SKYSCRAPER HEIGHT

Economic of Tall Building

Quantitative research on height determinants factors in China

P5 presentation
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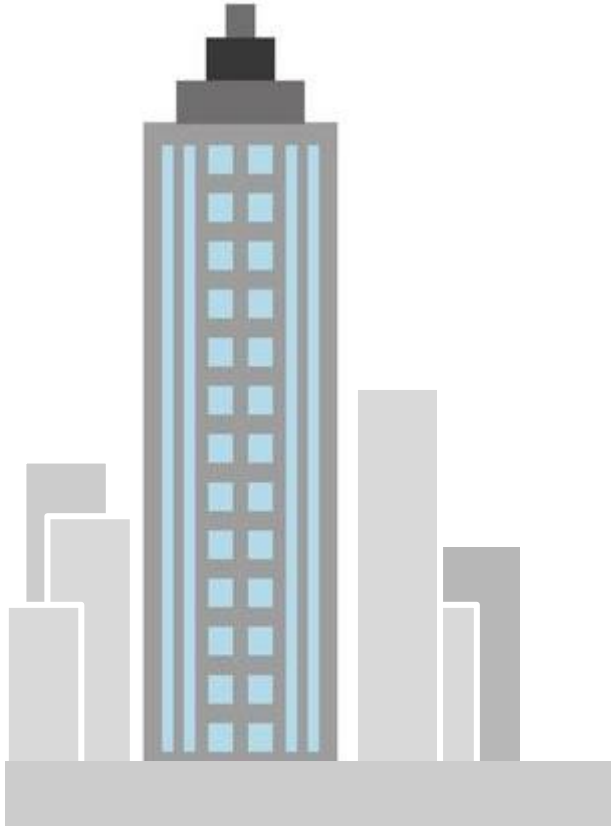
INTRODUCTION

Skyscraper & Height



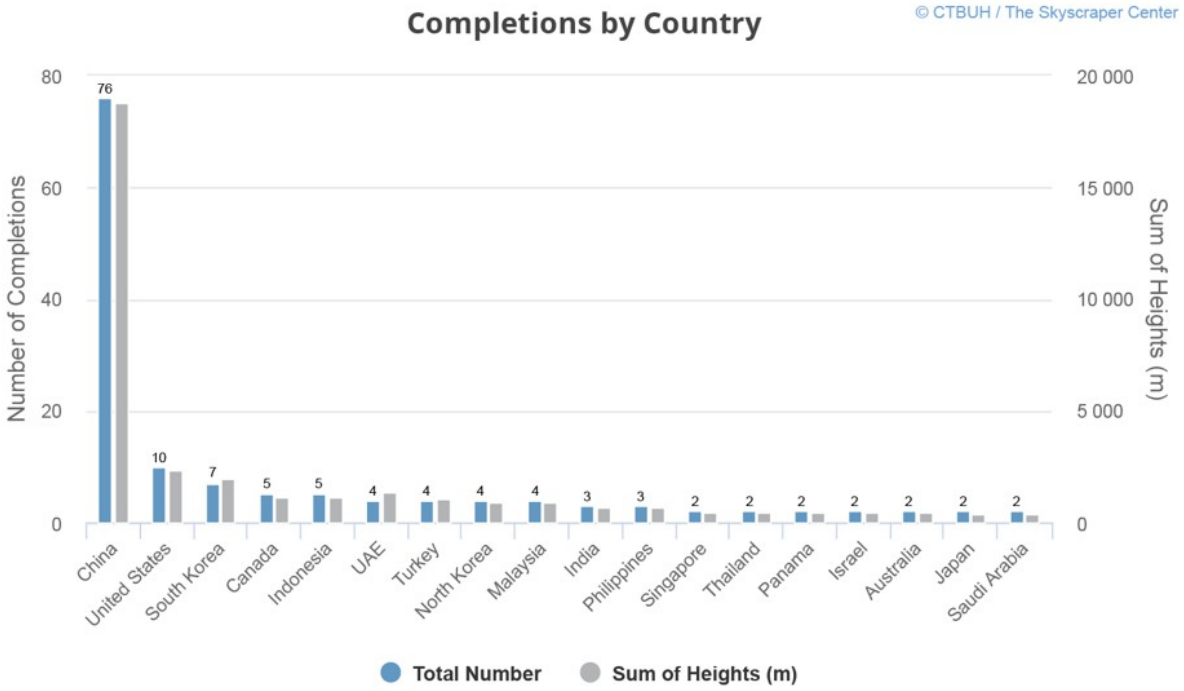
Amount of Tall buildings built

Around the world, there are 143 new towers constructed that reach above 200 meters tall in 2018.
That's more than have been built in any other single year (CTBUH, 2018)

