude commuting zones of states that signed voluntary collection agreements or where Amazon.com, Inc was collecting sales tax due to physical presence.



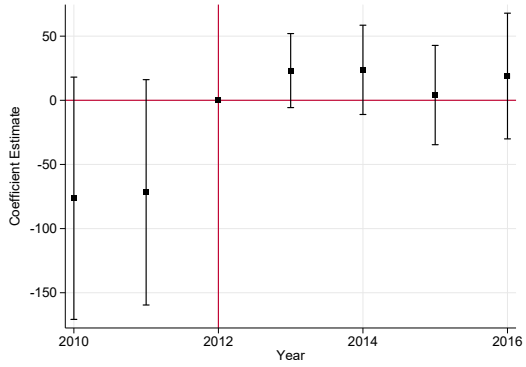
(a) Overall



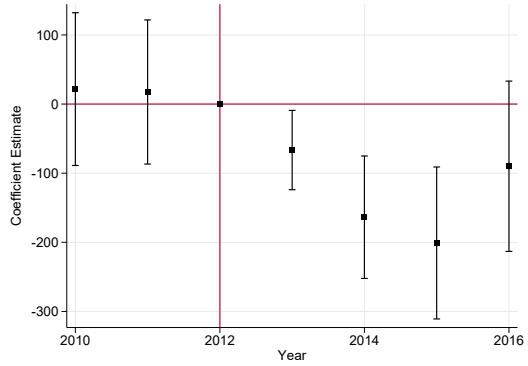
(b) Transportation & warehousing



(c) Retail



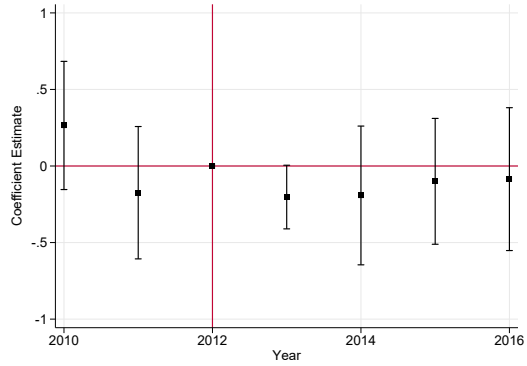
(d) Warehouse clubs & supercenters



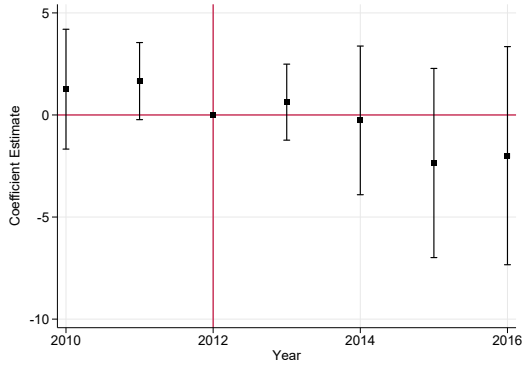
(e) General brick-and-mortar retail

Figure 12: Employment/working age population by sector

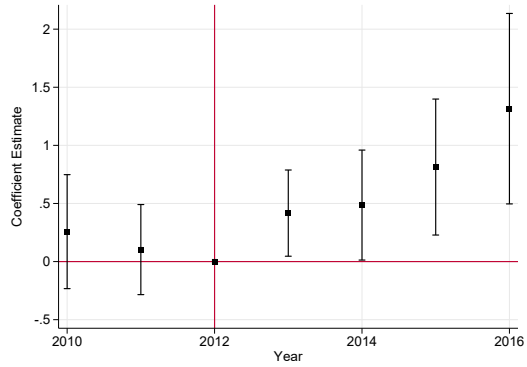
Notes: Each panel shows the coefficients and 95% confidence interval for separate event study regressions of the ratio between each sector employment and working age population. Regression coefficients are weighted by 2005 population and the standard errors are clustered at the state level.



