The taller the better?
Agglomeration determinants and urban structure

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Abstract

This study examines the economic impacts of tall building construction in the United States between 2000 and 2017. Using a novel zip-code-level dataset that combines building height data, establishment counts, employment, and housing values, we explore how tall buildings shape local economies. To address endogeneity, we use an instrumental variable strategy leveraging demand and supply factors to isolate the impact of tall buildings on urban economies. Our findings show that tall buildings significantly boost establishments and employment, particularly in business-oriented sectors like offices and hotels. They also foster knowledge-intensive activities, reduce space-intensive sectors such as manufacturing, and lead to housing appreciation. Furthermore, these benefits are concentrated near tall buildings and diminish with distance. Overall, our findings highlight how vertical urban growth fosters economic development and reshapes cities' industrial and spatial organization.

Keywords: tall buildings, agglomeration, economic activity, urban transformation, cities, agglomeration
JEL Classification: R10, R23, Z32

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1 Introduction

Urbanization is one of the key trends of the 21st century, with the United Nations estimating that 68% of the global population will reside in urban areas by 2050 (ONU, 2018). This unprecedented urban expansion, driven by rapid population growth and economic development, poses significant challenges for land use and infrastructure in cities. One solution to these challenges has been the vertical expansion of urban areas through the construction of tall buildings, which play a crucial role in accommodating rising demands for residential, commercial, and office space within increasingly constrained land markets (Ahlfeldt and Barr, 2022).

Tall buildings serve not only as a practical response to urban density pressures but also as disruption driver for local economies. By intensifying land use, they promote agglomeration economies, enabling businesses to benefit from proximity, shared infrastructure, and labor pooling (Liu et al., 2020). Additionally, their construction can reshape the urban landscape, influencing employment, sectoral composition, and housing markets in their vicinity. However, the economic impact of tall buildings is not uniform; it depends on their building use, location, and the broader urban context in which they are situated. Understanding how and why tall buildings drive urban economic transformation is essential for urban planning and policy, especially as cities continue to grow vertically to address land scarcity.

This paper explores how the construction of tall buildings affects urban economic dynamics, focusing on business establishments, employment patterns, and housing markets in the United States between 2000 and 2017. The United States, a global leader in skyscraper development, offers a compelling context for this analysis. Despite recent growth in tall buildings in Asia (Barr and Jedwab, 2023), the United States remains second worldwide in the number of tall buildings (CTBUH, 2024). By constructing a comprehensive dataset at the zip-code level by combining data on building heights, employment, establishments, and housing values, this study uncovers the mechanisms through which vertical growth reshapes urban economies.

Tall buildings are not distributed randomly across urban areas. Developers often choose locations based on unobserved characteristics, such as anticipated growth or economic trends. These factors pose potential biases, making it challenging to distinguish causality from correlation in assessing the impact of tall buildings. To address this issue, we propose in this paper a novel instrumental variable strategy based on the use of supply and demand shifters to isolate the impact of tall buildings on urban economies. In particular, the instrument combines cross-sectional variation in geological (bedrock depth and its square) and demand (historical population density) features with temporal variation in construction costs (concrete price indices) by interacting with these components. Bedrock depth affects the feasibility and cost of anchoring tall buildings, while population density reflects economic demand for vertical expansion. Additionally, concrete price fluctuations are one of the main materials that tall buildings use to provide temporal variation, enabling further refinement of causal estimates.

In this manner, the identification strategy leverages both geological and economic drivers of skyscraper construction. Empirical evidence indicates a U-shaped relationship between bedrock depth and building height (Barr et al., 2011; Ahlfeldt et al., 2023). Shallow bedrock increases blasting costs, while deep bedrock necessitates costly foundation solutions. By interacting bedrock depth and its square with historical zip code population densities and overlaying national concrete price indices, the instrument isolates exogenous variation in the cost and demand for tall buildings. This approach ensures that the instrument predicts tall building construction without directly influencing economic outcomes unrelated to building height. In this manner, the instrument builds upon the approach proposed by Ahlfeldt et al. (2023), adapting it to a panel data setting. Importantly, for the identification strategy, we show that our instrument strongly predicts tall building construction across urban geography. Also, we show that the instrument does not directly impact economic outcomes in areas prior to tall building construction. Lastly, we show that our results are robust enough to exploit different sources of exogenous variation using historical lag instruments or limit only the exogenous variation created by geological conditions.

The findings reveal a strong positive impact of tall buildings on local economies. The construction of tall buildings is associated with a 9% increase in both business establishments and employment in their vicinity. Effects are particularly pronounced in commercial-oriented skyscrapers such as offices and hotels, while residential tall buildings also exhibit positive but smaller impacts. Results are robust to different specifications and consistent with the functional specifications, varying measures of the variable of interest, more restrictive specifications, and alternative research designs.

Further analyses reveal substantial heterogeneity in the effects of tall building construction on local economic activity. In particular, these effects vary significantly across different sectors. Tall buildings positively impact knowledge-intensive sectors and consumption amenities such as education, accommodation services and retail trade but lead to a decrease in space-intensive sector activities such as manufacturing and wholesale trade This phenomenon signals a structural shift in the city's economic landscape, characterized by a progressive reduction of space-intensive sectors in favor of services, especially those targeting knowledge-intensive activities. Moreover, the economic effects of hotel openings also extend to the real estate market, leading to increased housing values. Last, the impact of hotel openings varies widely throughout the city, with stronger but persistent decays further away from the tall buildings.

This paper contributes to the emerging field of research on the economic impacts of tall buildings.[1] The rise in global urbanization, coupled with reductions in construction costs and improvements in economic conditions, has spurred the proliferation of tall buildings worldwide (Ahlfeldt and McMillen, 2018). This growth, primarily driven by residential developments, has facilitated the accommodation of larger populations and conserved land, particularly in the developing world (Barr and Jedwab, 2023; Ahlfeldt et al., 2023).

Despite the increasing importance of high-rise constructions across the world and its consequences in terms of land saving and agglomeration economies, little is known about the determinants and economic impacts of tall building heights. Although economic fundamentals have historically been the primary drivers of skyscraper heights (Grimaud, 1989; Sullivan, 1991; Ahlfeldt and Barr, 2022), recent research has identified additional complex forces influencing these dynamics. Studies have increasingly highlighted the role of within-building productivity (Koster et al., 2014; Liu et al., 2018, 2020) as a significant factor. Additionally, intercity competition (Barr, 2013; Lu, 2023), political influences (Barr and Luo, 2021; Chen et al., 2023), and landmark and reputation effects (Helsley and Strange, 2008; Barr, 2010, 2012) also play crucial roles. Regardless of the different contributors to skyscraper heights, the tendency of building up over out has contributed to minimizing the use of expensive land, minimizing disamenities like congestion and pollution (Jedwab et al., 2022; Ahlfeldt et al., 2023).

This paper makes several significant contributions to the literature. First, it is the first study to analyze the economic impacts of tall buildings on urban transformation at a finer spatial scale. While prior research has examined the effects of tall buildings on population growth and city-level indicators (Lu, 2023; Ahlfeldt et al., 2023; Dong and Wang, 2023), this study delves deeper to assess their localized economic effects. Second, it addresses a key methodological challenge by introducing a novel instrument—the interaction of bedrock depth, population density, and the concrete price index—to address the endogeneity stemming from the non-random geographic distribution of tall buildings. The instrument is based on the premise that tall building construction is driven by economic fundamentals. Areas with favorable geographical, material, and demand conditions are more likely to experience higher rates of tall building development. In this context, the closest paper to this is Ahlfeldt et al. (2023), which provides a theoretical framework for understanding the

[1]For a comprehensive list of the recent contributions in the literature on the economics of tall buildings, see Table A1 and Table A2

welfare effects of tall buildings across countries and empirically assesses their impact in terms of population and urban transformation. We further extend and complement their work by empirically testing the effects of tall building construction on urban economic outcomes within a country. Additionally, we draw on a similar instrument proposed by Ahlfeldt et al. (2023), adapting it to a panel data setting to suit our specific context.

This paper also contributes to the growing body of empirical research that exploits within-city variation to credibly identify the effects of economic shocks on urban outcomes. Relevant studies include those examining the impacts of immigration (Mazzolari and Neumark, 2012; Olney, 2013), the entry of big-box retailers (Haltiwanger et al., 2010; Wang, 2023), hotel openings (Hidalgo, 2024), ride-sharing services (Gorback, 2022; Daniele et al., 2022; Norris and Xiong, 2023), and sports facility developments (Bradbury, 2022; Abbiasov and Sedov, 2023). In this context, we leverage a supply shock—tall building construction—to provide new insights into how such developments influence business activity and employment dynamics at the local level.

The remainder of the paper is organized as follows: Section 2 introduces the data, while Section 3 outlines the empirical strategy. Section 4 presents the main findings and includes robustness checks to validate the results. Section 5 explores heterogeneity in the effects. Finally, Section 6 concludes with a discussion of implications and directions for future research.

2 Data

Given the expected local effects of tall buildings, it is advisable to use the finest level of analysis available. Therefore, our primary geographic units of analysis are Zip Code Tabulation Areas.[2] Because zip codes are constructed to align with census data and approximate zip codes, they allow for precise integration with a wide range of socioeconomic and demographic data.