Have large effect on urban development and city Image

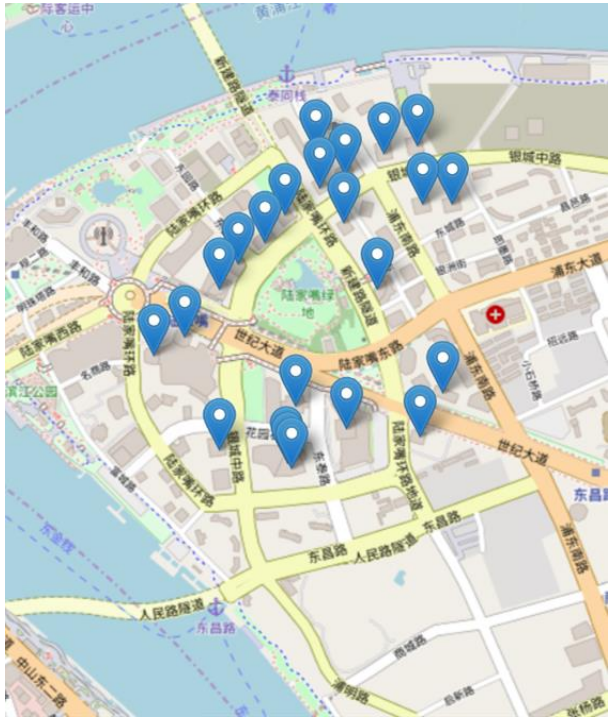
Building tall is one of the characteristic of skyscraper, and Height could be used as a tool to allocate city population and improve city efficiency. Thus Skyscraper distribution and height pattern is important to be understand for city development