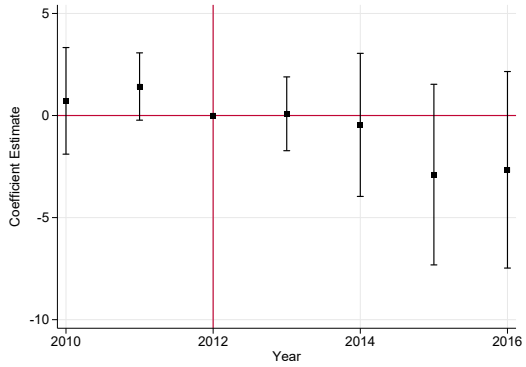
(a) Transportation & warehousing



(b) Retail



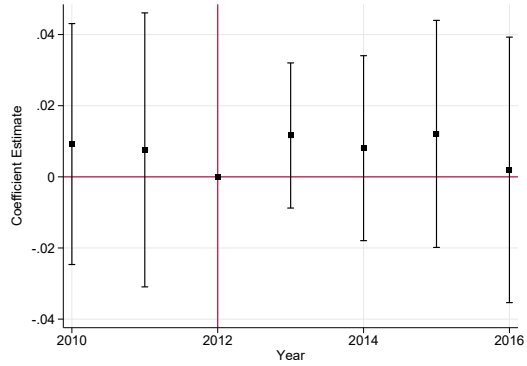
(c) Warehouse clubs & supercenters



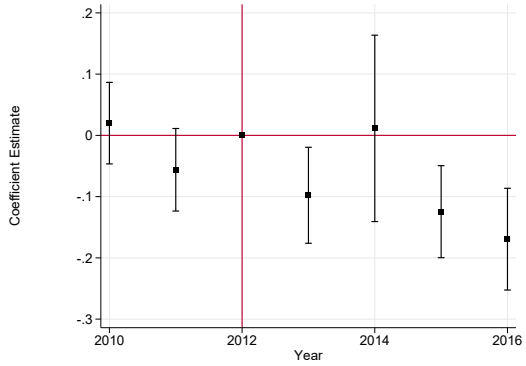
(d) General brick-and-mortar retail

Figure 13: Number of establishments/population by sector

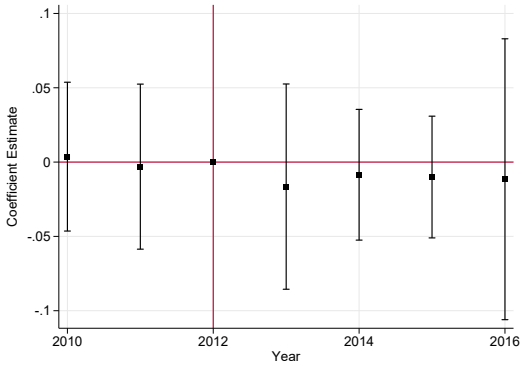
Notes: Each panel shows the coefficients and 95% confidence interval for separate event study regressions of the ratio between each sector number of establishment and total population. Regression coefficients are weighted by 2005 population and the standard errors are clustered at the state level.