2.1 Establishments and employment

The establishment and employment information code is sourced from the County Business Patterns (CBP) Database of the U.S. Census Bureau. This database offers annual data on the number of business establishments and employment figures based on a specific pay period,

[2]The U.S. Census Bureau developed Zip Code Tabulation Areas (ZCTAs) to meet the need for geographic areas that approximate zip codes for census data analysis. Unlike zip codes, which are intended for mail delivery, ZCTAs are constructed from census blocks, providing a consistent framework for presenting statistical data. For clarity, we will refer to them as "zip codes" in this paper, but it is important not to confuse ZCTAs with postal zip codes used by the U.S. Postal Service. We define geographies with respect to the 2000 census boundaries.

usually mid-March.[3] Moreover, establishment counts are disaggregated by 5-digit NAICS categories.

2.2 Tall buildings

The data set used in this analysis incorporates US tall buildings from 2000 to 2017. Tall buildings data is obtained from the Council on Tall Buildings and Urban Habitat (CTBUH).[4] According to CTBUH criteria, a building is considered tall if it meets one or more of the following characteristics regardless of the usage: height relative to its surroundings, proportion, and specialized building technologies.[5] Proportion is assessed by the building's size and floor area while building technologies refer to vertical transport technologies. Generally, a building is classified as tall if it has 14 or more stories or exceeds 50 meters in height, with at least 50 percent of its height dedicated to usable floor space. Importantly, this dataset provides information about not only the number of tall buildings constructed but also their height, number of floors, and usage.[6]

As shown in Figure I, 1,150 tall buildings were constructed between 2000 and 2017, with the majority being residential. This aligns with the idea that "boring skylines" dominate urban landscapes (Barr and Jedwab, 2023). The United States, as the birthplace of the modern skyscraper, remains a leader in tall building construction. Despite the rapid growth of skyscrapers in other regions, particularly Asia, the U.S. still holds the second-highest number of tall structures worldwide. As shown in Figure I, subplot (a), height densities are concentrated in the main agglomeration areas, which reflects the economic factors that drive their construction. Moreover, in subplot (b), we can see that there has been a notable contemporaneous increase in tall building construction in recent years. However, this growth has followed a cyclical pattern, with the financial crisis significantly curtailing skyscraper construction during its peak impact. This highlights the sensitivity of tall building development to broader economic conditions. Regarding heights, we can see that, on average, a tall building in our sample measured 128 meters, being the tallest of the mixed-used buildings uses as they optimize space utilization by allocating

[3] A critical consideration when using CBP employment data is the practice of data suppression for confidentiality. To protect individual business information, the U.S. Census Bureau suppresses employment counts in cases where a small number of businesses dominate a category within a geographic unit. Instead of exact figures, these entries are flagged to indicate suppression and instead reported with employment size ranges (e.g., 1-19, 20-99 employees, etc.). Therefore, we take the minimum of each category. The results remain consistent regardless of whether we do not impute the employment level.

[4] The Global Tall Building Database has been used in several studies, including Barr and Luo (2021) Jedwab et al. (2022), Ahlfeldt and Barr (2022), and Dong and Wang (2023)

[5] Further information is available at the following link.

[6] We have classified tall building use into four categories: residential, office, hotel, mixed, and others. Mixed represent those tall buildings where more than one economic activity coexists, such as retail and office, and others consider alternative economic activities like hospital or education

different functions to various sections of the building. This approach maximizes the return on investment for each floor, justifying the additional costs associated with greater heights (Koster et al., 2014; Liu et al., 2018, 2020).

Table 1 presents the descriptive statistics of the main variables in this study (see Table A3 in Appendix A for the description and sources of the variables).

Table 1: Summary Statistics of Establishments, Employment, and Building Heights (2000-2017)

	2000	**2017**	**Δ (2017 - 2000)**
Establishments			
Min	1.000	3.000	2.000
Mean	230.900	255.600	24.700
Max	7317.000	7277.000	-40.000
Employment			
Min	0	0	0
Mean	3641	3974	333
Max	161000	178598	17698
Tall Building Height (m)			
Min	0.000	0.000	0.000
Mean	0.486	5.112	4.626
Max	1202.400	6346.090	5143.690
Tall Building Count			
Min	0.000	0.000	0.000
Mean	0.004	0.042	0.038
Max	9.000	44.000	35.000

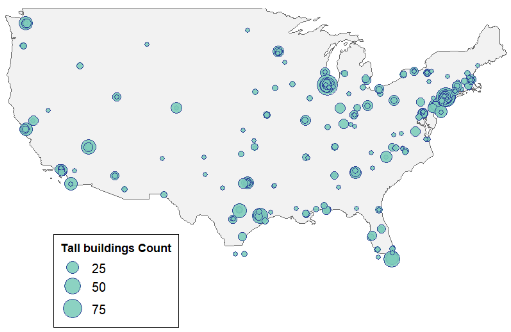
Notes: Summary statistics of establishments, employment, cumulative building height, and cumulative building count are shown for the years 2000, 2017, and the change between 2017 and 2000.

3 Empirical strategy

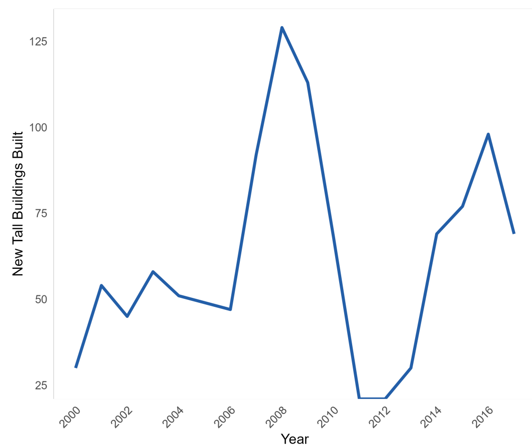
This paper examines the impact of tall building construction on local economic outcomes, particularly the number of establishments and employment in adjacent areas. We want to test whether tall buildings foster agglomeration economies by enabling vertical growth, which may generate positive economic spillovers. To analyze this hypothesis, we specify the following baseline model:

$$Log(Y_{i,t}) = \beta Log(Building\ Height_{i,t}) + \delta_t + \gamma_i + \tau Distance\ to\ Downtown_i \times \delta_t + \epsilon_{i,t} \quad (1)$$

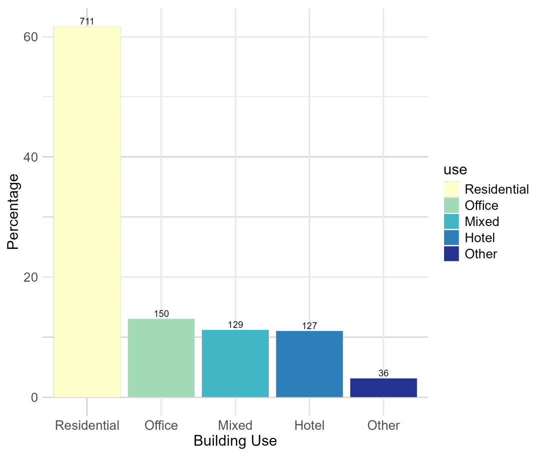
Figure I: Tall Buildings: Geographic and Temporal Distribution



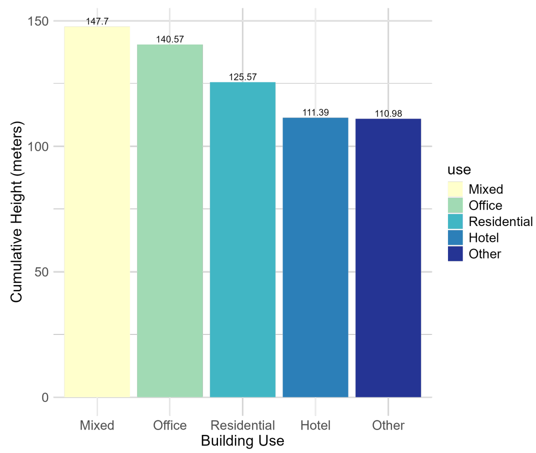
(a) Geographic distribution of tall buildings in 2017.



(b) Tall buildings constructed during 2000-2017.



(c) Distribution of tall buildings by use.



(d) Mean height of tall buildings by use.

Notes: Subplot a depicts the geographic distribution of tall buildings in the USA in 2017, and subplot b illustrates the time series of tall buildings built from 2000 to 2017. Subplot c shows tall building distribution by use between 2000 and 2017. Subplot d shows the mean height of tall buildings by use in the same period.

Here, $Y_{i,t}$ denotes the logarithm of the number of establishments or employment depending on the specification in zip code i in year t, while Building $\text{Height}_{i,t}$ is the logarithm of the cumulative height of tall buildings in each zip code, which we use as a proxy for vertical concentration. Year fixed effects, δ_t, and zip code fixed effects, γ_i, control for time and area-specific factors. We include an interaction term between time and distance to the central business district to capture varying economic growth trends based on proximity to the city center, consistent with our hypothesis that taller buildings are typically concentrated in central areas due to higher land prices.

Our parameter of interest, β, captures the effect of tall building height on establishment counts and employment within the same zip code. However, establishing causality is challenging due to potential endogeneity. Reverse causality may arise if agglomeration increases demand for tall buildings, and omitted variables—such as high land value or zoning changes that encourage commercial activity—may confound the results (Ahlfeldt and McMillen, 2018).