CURRENT SITUATION IN CHINA

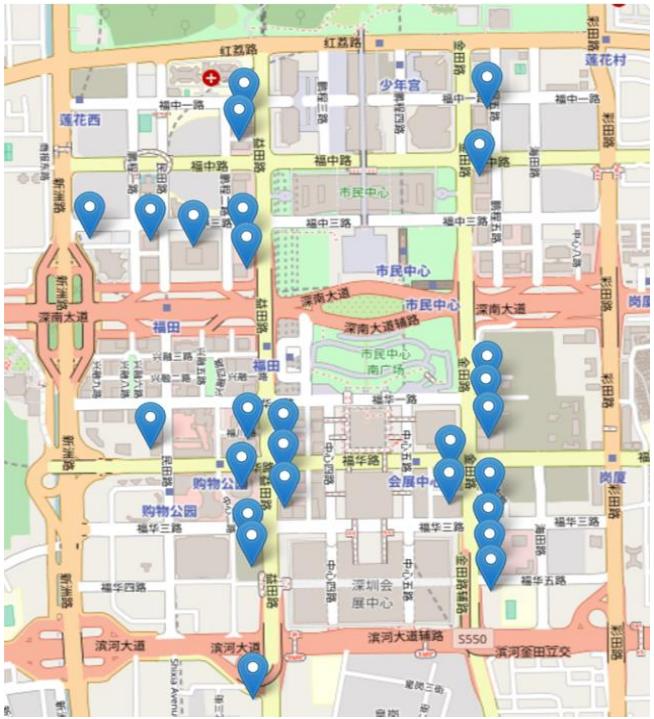


PROBLEM STATEMENT

Distribution of 200m+ Skyscrapers in China



23 skyscraper in an area
Shanghai



26 skyscraper in an area
Shenzhen

Source: CTBUH, 2019

Newly proposed skyscrapers in China

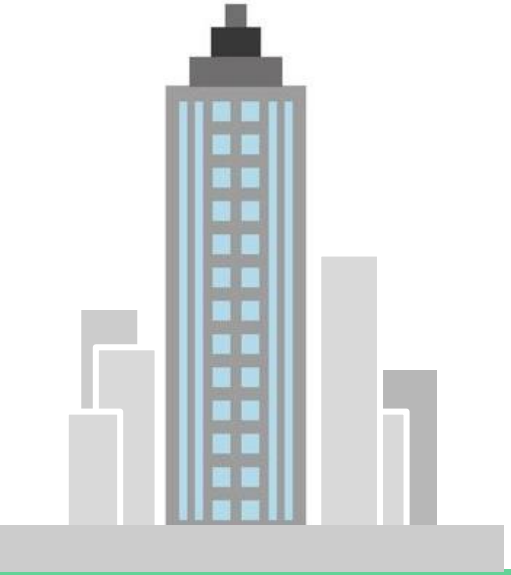
#	Building Name	City	Height (m)	Height (ft)	Floors	Completion	Material	Use
1	Bionic Tower	Hong Kong (CN)	1228	4,029	300	-		residential
1	Bionic Tower	Shanghai (CN)	1228	4,029	300	-		multiple
3	M Tower	Shanghai (CN)	900	2,953	-	-		
3	Nansha Tower	Guangzhou (CN)	900	2,953	-	-		
5	Sky City	Changsha (CN)	838	2,749	202	-	steel	hotel / residential / education / hospital / office
6	Chow Tai Fook Centre	Wuhan (CN)	808	2,651	124	-		hotel / serviced apartments / office
7	777 Tower	Qingdao (CN)	777	2,549	-	-		residential / office
8	Suzhou Zhongnan Center	Suzhou (CN)	729	2,392	137	-	composite	hotel / residential / office
9	Hua`s International Plaza	Wuhan (CN)	707	2,320	161	-		
10	Shenzhen Bay Super City - Xtemendous Tower 1	Shenzhen (CN)	680	2,231	-	-		
10	Shizimen CBD Tower	Zhuhai (CN)	680	2,231	-	-		multiple
12	Tianfu Center	Chengdu (CN)	677	2,221	157	2025		office
13	Baoneng Financial Center	Urumqi (CN)	668	2,192	-	-		
13	Shimao Shenzhen-Hong Kong International Centre	Shenzhen (CN)	668	2,192	-	2024		hotel / office
15	Caiwuwei Financial Center	Shenzhen (CN)	666	2,185	-	-		
15	Hanzheng Jie Project Tower 1	Wuhan (CN)	666	2,185	-	-		
17	Wuhan CTF Finance Center	Wuhan (CN)	648	2,126	121	2022	composite	office
18	Financial Street Concord City Tower	Chongqing (CN)	639	2,096	-	-		
19	Wuhan Greenland Center	Wuhan (CN)	636	2,087	126	-	composite	hotel / residential / office
20	Shanghai Tower	Shanghai (CN)	632	2,073	128	2015	composite	hotel / office
21	Changchun World Trade Center	Changchun (CN)	631	2,070	126	-		serviced apartments / hotel / office
22	Harmony 888 Tower 1	Xiamen (CN)	620	2,034	-	-		
23	Shenzhen Tower	Shenzhen (CN)	610	2,001	130	-		

Planning to Construct over 1km

Large cities continuously construct more skyscrapers

Source: CTBUH, 2019

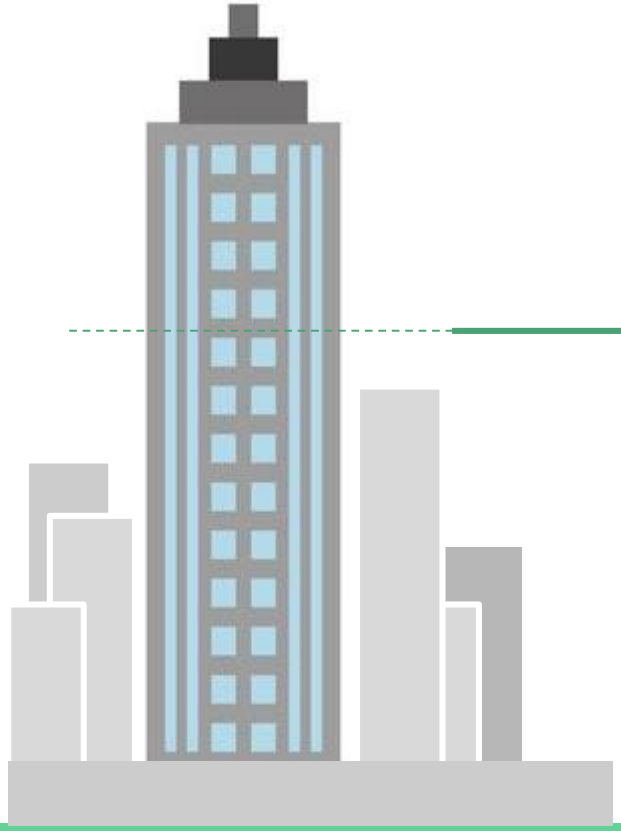
“What are the height determinants of Chinese skyscrapers and to what extent do these height determinant factors affect Chinese skyscraper heights Pattern?”