(a) Overall



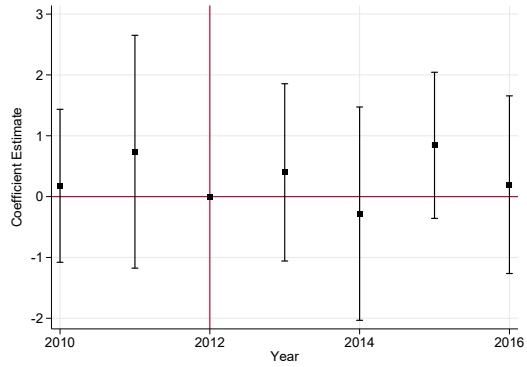
(b) Transportation & warehousing



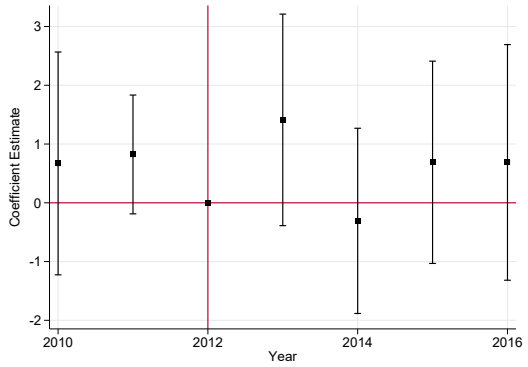
(c) Retail

Figure 14: log(annual income wages) by sector

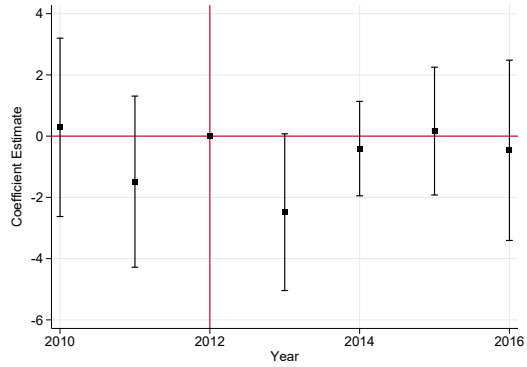
Notes: Each panel shows the coefficients and 95% confidence interval for separate event study regressions of the logarithm of each sector annual wages. Regression coefficients are weighted by 2005 population and the standard errors are clustered at the state level.



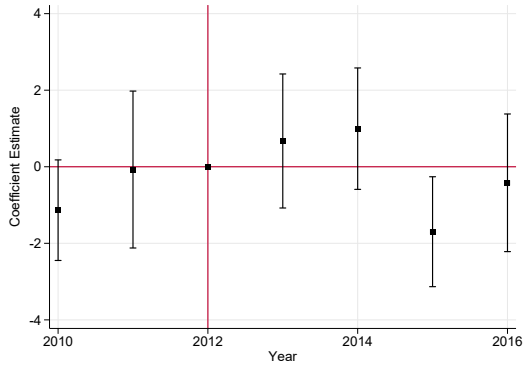
(a) Transportation, production & construction



(b) Office & services



(c) Sales



(d) Managerial & professional

Figure 15: retail occupational shares by occupation groups

Notes: Each panel shows the coefficients and 95% confidence interval for separate event study regressions of the retail occupational shares. Regression coefficients are weighted by 2005 population and the standard errors are clustered at the state level. Occupational shares classified as: transportation and material moving occupations, production and construction occupations (SOC 53-, 51-, 45-, 47- and 29-), office and service occupations (SOC 43-, and 3X-), sales and related occupations (SOC 41-), and managerial and professional occupations (SOC 1X- and 2X-)

Table 2: Balance Table - State characteristics before the Amazon Tax enactment

	Without Amazon Tax	With Amazon Tax	Difference
Number of Amazon FC	0.02	0.00	0.02
Median HHD income	47596	43898	3698***
Employment share ind. 1	0.01	0.00	0.00***
Employment share ind. 2	0.08	0.07	0.01**
Employment share ind. 3	0.12	0.15	-0.03***
Employment share ind. 4	0.25	0.24	0.01**
Employment share ind. 5	0.15	0.14	0.01**
Employment share ind. 6	0.20	0.24	-0.03***
Employment share ind. 7	0.14	0.11	0.03***
Employment share ind. 8	0.04	0.05	-0.00*
State sales tax rate	3.90	5.58	-1.68***
Population 0 to 14	0.20	0.18	0.01***
Population 15 to 24	0.13	0.13	-0.00
Population 25 to 44	0.23	0.23	0.00
Population 45 to 64	0.28	0.28	-0.00
Population 65 to 84	0.14	0.15	-0.01***
Working age population	93995	120859	-26865
Total Population	141580	181500	-39920
College rate	0.20	0.18	0.02***
High school degree rate	0.52	0.56	-0.05***
Rate of white	0.84	0.94	-0.10***
Rate of black	0.05	0.03	0.03**
Rate of Hispanic	0.09	0.03	0.06***
Rate of female	0.50	0.50	-0.01***

Notes: Comparison of selected characteristics between states that enacted Amazon Tax in 2013 and states that did not enact Amazon Tax or signed Voluntary Collection Agreements before 2017. Employment shares by industries grouped at 1 digit code: Agriculture, forestry, fishing and hunting (ind 1), Mining, Utilities and Construction (ind 2), Manufacturing (ind 3), Wholesale trade, Retail, Transportation and Warehousing (ind 4), FIRE and Professional and Business Services (ind 5), Education, Health Care, and Social Assistance (ind 6), Arts, Entertainment, Recreation, Accommodation, and Food Services (ind 7) and Other services (ind 8). Sources: American Community Survey (ACS) years 2010-2016, Census Intercensal Population Estimates 2010-2020, Small Area Income and Poverty Estimates Program, MWPVL International and TaxFoundation.org