To address these endogeneity concerns, we instrument the cumulative height of tall buildings using supply and demand shifters that capture exogenous variation in construction costs across zip codes. Specifically, we exploit differences in construction costs, which vary due to local bedrock depth, population density, and concrete prices.[7] This approach leverages both supply-side and demand-side factors to predict the likelihood of tall building construction across zip codes.

On the supply side, foundation costs are influenced by bedrock depth, a critical factor in skyscraper construction. Tall buildings are typically built on steel foundations and anchored to bedrock to prevent structural settling (Barr et al., 2011). This dependency on bedrock makes construction costs higher in areas where the bedrock is either very shallow (requiring costly removal through blasting or jackhammering) or very deep (increasing costs due to more extensive foundation work). To capture this non-monotonic cost relationship, we use both bedrock depth and its square as instrumental variables, allowing us to account for the fact that intermediate bedrock depths may minimize construction costs. In fact, we can see this non-monotonic relationship in our data in Figure II, where tall building constructions in the US tend to happen in areas with intermediate bedrock.

We also include a concrete price index as a time-varying supply shifter, adding temporal variation to our instrument and capturing shifts in the cost of key building materials. Bedrock depth affects tall building construction costs, as deeper bedrock often requires more concrete

[7]Bedrock information comes from the global data set developed by Pelletier et al. (2016), which provides high-resolution depth estimates about the depth of unweathered bedrock. Concrete prices index comes from the Bureau of Labor Statistics (U.S. Bureau of Labor Statistics, 2024)

for support, sometimes involving techniques like driving concrete or steel piles with heavy weights. This makes the impact of bedrock depth on construction costs more pronounced when concrete prices are high. Our instrument thus combines bedrock depth with concrete prices, introducing both time and spatial variation, which allows for the use of geographic and time fixed effects. Since skyscraper construction relies heavily on concrete, fluctuations in concrete prices provide additional exogenous variation in building height across zip codes and over time. Fig. II displays the time variation in concrete prices, which, according to Watson (2005), fueled by development in India and China which this last country alone currently consumes about 40 percent of the world's cement, with the majority going toward concrete production.

On the demand side, we incorporate population density as a proxy for land values, which influence the economic incentive for vertical construction. High population density suggests high land prices, encouraging developers to economize on land by investing more heavily in building height. By interacting bedrock depth (and its square) with population density and concrete prices, we capture the combined effect of local geological conditions, material costs, and economic incentives on tall building construction. In this way, the instrument builds on the approach introduced by Ahlfeldt et al. (2023), using geographical and demand factors to predict building height but tailoring it to a panel data framework.

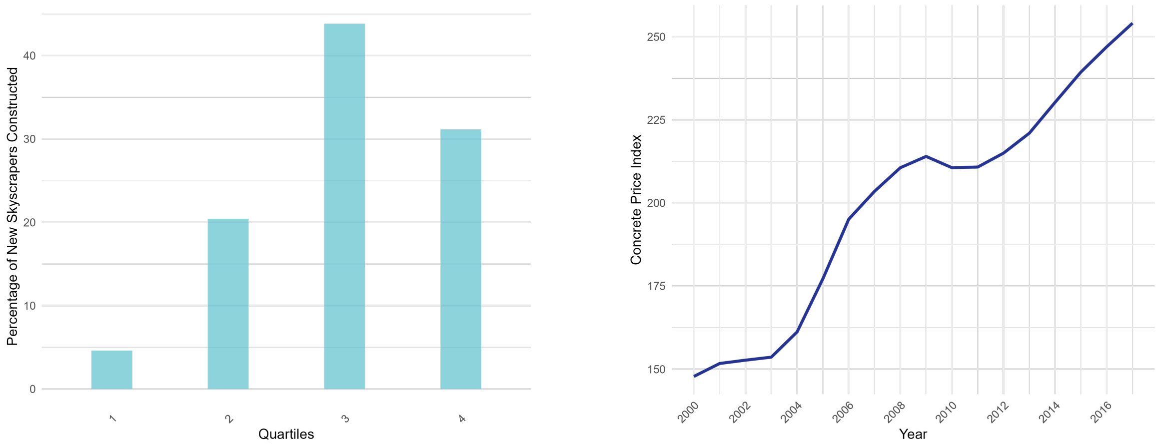
More formally,

$$\begin{aligned}\text{Log(Builds. height}_{i,t}) = {} & \theta_1(\text{Bedrock} \times \textit{Pop density} \times \text{concrete}) + \theta_2(\text{Bedrock}^2 \times \textit{Pop density} \times \text{concrete}) \\ & + \delta_t + \gamma_i + \tau Pop_{i,2000} \times \delta_t + \eta_{i,t}\end{aligned} \tag{2}$$

Given that our identification relies on interaction terms, the critical assumption is more nuanced than simply assuming that bedrock depth is exogenous to local demand shocks. Instead, our identifying assumption is that denser zip codes on more favorable bedrock before the rise of concrete prices did not experience different patterns of change over time compared to denser zip codes on less favorable bedrock or relative to less dense zip codes on either favorable or unfavorable bedrock. This approach relies on a triple-difference framework, comparing differences across time, zip code population density, and bedrock, which is central to establishing causality in our analysis.

Regarding the exclusion restriction, it is unlikely that the national concrete price index directly correlates with characteristics specific to individual zip codes. This suggests that the time-varying component of our instrument is exogenous to local zip code conditions. To satisfy the exclusion restriction, the cross-sectional component of our instrument—the interaction between bedrock, its square, and population density—must correlate with changes

Figure II: Tall buildings use and height.



(a) Bedrock decile and cumulative height (b) Time series concrete price index

Notes: Subplot (a) depicts how tall building supply in 2017 is positively correlated with the bedrock depth divided by quartiles in the middle and negatively correlated with the tails. Subplot (b) shows the evolution of the national concrete price index.

in our dependent variable only through the effect of tall building construction heights. In our framework, the primary channel by which these instruments influence the number of establishments and employment is through shifts in geological conditions, material costs, and economic incentives for tall building construction. We test this condition as follows.

First, a key concern is whether zip codes with favorable characteristics for tall building construction might have already experienced economic changes before construction occurred. To assess parallel trends in our setting, we regress the change in the number of establishments and employment from the pre-period 1994–1999 on the instrument-predicted change in tall building heights during the period 2000–2017. The coefficient of interest is not statistically significant in the pre-period, indicating no pre-existing trend in local economic outcomes tied to favorable conditions for tall building construction. In contrast, in the 2000–2017 period—when we repeat this specification using contemporaneous data on establishments and employment—the coefficient is significant (see Table 2, Columns 2 and 3). These results provide evidence that zip codes with favorable conditions for tall building construction were not already experiencing divergent economic trends correlated with local economic outcomes.

Second, we show that our primary results are robust across different sources of exogenous variation in our identification strategy. Initially, we restrict the variation to geological conditions and material costs alone by excluding population density from our instrument's interaction terms. Next, we employ a different shifter in our baseline instrumental strategy, replacing the national concrete price index with global steel prices—a key component of tall building construction costs. Finally, we calculate population density based on 1990 values to minimize potential contemporaneous effects and mitigate reverse causality concerns. Table 2 summarizes the main results, showing consistently positive and significant effects across all sources of exogenous variation.

Table 2: IV Validity Exercises

	Parallel trend (Replicated)				Alternative instruments					
	Log(Est. +1)	*Log(Emp. +1)*	*Log(Est. +1)*	*Log(Emp. +1)*	*Log(Est. +1)*	*Log(Emp. +1)*	*Log(Est. +1)*	*Log(Emp. +1)*	*Log(Est. +1)*	*Log(Emp. +1)*
	1994-1999	1994-1999	2000-2017	2000-2017	Only Geol.	Only Geol.	Steel	Steel	Pop. density 1990	Pop. density 1990
	(1)	(2)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ Log(Building Height + 1)	0.0624	-0.0170	0.1839**	0.2148**	0.2515**	0.7249***	0.1200***	0.0856***	0.1425***	0.1185***
	(0.0461)	(0.0814)	(0.0819)	(0.0937)	(0.1220)	(0.2651)	(0.0265)	(0.0312)	(0.0283)	(0.0324)
Covariates	x	x	x	x	x	x	x	x	x	x
Census Tract FE	x	x	x	x	x	x	x	x	x	x
Year FE	x	x	x	x	x	x	x	x	x	x
F Stat					67.299	62.123	78.450	20.565	75.826	75.826
Observations	28,868	28,868	28,868	28,868	28,860	28,860	22,189	22,189	22,189	22,189

Notes: Statistical significance at the 1, 5, and 10% levels is indicated by ***, **, and *, respectively. Clustered standard errors are at the zip code level. The dependent variables are the Logarithms of the number of establishments and employment during the 1994 and 1999 periods in columns 1-2 (replicated in 3-4) and during the 2000 and 2017 periods in columns 5-10. The interaction between bedrock depth, pre-treatment population density measured in 2000 and its square, national concrete prices are used as instruments for variation in building heights between 2000 and 2017 in columns 1-4, whereas population in 2000, population in 1990, and population density in 1990 are included in columns 5-10, respectively. Population trends in 2000, as well as zip and year-fixed effects, are included in all specifications.

4 Results

Table 3 presents the results of our baseline IV specifications.[8] The baseline sample consists of 28,856 zip codes observed over 18 years. The dependent variables are the number of establishments and total employment within each zip code. Columns 1 and 2 report the regression of the number of establishments and employment, respectively, on the predicted tall building height. To account for the potential influence of time-invariant, zip code-specific characteristics or common trends that uniformly affect all geographical units, we include zip code and year fixed effects in Columns 3 and 4. Finally, to allow for varying trends based on geographical location, we interact a time trend with the distance to downtown in Columns 5 and 6.