Sub-questions

- How does the height pattern of skyscrapers above 200m vary across China?
- What is the factor that causes the specific height pattern across the country?
- To what extent do each height determinant factors affect the height pattern of skyscrapers in China?

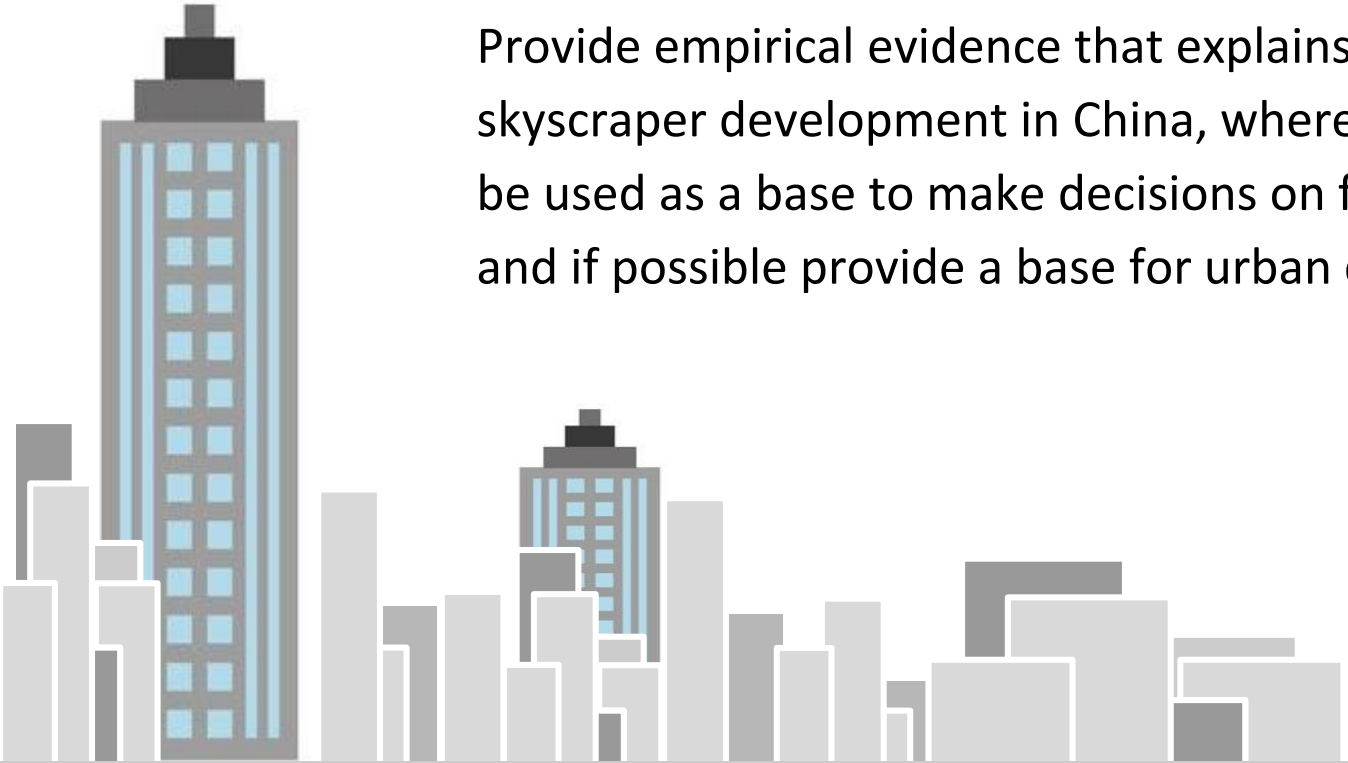
Research Scope



Study focuses on:

- China, Excluding Hong Kong and Macau
  - Due to different Legal structure
- Skyscrapers over 200m
  - Skyscraper over 200m could have more effect on the location in terms of city image, population accommodate Capacity
  - Higher buildings require more governmental interventions and negotiations, which may includes more aspects that affected the decision
  - The study focuses on height