Table 3: Employment

Panel A: Sample all commuting zones

	Overall	Transportation & Warehousing	Retail	Warehouse Clubs & Supercenters	General Brick-and-Mortar Retail
Enactment of Amazon Tax	326.5	-34.82**	-74.56**	66.84*	-143.3***
	(485.6)	(13.55)	(31.41)	(31.85)	(40.53)
Baseline mean	46848.09	364.31	7349.84	1062.36	6183.85
Observations	2,051	2,051	2,051	2,051	2,051
Year and CZ FE	YES	YES	YES	YES	YES

Panel B: Sample urban commuting zones

	Overall	Transportation & Warehousing	Retail	Warehouse Clubs & Supercenters	General Brick-and-Mortar Retail
Enactment of Amazon Tax	532.4	-33.20*	-96.48**	86.22**	-181.6***
	(533.5)	(18.08)	(38.84)	(38.83)	(43.44)
Baseline mean	54564.11	496.60	7866.42	1112.24	6589.61
Observations	518	518	518	518	518
Year and CZ FE	YES	YES	YES	YES	YES

Panel C: Sample non-urban commuting zones

	Overall	Transportation & Warehousing	Retail	Warehouse Clubs & Supercenters	General Brick-and-Mortar Retail
Enactment of Amazon Tax	-532.9	-39.13	-1.150	-10.00	0.0713
	(328.4)	(25.56)	(61.91)	(30.77)	(71.85)
Baseline mean	44240.85	319.61	7175.28	1045.51	6046.74
Observations	1,533	1,533	1,533	1,533	1,533
Year and CZ FE	YES	YES	YES	YES	YES

Notes: Enactment of Amazon Tax refers to the difference-in-differences estimation coefficient (δ) from $Y_{cy} = \alpha_c + \gamma_y + \delta D_{sy} + \epsilon_{cy}$, where outcome variable is $\frac{Emp_{cy}}{Pop_{cy}} \times 100000$ for both each corresponding sector (columns). All specifications include year and commuting zone fixed effects and standard errors cluster at the state level.

Table 4: Establishments

Panel A: Sample all commuting zones

	Transportation & Warehousing	Retail	Warehouse Clubs & Supercenters	General Brick-and-Mortar Retail
Enactment of Amazon Tax	-0.175	-1.970	0.638*	-2.195
	(0.187)	(2.107)	(0.312)	(1.954)
Baseline mean	9.33	441.13	20.33	414.69
Observations	2,051	2,051	2,051	2,051
Year and CZ FE	YES	YES	YES	YES

Panel B: Sample urban commuting zones

	Transportation & Warehousing	Retail	Warehouse Clubs & Supercenters	General Brick-and-Mortar Retail
Enactment of Amazon Tax	-0.304	-3.712*	0.685**	-3.969**
	(0.183)	(1.869)	(0.307)	(1.656)
Baseline mean	9.79	379.34	14.07	357.23
Observations	518	518	518	518
Year and CZ FE	YES	YES	YES	YES

Panel C: Sample non-urban commuting zones

	Transportation & Warehousing	Retail	Warehouse Clubs & Supercenters	General Brick-and-Mortar Retail
Enactment of Amazon Tax	0.275	4.006	0.523	3.951
	(0.338)	(3.484)	(0.468)	(3.543)
Baseline mean	9.18	462.01	22.44	434.11
Observations	1,533	1,533	1,533	1,533
Year and CZ FE	YES	YES	YES	YES

Notes: Enactment of Amazon Tax refers to the difference-in-differences estimation coefficient (δ) from $Y_{cy} = \alpha_c + \gamma_y + \delta D_{sy} + \epsilon_{cy}$, where outcome variable is $\frac{Emp_{cy}}{Pop_{cy}} \times 100000$ for both each corresponding sector (columns). All specifications include year and commuting zone fixed effects and standard errors cluster at the state level.