[8] Table A4 in Appendix A provides the first-stage, reduced-form, and regression results as a robustness check by excluding zip codes with censored employment data. These results confirm the strength of the instrument, though the magnitude of the employment coefficient changes slightly while remaining statistically significant.

Table 3: Baselines estimates

Dependent Variables:	$Log(Est.+1)$	$Log(Emp.+1)$	$Log(Est.+1)$	$Log(Emp.+1)$	$Log(Est.+1)$	$Log(Emp.+1)$
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Log(Building Height + 1)	4.15***	6.14***	0.174***	0.144***	0.143***	0.118***
	(0.004)	(0.005)	(0.031)	(0.033)	(0.028)	(0.032)
Fixed-effects						
zip code	No	No	Yes	Yes	Yes	Yes
Year	No	No	Yes	Yes	Yes	Yes
Distance Trend	No	No	No	No	Yes	Yes
F statistics	36.426	36.426	26.354	26.354	26.230	26.230
Observations	519,408	519,408	519,408	519,408	519,408	519,408

Notes: Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively. Clustered standard errors are at the zip code level. The dependent variables are the logarithms of the number of establishments and employment. The interaction between bedrock depth and its square, population density in 2000, and concrete price index are used as instruments for variation in building heights between 2000 and 2017. Zip code and year fixed effects are included in columns 3-6, and additional distance to the center trends, as well as ZIP and year-fixed effects, are included in columns 5 to 6.

At first glance, the results do not seem to depend on the selected model: in all models, we find a positive and significant effect of tall building height construction both in the number of establishments and employment. In this way, our results confirm current findings in the literature that have shown a positive link between tall buildings and urban economic activity (Patto, 2023; Dong and Wang, 2023). The inclusion of the distance to the city center trend slightly reduces the magnitude of the main coefficients. However, they remain significant across all specifications. It is worth noting the strength of our instrument, the interaction between bedrock and its square, population density measured in 2000, and the concrete price index, as can be seen in the Kleibergen-Paap Wald F-test value.

It is noteworthy that both IV coefficients are larger than OLS coefficient (see Table A4 in the Appendix A). This result is consistent with previous studies that also found a downward bias in the OLS specification using an instrumental strategy design in the tall building literature (Koster et al., 2014; Ahlfeldt et al., 2023). A potential reason for this downward bias is that measurement error presents a challenge in accurately determining the number of tall buildings in the market. There are likely many buildings that are not included in the database since the Council on Tall Buildings and Urban Habitat database is focused mainly on buildings of at least 100 meters. This uncertainty introduces noise into the data that can bias the estimated coefficients.

In economic terms, our estimates show that increasing the height of tall buildings by 128 meters results in approximately a 9% increase in both the number of establishments and employment.[9] However, the positive impacts of tall building height construction on

[9]This figure is calculated by multiplying the coefficients from columns 7 and 8 in Table A4 in the Appendix A by the average height of tall buildings constructed.

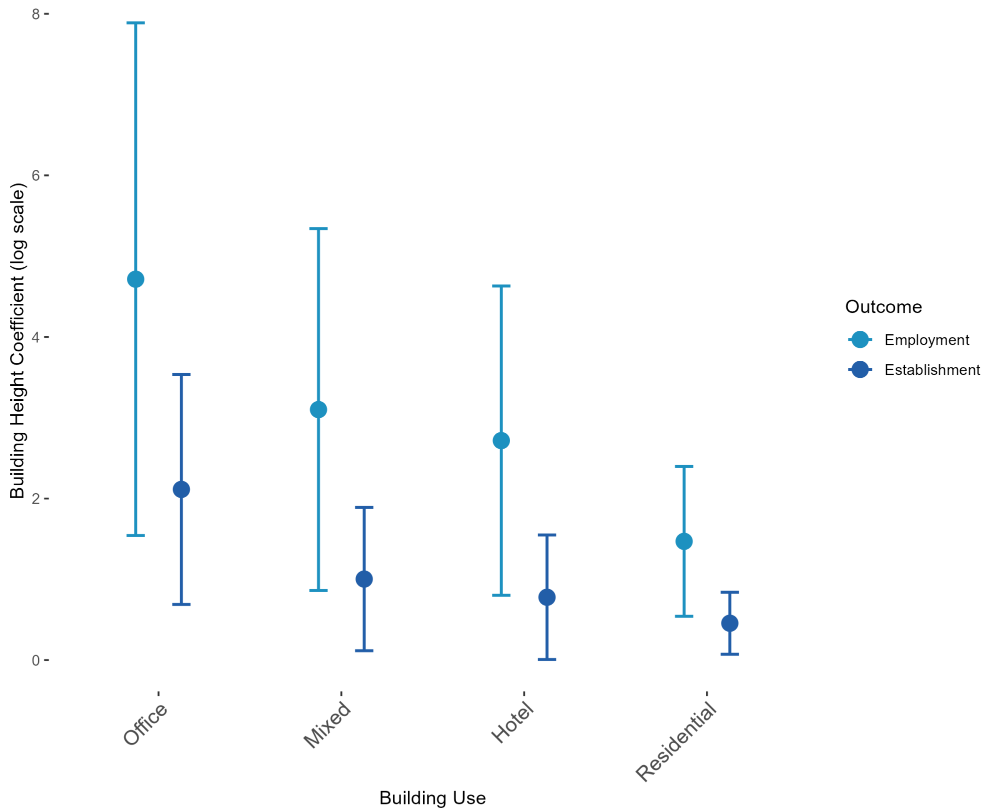
establishments and employment outcomes may mask heterogeneous effects depending on the building use. In this regard, it is expected that more business-oriented uses, such as offices or hotels, have larger effects on economic activity due to the productivity gains associated with higher density areas. Offices, for instance, concentrate firms and workers in dense urban environments, facilitating agglomeration economies, knowledge spillovers, and networking opportunities, all of which are key drivers of productivity and innovation (Combes and Gobillon, 2015). Similarly, hotels stimulate local economies by attracting visitors and business travelers who increase demand for surrounding services such as restaurants, retail, and transportation (Kadiyali and Kosová, 2013; Hidalgo, 2024).

In contrast, residential skyscrapers are less likely to generate comparable economic spillovers. While they contribute to urban density and housing supply, their primary function is to provide living space, which has a more limited direct impact on business formation and employment (Asquith et al., 2023). Mixed-use buildings, combining residential, commercial, and office spaces, fall between these categories, potentially benefiting from the complementarities between their uses, especially if they attract high-income households, albeit to a lesser degree than buildings dedicated exclusively to economic activities (Blanco and Neri, 2023).

As can be seen in Figure III, offices are the category with the largest effects, regardless of how economic activity is measured, followed by mixed-use buildings, hotels, and finally, residential buildings.[10]

[10] We have omitted the "other" category as it encompasses different business and non-business oriented activities like education and health care.

Figure III: Effects of tall building height on employment and establishment by building use.



Notes: 95% confidence intervals.

4.1 Robustness checks

The results remain robust across various changes in variable measurement, model specifications, and research designs. First, we leverage the cross-sectional and temporal variation in our setting by employing a long-difference specification. Specifically, we analyze how the predicted change in cumulative tall building height affects the change in the logarithm number of establishments and employment from 2000 to 2017. As shown in Result A of Table 4, the magnitude and significance of the coefficients corroborate our initial findings, confirming the effect by using exogenous variation generated by our instrument within a panel data setting.

Additionally, we conduct robustness checks by assessing the impact of tall buildings through the logarithm number of tall building units rather than cumulative height. The choice of cumulative height in the baseline specification was guided by our ability to control for building size. However, as seen in Result B in Table 4, our findings are not sensitive to alternative measures of tall building exposure; although the coefficient's magnitude varies due to the different metrics, the sign and significance remain consistent. To assess the robustness of our results to the functional form of the specification, we also estimate the baseline model in levels rather than using a logarithm transformation. Result C demonstrates that our core findings are unaffected by this change in functional form.

Then, we examine whether additional pre-treatment controls and city-level trends influence the main findings. In particular, beyond the baseline controls, which account for distance to the city center, we include median household income and city-specific trends. As evident in Result D in Table 4, the coefficient magnitudes remain largely stable, suggesting that potential confounding factors are unlikely to drive the results. To further validate our findings, we test the robustness of our results by employing an alternative research design to explore the causal effects of tall building construction on business and employment outcomes. Specifically, we implement a difference-in-differences (DiD) approach following Callaway and Sant'Anna (2021).[11] As reported in E. Table 4, the results confirm a positive and statistically significant effect on both the number of establishments and employment levels.[12]

Finally, we investigate whether specific areas with high-intensity tall building construction drive our results. To address this, we conduct a leave-one-out analysis, sequentially excluding zip codes within each county from the estimation. The results, presented in Figure A1 of Appendix A, show that the significance of the coefficients for both the establishment and employment specifications persists, underscoring the robustness of our findings.

[11] In this approach, the treatment year for each zip code is defined as the year when the first tall building opened within the eighteen-year study period. Not-yet-treated zip codes are used as control units. However, this methodology has two notable limitations. First, the treatment is inherently continuous, but we discretize it, assigning equal weight to zip codes where a 60-story building opened and those with a 20-story building. Second, some zip codes are treated multiple times over the study period, a complication not addressed by the Callaway and Sant'Anna (2021) framework.