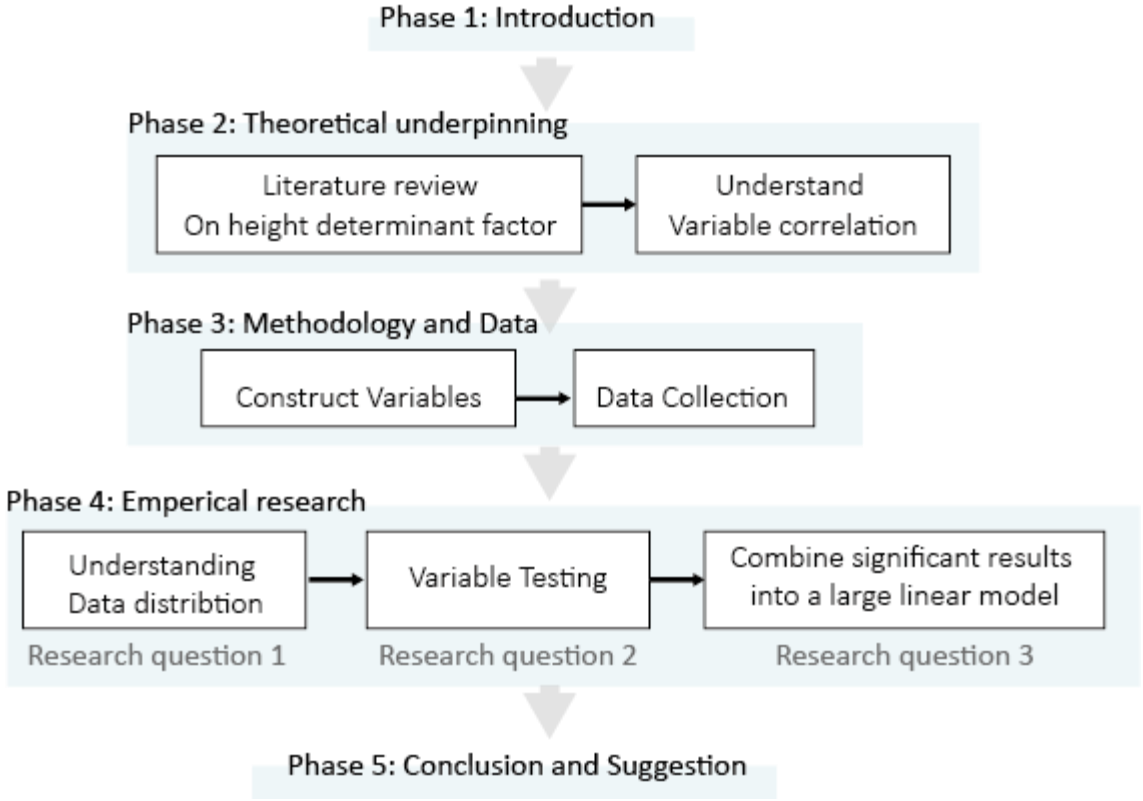
Motivation



Provide empirical evidence that explains the mechanism of skyscraper development in China, where these results could be used as a base to make decisions on future development, and if possible provide a base for urban development policies

METHODOLOGY

Research process



Regression analysis

Regression analysis is a method that is used to understand the relationship between

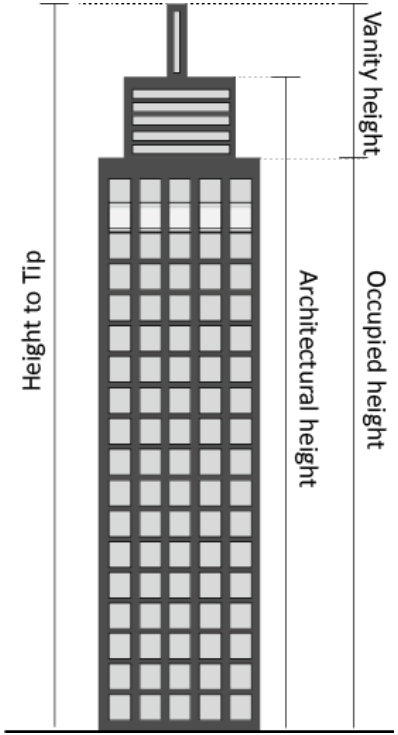
a **dependent variable** (Outcome variable) and

multiple independent variable (Predictor Variable)

Outcome = Model + error

Linear regression model uses databases from the previous event to predict future events

Type of Heights: Dependent variables



(CTBUH, 2018)

Architectural Height:

- ➔ Overall height of skyscraper Including Vanity Height
- ➔ Express total height of skyscraper

Occupied Height:

- ➔ Height that could accommodate function and people
- ➔ Show that height that is design for occupied

Vanity Height:

- ➔ Height that could not accommodate function
- ➔ Could use to spot possible competitions between building

Height Determinant factors

City Level Determinant

Building Level Determinant

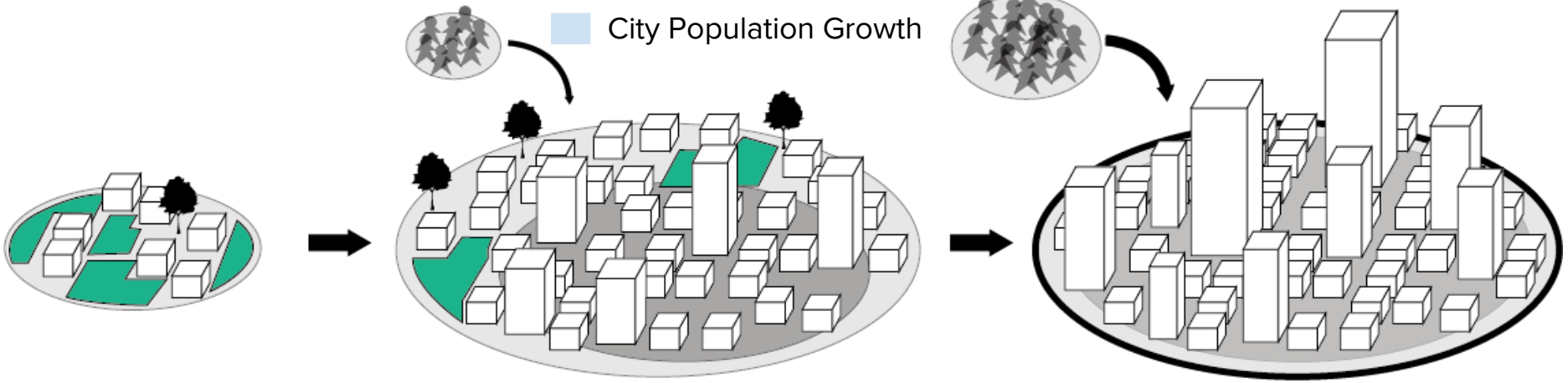
Height Determinant factors

- ➔ Factors that are stated in previous research that have effect on skyscraper height
- ➔ Determinant factors that have poven to have effect on skyscraper development
- ➔ Factors that in theory have connection to skyscraper height and or development
- ➔ Factors that are added, due to predictions, according to observation and theories

City Level Determinant

- These are specific factors of each city
- These are factors that affect the urbans space as a whole, including :
  - Demographic changes
  - City Economic condition
  - City development directions

Urban Development aspects



(Yaping & Min, 2009; Lin et al., 2016)

City Population

City Urbanization rate

City Urban Population

City Urbanization rate Growth

Economical Aspect

- ➔ Research shows that Skyscraper development follows the **economic cycles**

(Barr, 2018)

- ➔ Height of **record breaking skyscrapers** follows economical cycle

(Rovelli, 2018)

- ➔ Increase in percentage of **tertiary industry** increase **city urbanization rate**

(Zeng, Xu & Chen, 2018)

- ➔ **Tertiary industry**, which includes service and technological sector triggers skyscraper development

(Zeng, Xu, 2018)

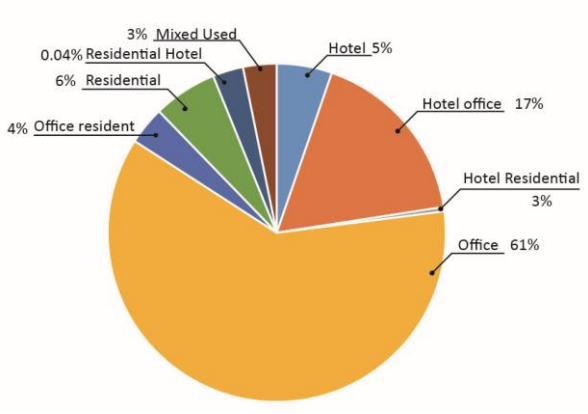
City GDP, City GDP Growth

City percentage of Tertiary industry & Growth

Building level determinant

- ➔ These are specific factors that affect each building
- ➔ These factors are based on decisions made for each building, including :
  - Choice of material and function
  - Personal perspective of the designer
  - Building design