Table 5: Annual wages and hourly wages

Panel A: Sample all commuting zones

	ln(annual income wages)			ln(hourly wages)		
	Overall	Transportation & Warehousing	Retail	Overall	Transportation & Warehousing	Retail
Enactment of Amazon Tax	0.00283	-0.0830***	-0.0119	-0.0107	-0.0770**	-0.0132
	(0.00985)	(0.0228)	(0.0199)	(0.00739)	(0.0310)	(0.0204)
Baseline mean	25170.64	36413.11	21520.36	17.84	22.80	14.30
Observations	2,051	2,051	2,051	2,051	2,051	2,051
Year and CZ FE	YES	YES	YES	YES	YES	YES

Panel B: Sample urban commuting zones

	ln(annual income wages)			ln(hourly wages)		
	Overall	Transportation & Warehousing	Retail	Overall	Transportation & Warehousing	Retail
Enactment of Amazon Tax	0.00498	-0.0740**	-0.00458	-0.0100	-0.0815*	-0.0109
	(0.0101)	(0.0350)	(0.0191)	(0.00794)	(0.0387)	(0.0270)
Baseline mean	27283.75	38113.17	22127.82	19.41	23.84	15.35
Observations	518	518	518	518	518	518
Year and CZ FE	YES	YES	YES	YES	YES	YES

Panel C: Sample non-urban commuting zones

	ln(annual income wages)			ln(hourly wages)		
	Overall	Transportation & Warehousing	Retail	Overall	Transportation & Warehousing	Retail
Enactment of Amazon Tax	-0.00428	-0.114	-0.0403	-0.0106	-0.0572	-0.0212
	(0.0193)	(0.0966)	(0.0326)	(0.0109)	(0.0806)	(0.0177)
Baseline mean	24456.62	35838.67	21315.10	17.31	22.45	13.94
Observations	1,533	1,533	1,533	1,533	1,533	1,533
Year and CZ FE	YES	YES	YES	YES	YES	YES

Notes: Enactment of Amazon Tax refers to the difference-in-differences estimation coefficient (δ) from $Y_{cy} = \alpha_c + \gamma_y + \delta D_{sy} + \epsilon_{cy}$, where outcome variable is annual wages and hourly wages for each corresponding sector (columns). All specifications include year and commuting zone fixed effects and standard errors cluster at the state level.

Table 6: Retail occupational shares

Panel A: Sample all commuting zones

	Occupational Share			
	Transportation, Construction & Production	Office & Sales Services		Managerial & Professional
Enactment of Amazon Tax	-0.0160	0.123	-0.397	0.290
	(0.553)	(0.377)	(0.503)	(0.448)
Baseline mean	17.32	21.15	52.67	8.86
Observations	2,051	2,051	2,051	2,051
Year and CZ FE	YES	YES	YES	YES

Panel B: Sample urban commuting zones

	Occupational Share			
	Transportation, Construction & Production	Office & Sales Services		Managerial & Professional
Enactment of Amazon Tax	-0.274	-0.240	0.200	0.314
	(0.610)	(0.425)	(0.468)	(0.440)
Baseline mean	15.65	21.10	53.26	9.99
Observations	518	518	518	518
Year and CZ FE	YES	YES	YES	YES

Panel C: Sample non-urban commuting zones

	Occupational Share			
	Transportation, Construction & Production	Office & Sales Services		Managerial & Professional
Enactment of Amazon Tax	0.847	1.512***	-2.515**	0.156
	(0.773)	(0.507)	(0.940)	(0.823)
Baseline mean	17.88	21.17	52.47	8.47
Observations	1,533	1,533	1,533	1,533
Year and CZ FE	YES	YES	YES	YES

Notes: Enactment of Amazon Tax refers to the difference-in-differences estimation coefficient (δ) from $Y_{cy} = \alpha_c + \gamma_y + \delta D_{sy} + \epsilon_{cy}$, where outcome variable is $Y_{cyi} = \frac{Emp_{cyi}}{Emp_{cy}}$ for each occupational group: transportation and material moving occupations, production and construction occupations (SOC 53-, 51-, 45-, 47- and 29-), office and service occupations (SOC 43-, and 3X-), sales and related occupations (SOC 41-), and managerial and professional occupations (SOC 1X- and 2X-). All specifications include year and commuting zone fixed effects and standard errors cluster at the state level.