[12] Further analysis presented in Figure A2 of the Appendix A provides evidence that these positive effects grow over time, while the absence of pre-trends supports the validity of our identification strategy.

Table 4: Robustness checks

	Establishment	**Employment**
Alternative specification		
A. Long-difference	0.184**	0.215**
	(0.082)	(0.094)
B. Number of tall buildings	0.452***	0.394***
	(0.094)	(0.102)
C. Level specification	0.575**	8.18**
	(0.237)	(3.76)
D. City level and other trends	0.109***	0.067**
	(0.029)	(0.033)
E. DiD (Callaway and Sant'Anna, 2021)	0.032*	0.084*
	(0.007)	(0.026)

Notes: Statistical significance levels are indicated as follows: 1% (***), 5% (**), and 10% (*). . All specifications are IV regressions with clustered standard errors at the MSA level for Result A and at the ZIP code level for Results B–E. The dependent variables vary across results: for Result A, it is the logarithmic difference in the number of establishments and employment between 2000 and 2017; for Results B, D, and E, it is the logarithm of the number of establishments and employment from 2000 to 2017; and for Result C, it is the number of establishments and employment during the same period. The main variable of interest differs as follows: in Result A, it is the logarithmic difference in tall buildings' height between 2000 and 2014; in Result B, the logarithm of the number of tall buildings; in Results D and E, the logarithm of tall building height; and in Result C, the absolute height of tall buildings. Fixed effects vary by specification: Result A includes MSA-level fixed effects, while Results B–E includes ZIP code-level fixed effects. All specifications, except for Result A, include trends in population starting in 2000, while Result D also accounts for city-level trends and trends in median household income. Control variables, measured in 2000, include average household size, median age, median household income, median asking price, and ZIP area for Result A. The number of observations is consistent across Results B–E, with 519,408 observations, while Result A includes 28,856 observations.

5 Heterogeneous impacts

Having explored the impact of tall building construction on local economic outcomes and the robustness of the findings, we now explore other aspects of the urban landscape that may be affected by tall buildings in more detail. First, we analyze the heterogeneous effects of tall building construction on the composition and specialization of industries and its spillover effects over the real estate sector. Then, we study whether the economic impacts of tall building constructions are local or spread across urban geography.

5.1 Composition and specialization of industries

The opening of tall buildings in a particular area significantly reshapes the composition of economic activities. As urban density increases and space becomes more valuable, sectors reliant on extensive physical space, such as manufacturing and wholesale trade, may tend to relocate to less dense areas. In contrast, sectors that thrive on labor and idea concentration, such as retail trade and education, are drawn to these areas, benefiting from proximity to workers, consumers, and complementary businesses. The positive effects on sectors can also extend to consumption amenities such as accommodation, food services, and arts and entertainment, as tall buildings can amplify consumption-related activities by creating a dense pool of potential customers (Koster et al., 2019). This is particularly relevant for industries that rely on high foot traffic. Additionally, sectors like professional and technical services benefit from agglomeration economies, as the clustering of firms and workers fosters knowledge spillovers and innovation. Conversely, space-intensive sectors like manufacturing and wholesale trade are less compatible with the constraints of high-density urban environments.

To test whether tall building construction has an even impact on economic activities, we turn to the narrower analysis of the effect of tall buildings on economic activity by focusing on its differential effects on establishment and employment depending on the activity sector. Figure IV shows how tall buildings have an unequal effect across the establishment sectors, primarily benefiting activities knowledge-intensive and consumption amenities activities and negatively impacting space-intensive industries. These patterns underscore the dual role of tall buildings as both drivers of economic transformation and instruments for reshaping urban landscapes toward activities that thrive in dense, high-value environments.[13]

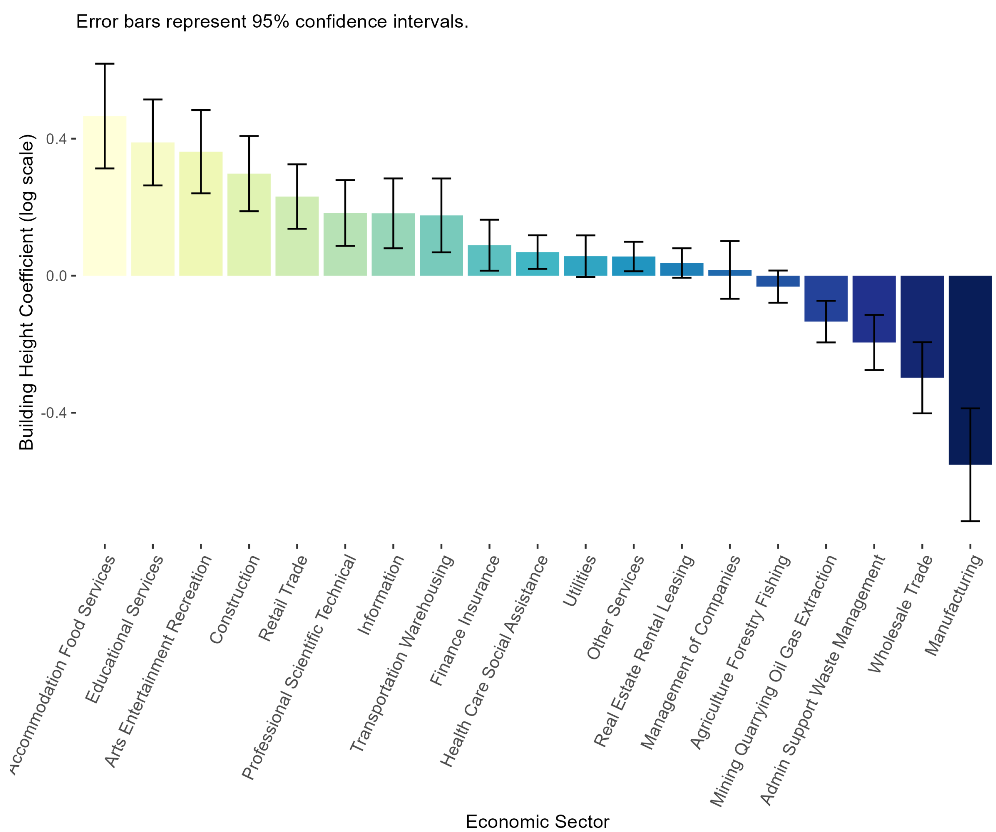
We can further understand the impact of tall buildings on the economic activity of a city by examining how they influence the overall spatial distribution of establishments. First, we investigate whether tall buildings affect the concentration of establishments in specific locations within a city. Let us define x_{zt} as the proportion of MSA m establishments located in zip code z, and s_{jzt} as the proportion of zip code z establishments that belong to sector j. To assess whether establishments are concentrated in a particular zip code, we use the following concentration index:

$$G_{jmt} = \sum_{z \in m} (x_{zt} - s_{jzt})^2 = \sum_{z \in m} \left(\frac{\sum_j est_{jzt}}{\sum_{z \in m} \sum_j est_{jzt}} - \frac{est_{jzt}}{\sum_j est_{jzt}} \right)^2 .$$

If establishments within an industry are distributed across zip codes in the same manner as total establishments, $x_{zt} = s_{jzt}$, there is no concentration, and $G_{jmt} = 0$. As shown in Table 5, column 1, we can see that the completion of tall buildings in one city does not increase the concentration of establishments in one ZIP code. This result is consistent

[13] Results for the employment specification as well as the table with the regression coefficients can be found in Figure A3, Table A5, Table A6 in the Appendix A.

Figure IV: Heterogeneous effects of tall buildings across economic activities.



Notes: Point estimates and 95% confidence intervals from regressing the predicted log of tall building height from our instrument on the log of the number of establishments across NAICS sectors.

with a heterogeneous impact of tall buildings on local establishments' locations, depending on the sectors. That is, while some sectors increase agglomeration in the ZIP code where tall buildings are built, some others, like manufacturing or wholesale trade, decrease their presence.

Second, we examine whether zip codes become more specialized in specific NAICS sectors following the completion of tall buildings. Specialization at the zip code level is measured using the Herfindahl index:

$$H_{zt} = \sum_j (s_{jzt})^2 = \sum_j \left(\frac{est_{jzt}}{\sum_j est_{jzt}} \right)^2 .$$

From Table 5, column 2, we observe that tall buildings decrease zip code specialization. Instead, they appear to encourage the agglomeration of a variety of sectors within the same zip code. This is in line with multiple activities that tall buildings usually host in order to diversify rents across heights (Koster et al., 2014).

Third, we assess whether tall buildings influence sectoral specialization at the MSA level. Tall buildings may attract firms from other MSAs or lead certain sectors to relocate to different cities. We measure MSA-level specialization using the following Herfindahl index:

$$H_{mt} = \sum_j (s_{jmt})^2 = \sum_j \left(\frac{\sum_{z \in m} est_{jzt}}{\sum_j \sum_{z \in m} est_{jzt}} \right)^2 .$$

From Table 5, column 3, we find that the construction of tall buildings does not affect the overall sectoral specialization within the MSA.