Building Function & Material

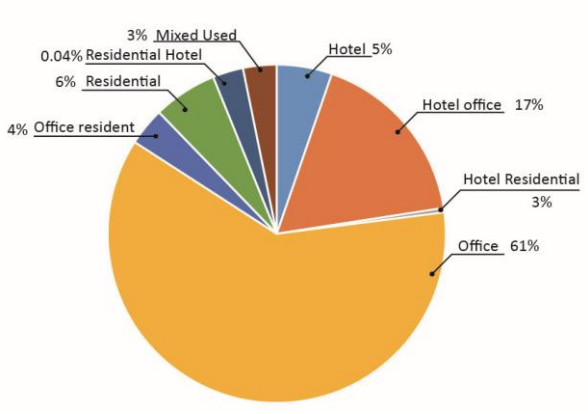


➔ Function of a building affects the average floor height, where office building requires more height per floor compares to residential

Building function (Zeng, Xu & Chen, 2018)
Categorical Variable

Function	**Average height per floor**
Residential	3.72 m/ floor
Office	4.71 m/floor
Hotel	4.38 m/floor
Office/ Hotel	4.62 m/floor
Residential/ office	4.55 m/ floor
Residential/ hotel	4.22 m/floor
Mixed use	4.56 m/floor

Building Function & Material



Choudhary, 2014

Wikipedia, 2019

Donatas, 2019

➔ Function of a building affects the average floor height, where office building requires more height per floor compares to residential

Building function (Zeng, Xu & Chen, 2018)
Categorical Variable

➔ Material for construction connected to the load it could withstand, therefore it could have effect on skyscraper height

Building Material (Moon, 2018)
Categorical Variable

Competition & Social status

Source: Hayett Hotel, 2019

Source: Lin, 2018

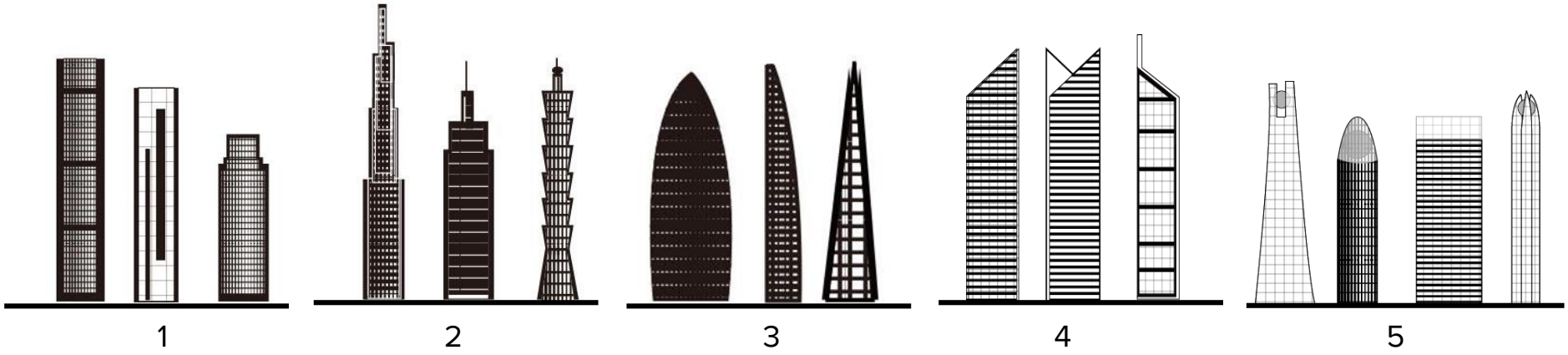
Source: CTBUH, 2019

➔ Many researchers have spotted competition between skyscraper to be the tallest

Vanity Height

(H&s)

Design aspects

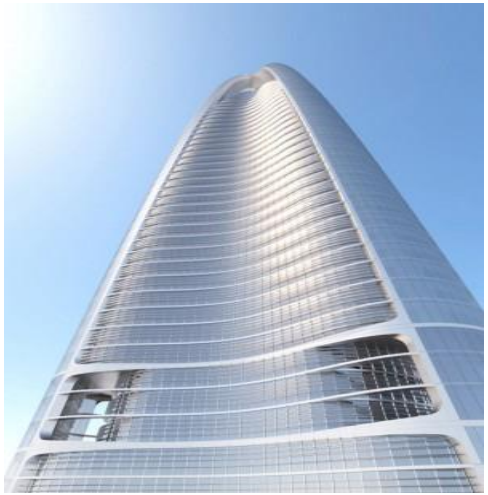


➔ As observed, each building shape has different occupy possibility, which could affect the efficiency and height of the building