Table 5: Other Effects

	Concentration MSA	Specialization ZIP	Specialization MSA	Housing price
Model:	(1)	(2)	(3)	(4)
Log(Building Height + 1)	0.0006	-0.064***	-0.008	0.410***
	(0.001)	(0.009)	(0.006)	(0.065)
Observations	141,246	519,408	7,434	307,511

Notes: Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively. Clustered standard errors are at the zip code level. The dependent variables are the concentration and specialization measures in the above section. The interaction between bedrock depth and its square, population density in 2000, and national concrete price index are used as instruments for variation in building heights between 2000 and 2017. Distance to the city center trends, as well as zip and year-fixed effects, are included in all specifications.

The increase in amenities and improvements in urban aesthetics driven by tall building construction may significantly impact housing prices and contribute to urban revitalization. Prior research has consistently highlighted the role of amenities and architectural enhancements in increasing the value of nearby residences, as evidenced by studies on the effects of hotel openings (Hidalgo, 2024). To evaluate whether tall building construction leads to housing appreciation, we analyze zip-code-level housing values from the Zillow platform.[14] As shown in column 4 of Table 5, tall building construction is associated with an increase in housing values, even in cases where the construction of tall buildings could contribute to an expansion of the local housing supply. This suggests that the benefits of enhanced amenities and aesthetic improvements may outweigh the supply-driven moderation of housing price growth.

5.2 Spatial heterogeneous effects

In the previous section, we argued that an increase in building height within a zip code attracts firms from specific sectors and induces an overall concentration increase in the area. The mechanical filling of new office spaces by firms can partially explain the positive effect of tall buildings on local agglomeration. However, to demonstrate that tall buildings generate agglomeration effects beyond this mechanical filling, we examine their impact not only on the zip code where they are constructed but also on neighboring areas and the broader city.

By incorporating the completion of skyscrapers within zip codes at various distances into Equation (1), it is possible to investigate further the spillover effects of tall buildings on neighboring areas. We consider several distance intervals: 0–5 km, 0–10 km, and 0–15 km. A zip code is considered to be within a particular radius if its centroid lies within the specified distance from the centroid of the zip code under consideration. This analysis provides insights into the existence of economies of scale and potential congestion effects in areas surrounding tall buildings.

Let j represent the distance from a zip code. We modify the baseline model to estimate the effect of skyscraper construction in neighboring zip codes, as shown in Equation (3). For each distance interval, we estimate this model using the interaction between the bedrock depth and its square, the zip code population density in 2000 and the concrete price index.

$$\begin{aligned}\text{Log}(\text{Builds. height}_{z,j,t}) &= \theta_{1,j}(\text{Bedrock}_j \times \textit{Pop density}_{z,j} \times \text{Concrete}_{z,j,t}) + \theta_{2,j}(\text{Bedrock}_j^2 \times \textit{Pop density}_{z,j} \times \text{Concrete}_{z,j,t}) \\ &+ \alpha_z + \alpha_t + \tau Pop_{z,j,2000} \times \alpha_t + \epsilon_{z,j,t}, \quad \text{for } j = \{0, 5, 10, 15\}.\end{aligned} \tag{3}$$

Table 6 presents the results of these estimations, showing the effect of completing a tall building at different distance intervals. The findings reveal that the overall agglomeration

[14] Housing value data from Zillow can be accessed here.

effect extends beyond the zip code where the tall building is constructed. Although the spillover effects are significantly smaller than the effects within the zip code of construction, they remain statistically significant across all considered radii. Compared to the effects within the central zip code, spillover effects account for approximately 6–8% of the central effect. These findings lead to two key conclusions.

First, the results in Table 6 suggest that the construction of tall buildings generates an overall increase in firm agglomeration at the broader area than the zip code. Second, the magnitude of this agglomeration effect diminishes rapidly with distance, a result consistent with the findings of Rosenthal and Strange (2020).

Table 6: Baselines estimates (Complementary)

	Buffer		County	
Dependent Variable:	Log(Establishments + 1)	Log(Employment + 1)	Log(Establishments + 1)	Log(Employment + 1)
Model:	(1)	(2)	(3)	(4)
Variables				
Log(Building Height + 1)	0.143***	0.118***	0.072***	0.033
	(0.028)	(0.032)	(0.021)	(0.023)
Log(Building Height 5000 m + 1)	0.012***	0.016***		
	(0.003)	(0.004)		
Log(Building Height 10000 m + 1)	0.010***	0.008***		
	(0.002)	(0.003)		
Log(Building Height 150000 m + 1)	0.008***	0.006**		
	(0.001)	(0.002)		
Observations	519,408	519,408	56,124	56,124

Notes: Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively. Clustered standard errors are at the zip code level. The dependent variables are the logarithms of the number of establishments and employment. The interaction between bedrock depth and its square, population density in 2000, and concrete price index are used as instruments for variation in building heights between 2000 and 2017. Zip code and year-fixed effects and distance to the center trends are included in columns 1-2, whereas county and year-fixed effects are included in columns 3-4. Columns 1 and 2 collect the coefficients for building heights at different buffer distances (5000, 10000, and 150000 meters from each zip code centroid performed separately.

Parallelly, to assess whether the benefits of tall buildings extend to areas outside the zip code where they are built, we use the county as our unit of analysis. As can be seen in columns (3) and (4) of Table 6, the positive effects on the number of establishments persist, albeit with reduced magnitude, suggesting that tall buildings contribute to the reallocation and concentration of economic activity at the county level. However, the effects on employment diminish and become statistically insignificant, indicating that while tall buildings foster agglomeration through firm establishment growth, their impact on total employment may be localized and not easily transmitted to broader areas.

Overall, our results show that tall buildings generate substantial localized economic benefits, including firm clustering and agglomeration, while also inducing modest spillover effects into neighboring areas and counties. These findings suggest that the spatial extent of the benefits from vertical construction is limited, supporting the notion that agglomeration economies tend to decay with distance. The lack of employment spillovers at the county level further emphasizes the importance of local labor markets and accessibility in shaping the economic returns to tall buildings.

6 Conclusions

This study shows that tall building construction significantly reshapes local economic landscapes by fostering agglomeration economies and shifting industry composition within urban areas. Using a fine-grained dataset at the zip code level and exploiting exogenous variation from geographical, demand, and supply-driven factors, we find that tall building construction is associated with a 9% increase in both business establishments and employment. These impacts are particularly pronounced for commercial skyscrapers, such as offices and hotels, while residential tall buildings exhibit positive but smaller effects. The findings are robust to various specifications and research designs, confirming the reliability of the results.

Moreover, the analysis highlights substantial heterogeneity in the economic spillovers of tall buildings across industries. Knowledge-intensive and consumption amenities sectors, such as education, retail trade, and accommodation services, benefit the most, while space-intensive industries, including manufacturing and wholesale trade, experience displacement. This sectoral reallocation underscores a broader structural transformation of urban economies, where service-oriented and knowledge-based activities increasingly dominate. The impacts of increasing building height extend to the land market, leading to an apreciation of housing values. The spatial dynamics of these effects further reveal a concentration of benefits near tall buildings, with diminishing impacts at greater distances. Overall, our findings contribute to the understanding of how vertical urban growth fosters economic development and reshape the industrial and spatial organization of cities.

As urban populations are projected to grow significantly in the coming decades, cities will face increasing pressure to accommodate the demand for housing, firms, and services within limited land areas. Without adequate planning, this growth could result in higher land prices, congestion, and displacement of economic activities. Tall buildings provide a practical solution to these challenges by enabling higher-density development in dense urban areas. By intensifying land use, they help meet the rising demand for space while fostering agglomeration economies that enhance productivity and economic growth. To address these challenges effectively, policymakers should integrate tall buildings into urban development strategies. Mixed-use skyscrapers that combine residential, commercial, and retail spaces can help maximize the economic and social benefits of vertical expansion. Zoning regulations should be designed to incentivize the construction of tall buildings in areas where demand is highest while ensuring adequate infrastructure and public services to support these developments. Moreover, policymakers should consider measures to mitigate the displacement of space-intensive industries, such as creating designated industrial zones in less dense areas or supporting their relocation to suburban regions.

Yet, this paper is not out of limitations. Although we have found positive impacts on urban economics in terms of increasing economic activity and employment, there may be other negative externalities associated with tall buildings, housing affordability, inequality, or environmental sustainability. In addition, while this study is based on data from the United States, the findings may not fully generalize to other contexts with different regulatory and economic environments. In contexts with less developed transportation systems or weaker institutional frameworks, the potential for tall buildings to drive local economic growth might be more limited, as accessibility and integration into the broader urban economy could be constrained. Compare studies across countries or cities that could offer deeper insights into the global implications of tall buildings. Lastly, future work should explore the interactions between tall buildings and other urban policies, such as transportation networks, to better understand how vertical growth integrates into broader urban systems.

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A Appendix - Additional Tables and Figures

Table A1: Literature review for the economics of skyscrapers (Part 1).

Topic	Reference	Country/City	Technique and Results
Determinants of skyscraper heights	Sullivan (1991)	-	Optimal building height depends on intrabuilding travel costs (Theoretical framework)
	Helsley and Strange (2008)	-	Economic factors influence the inherent value of being the tallest
	Barr (2010)	United States (New York)	Profit maximization and economic fundamentals generally drive tall building height (Time-series)
	Barr (2012)	United States (New York)	Height competition due to social status during boom periods (Theoretical frameworks and spatial regressions)
	Barr (2013)	United States (Chicago and New York)	Strategic interaction in skyscraper construction; strategic complements (Theoretical frameworks and spatial regressions)
	Ahlfeldt and McMillen (2018)	United States (Chicago)	High land prices, construction costs, and extra floor space drive skyscrapers (IV)
	Barr and Luo (2021)	China (78 cities)	Economic fundamentals and political factors drive skyscraper construction (Spatial regression)
	Chen et al. (2023)	China	Political factors drive building construction (DID)
	Ahlfeldt and Barr (2022)	-	Height limits negatively impact urban economic outcomes (GE)
Economic Effects	Jedwab et al. (2022)	World (158 countries)	Building height gaps are mainly present in rich countries and correlate with several disamenities (Panel fixed effects)
	Ahlfeldt et al. (2023)	World (12,877 cities)	Taller buildings save land use and increase urban population (Structural model and IV)

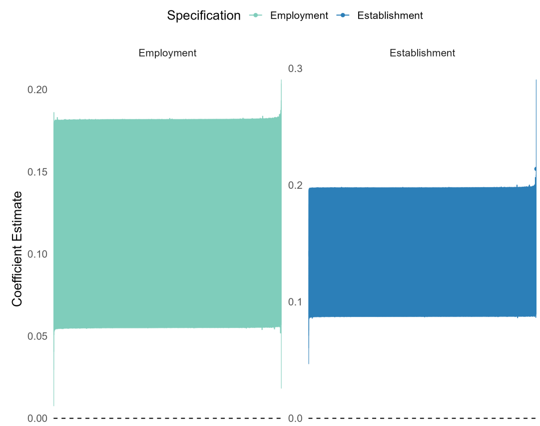
Table A2: Literature review for the economics of skyscrapers (Part 2).

Topic	Reference	Country/City	Technique and Results
Economic Effects	Lu (2023)	China (32 cities)	Height competition between cities (Theoretical framework and RDD)
	Barr and Jedwab (2023)	World (163 countries and 12,877 cities)	Residential tall buildings drive height variation (OLS)
	Dong and Wang (2023)	China	Skyscrapers promote subcenter formation and increase firm numbers (OLS)
Within Building Effects	Koster et al. (2014)	Netherlands (Amsterdam, Rotterdam, Utrecht)	Height premium explained by agglomeration, views, and landmark effects (IV)
	Liu et al. (2018)	United States (18 metropolitan areas)	Uneven sorting of firms within tall buildings due to vertical patterns (Theoretical framework and OLS)
	Liu et al. (2020)	United States (18 metropolitan areas)	U-shaped vertical density gradient influenced by street access and vertical amenities (Theoretical framework and OLS)

Table A3: Variable definition and source.

Variable	Definition	Source
Dependent variables:		
Establishments	Nº of establishments at the zip code	County Business Patterns
Employment	Nº of employees at the zip code level	County Business Patterns
Explanatory variables:		
Building height	Cumulative tall buildings height	The Council of Tall Buildings and Urban Habit
Distance to downtown	Euclidean distance in meters to downtown from zip code centroid	U.S. Census Bureau
Median Income household	Median income household in 2010	2000 Decennial U.S. Census Bureau
Instrument:		
Bedrock	Depth to unweathered bedrock	Pelletier et al. (2016)
Concrete price	National concrete price index	Bureau of Labor Statistics
Population density	Population per meter square in 2000	2000 Decennial U.S. Census Bureau

Figure A1: Leave-one-out exercise.



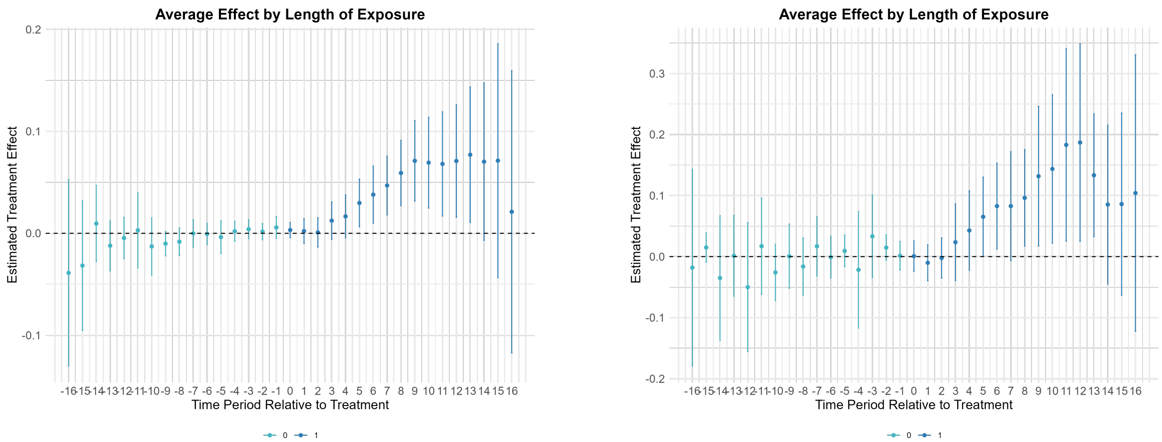
Notes: 95% confidence intervals. Leave-one-out analysis, sequentially excluding zip codes within each county from the baseline equation(Equation (1) and Equation (2)).

Table A4: Baseline Estimates (Complementary)

Dependent Variable:	First Stage	Reduced Form	Reduced Form	OLS		IV (Cumulative Height Added)	Log-level IV	
	Log(Building Height + 1)	Log(Est. +1)	Log(Emp. +1)	Log(Est. +1)	Log(Emp. +1)	Log(Emp. +1)	Log(Est. +1)	Log(Emp. +1)
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Bedrock × *Pop density* × *Concrete price*	0.040***	0.006***	0.007***					
	(0.008)	(0.001)	(0.001)					
Bedrock^2 × *Pop density* × *Concrete price*	-0.0007***	-0.0001***	-0.0002***					
	(0.0002)	(3×10^{-5})	(3.89×10^{-5})					
Log(Building Height + 1)				0.009***	0.014***	0.602***		
				(0.002)	(0.003)	(0.111)		
Cumulative Building Height							0.0007***	0.0007***
							(0.0002)	(0.0002)
Observations	519,408	519,408	519,408	519,408	519,408	519,408	519,408	519,408

Notes: Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively. The dependent variable is the log of tall building heights in column 1, the log of the number of establishments in columns 2, 4, and 7, and the log of employment in columns 3, 5, 6, and 8. To demonstrate robustness, column 8 does not impute employment with the minimum of each employment category. The main variable of interest is the instrument: the interaction between bedrock depth, its square, population density, and the concrete price index in columns 1 to 3. In columns 4 to 6, the main variable is the predicted log of tall building heights based on that instrument, while in columns 7 and 8, it is the level of tall building height. All specifications include zip code and year fixed effects, as well as trends based on the distance to the city center.

Figure A2: Event study (Callaway and Sant'Anna, 2021).



(a) Establishment specification

(b) Employment specification

Notes: Subplot (a) depicts the establishment event study specification using the Callaway and Sant'Anna (2021) estimator. Instead, Subplot (b) shows the employment event study specification using the same estimator.

Table A5: Sectoral Analysis of Building Heights Impact

Dependent Variables:	Agriculture	Mining	Utilities	Construction	Wholesale
Model:	(1)	(2)	(3)	(4)	(5)
log(Cumulative Building Height + 1)	-0.032	-0.134***	0.057*	0.298***	-0.298***
	(0.024)	(0.031)	(0.031)	(0.056)	(0.053)
Dependent Variables:	Retail	Transportation	Prof. Services	Finance	Real Estate
Model:	(6)	(7)	(8)	(9)	(10)
log(Cumulative Building Height + 1)	0.231***	0.176***	0.183***	0.089**	0.037
	(0.048)	(0.055)	(0.049)	(0.038)	(0.022)
Dependent Variables:	Health Care	Education	Accommodation	Arts	Admin Support
Model:	(11)	(12)	(13)	(14)	(15)
log(Cumulative Building Height + 1)	0.069***	0.389***	0.466***	0.362***	-0.195***
	(0.025)	(0.064)	(0.078)	(0.062)	(0.041)
Dependent Variables:	Manufacturing	Management	Other Services	Information	
Model:	(16)	(17)	(18)	(19)	
log(Cumulative Building Height + 1)	-0.552***	0.017	0.056**	0.182***	
	(0.084)	(0.043)	(0.022)	(0.052)	
Observations	490,552	490,552	490,552	490,552	490,552

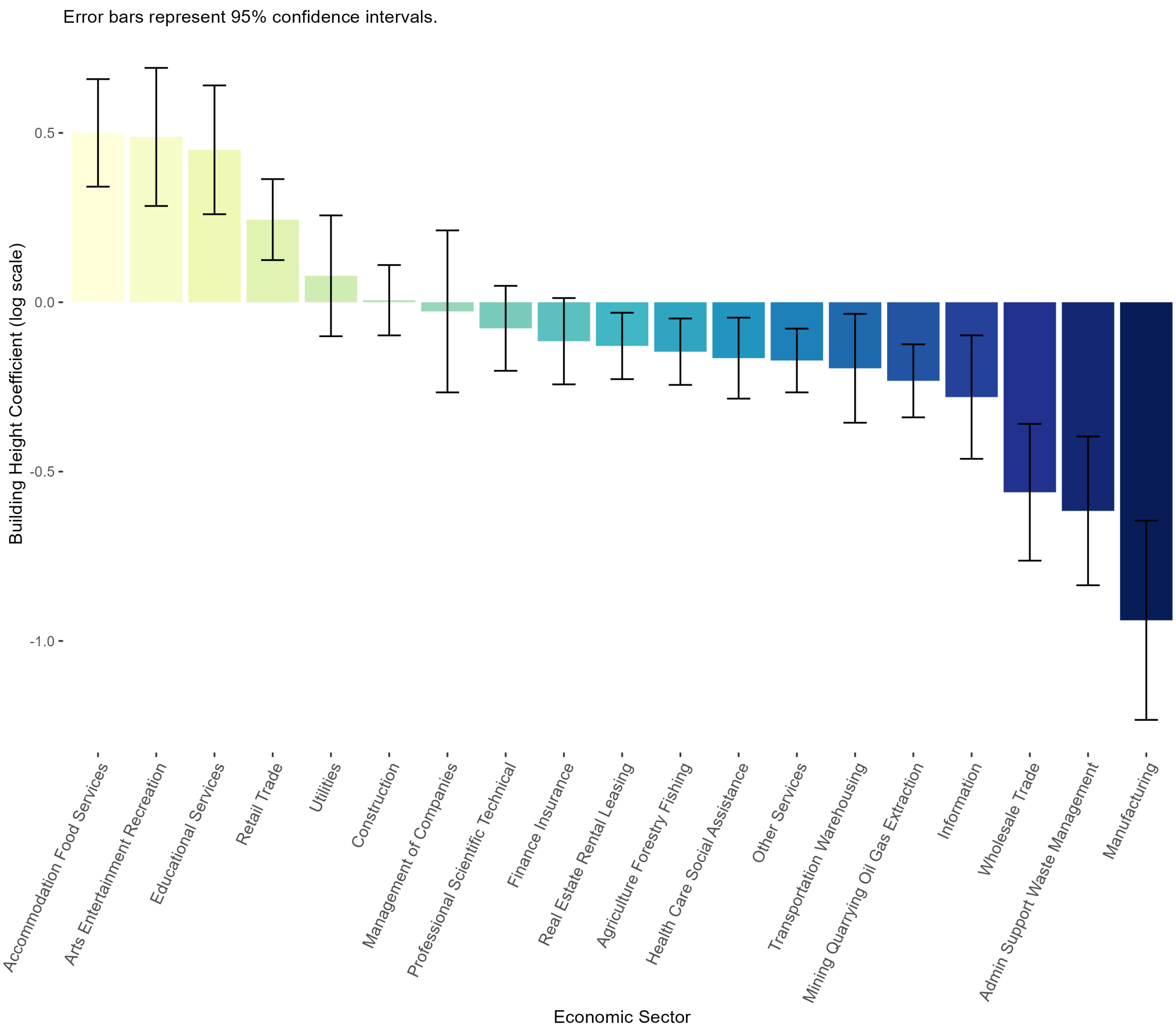
Notes: Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively. Clustered standard errors are at the zip code level. The dependent variables are the logarithm of the number of establishments across different NAICS sectors. The interaction between bedrock depth and its square, population density in 2000, and concrete price index are used as instruments for variation in building heights between 2000 and 2017. All specifications include zip code and year fixed effects, as well as trends based on the distance to the city center.

Table A6: Sectoral Analysis of Building Heights Impact

Dependent Variables:	Agriculture	Mining	Utilities	Construction	Wholesale
Model:	(1)	(2)	(3)	(4)	(5)
log(Cumulative Building Height + 1)	-0.146***	-0.232***	0.078	0.006	-0.561***
	(0.050)	(0.055)	(0.091)	(0.053)	(0.103)
Dependent Variables:	Retail	Transportation	Prof. Services	Finance	Real Estate
Model:	(6)	(7)	(8)	(9)	(10)
log(Cumulative Building Height + 1)	0.244***	-0.195**	-0.077	-0.115*	-0.129***
	(0.061)	(0.082)	(0.064)	(0.065)	(0.050)
Dependent Variables:	Health Care	Education	Accommodation	Arts	Admin Support
Model:	(11)	(12)	(13)	(14)	(15)
log(Cumulative Building Height + 1)	-0.165***	0.450***	0.500***	0.488***	-0.616***
	(0.061)	(0.097)	(0.081)	(0.104)	(0.112)
Dependent Variables:	Manufacturing	Management	Other Services	Information	
Model:	(16)	(17)	(18)	(19)	
log(Cumulative Building Height + 1)	-0.939***	-0.027	-0.172***	-0.280***	
	(0.150)	(0.122)	(0.048)	(0.093)	
Observations	490,549	490,549	490,549	490,549	490,549

Notes: Statistical significance at the 1%, 5%, and 10% levels is indicated by ***, **, and *, respectively. Clustered standard errors are at the zip code level. The dependent variables are the logarithm of the employment level across different NAICS sectors. The interaction between bedrock depth and its square, population density in 2000, and concrete price index are used as instruments for variation in building heights between 2000 and 2017. All specifications include zip code and year fixed effects, as well as trends based on the distance to the city center.

Figure A3: Effects of Tall Building Types on Employment and Establishment by Building Use.



Notes: Point estimates and 95% confidence intervals from regressing the predicted log of tall building height from our instrument on the log of the number of establishments across NAICS sectors.

Table A7: ESTABLISHMENT SECTORAL ANALYSIS OF BUILDING HEIGHTS IMPACT

Sector	All zip codes (%)		zip codes with tall buildings (%)		Change All (%)	Change tall buildings (%)
	2000	2017	2000	2017		
Agriculture, Forestry, Fishing	0.35	0.28	0.03	0.03	-20.20	-5.70
Mining, Quarrying, Oil, Gas Extraction	0.28	0.32	0.17	0.28	+15.80	+61.30
Utilities	0.23	0.22	0.13	0.16	-4.30	+30.20
Construction	9.54	8.55	2.53	2.60	-10.40	+2.80
Manufacturing	4.86	3.61	3.43	1.84	-25.70	-46.40
Wholesale Trade	6.08	4.99	8.14	5.14	-17.90	-36.80
Retail Trade	15.50	13.30	10.70	9.61	-14.20	-10.20
Transportation, Warehousing	2.59	2.84	1.17	1.20	+9.70	+2.60
Information	1.82	1.78	3.74	3.30	-2.20	-11.80
Finance, Insurance	5.74	5.80	7.44	7.56	+1.00	+1.60
Real Estate, Rental, Leasing	9.90	9.31	9.01	8.87	-6.00	-1.60
Professional, Scientific, Technical Services	9.82	10.90	17.90	20.00	+11.00	+11.70
Management of Companies	0.63	0.67	1.36	1.31	+5.90	-3.70
Administrative, Support, Waste Management	7.00	5.93	5.05	4.47	-15.30	-11.50
Educational Services	9.17	11.00	7.17	8.10	+20.00	+12.90
Health Care, Social Assistance	7.56	8.75	7.12	10.10	+15.70	+41.90
Arts, Entertainment, Recreation	1.42	1.69	2.32	2.60	+19.00	+12.10
Accommodation, Food Services	9.90	9.31	9.01	8.87	-6.00	-1.60
Other Services	4.12	4.78	6.57	6.96	+16.00	+5.90

Notes: The table shows the proportions of establishment by sector for all zip codes in the USA and zip codes with skyscrapers. The columns "Change All (%)" and "Change tall buildings (%)" show the percentage change within each group.

Table A8: Employment Sectoral Analysis of Building Heights Impact

Sector	All zip codes (%)		zip codes with tall buildings (%)		Change All (%)	Change tall buildings (%)
	2000	2017	2000	2017		
Agriculture, Forestry, Fishing	0.16	0.13	0.0223	0.0134	-18.8	-39.9
Mining, Quarrying, Oil, Gas Extraction	0.30	0.40	0.130	0.395	+34.4	+203.8
Utilities	0.54	0.51	0.604	0.719	-5.4	+19.0
Construction	5.59	5.02	2.72	2.17	-10.2	-20.2
Manufacturing	13.2	8.82	3.21	1.57	-33.2	-51.1
Wholesale Trade	5.22	4.72	4.60	3.03	-9.6	-34.1
Retail Trade	13.3	13.0	6.46	6.27	-2.3	-2.9
Transportation, Warehousing	2.73	3.55	2.14	1.68	+30.0	-21.5
Information	2.94	2.53	6.18	5.26	-14.0	-14.9
Finance, Insurance	4.70	4.61	8.95	10.2	-1.9	+14.0
Real Estate, Rental, Leasing	4.56	4.41	4.61	4.61	-3.3	0.0
Professional, Scientific, Technical Services	5.69	6.57	13.4	14.8	+15.4	+10.4
Management of Companies	1.73	1.75	3.38	4.61	+1.2	+36.4
Administrative, Support, Waste Management	7.00	5.93	8.75	6.37	-15.3	-27.2
Educational Services	11.4	14.5	6.66	8.74	+27.2	+31.2
Health Care, Social Assistance	5.69	6.57	6.66	8.74	+15.4	+31.2
Arts, Entertainment, Recreation	1.47	1.81	1.97	2.90	+23.1	+47.2
Accommodation, Food Services	8.66	11.1	11.8	14.5	+28.1	+22.9
Other Services	4.56	4.41	2.90	2.80	-3.3	-3.4

Notes: The table shows the proportions of employment by sector for all zip codes in the USA and zip codes with skyscrapers. The columns "Change All (%)" and "Change tall buildings (%)" show the percentage change within each group.