Type of finishing
Categorical Variable

Nationality of Construction Coalition

Frearson, 2014



CTBUH, 2019

➔ Famous Architect design special buildings, this variable mainly aims to test if they have effect on skyscraper height

Nationailty Construction coalition
Categorical Variable

Other factors

➔ **Regulation**

- Specific city regulation on height & development

➔ **land quality**

- Some areas are suitable for construction of taller buildings than others

➔ **Building technology**

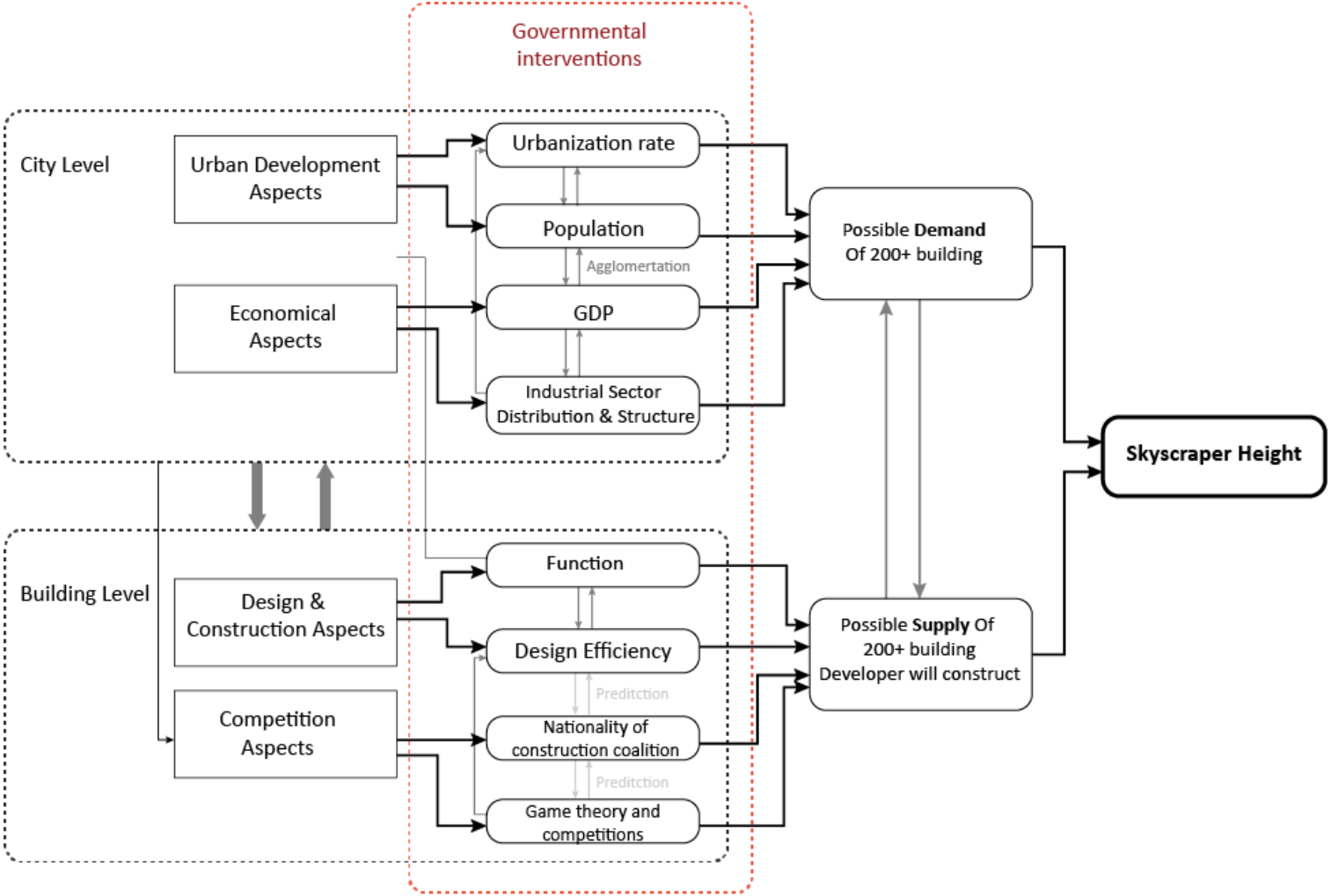
- The improve in technology each year

➔ **Construction From Previous year**

City Fixed effect and year fixed effect

➔ **Material cost**

- Data available only for the whole country, so its the same for all cases across China

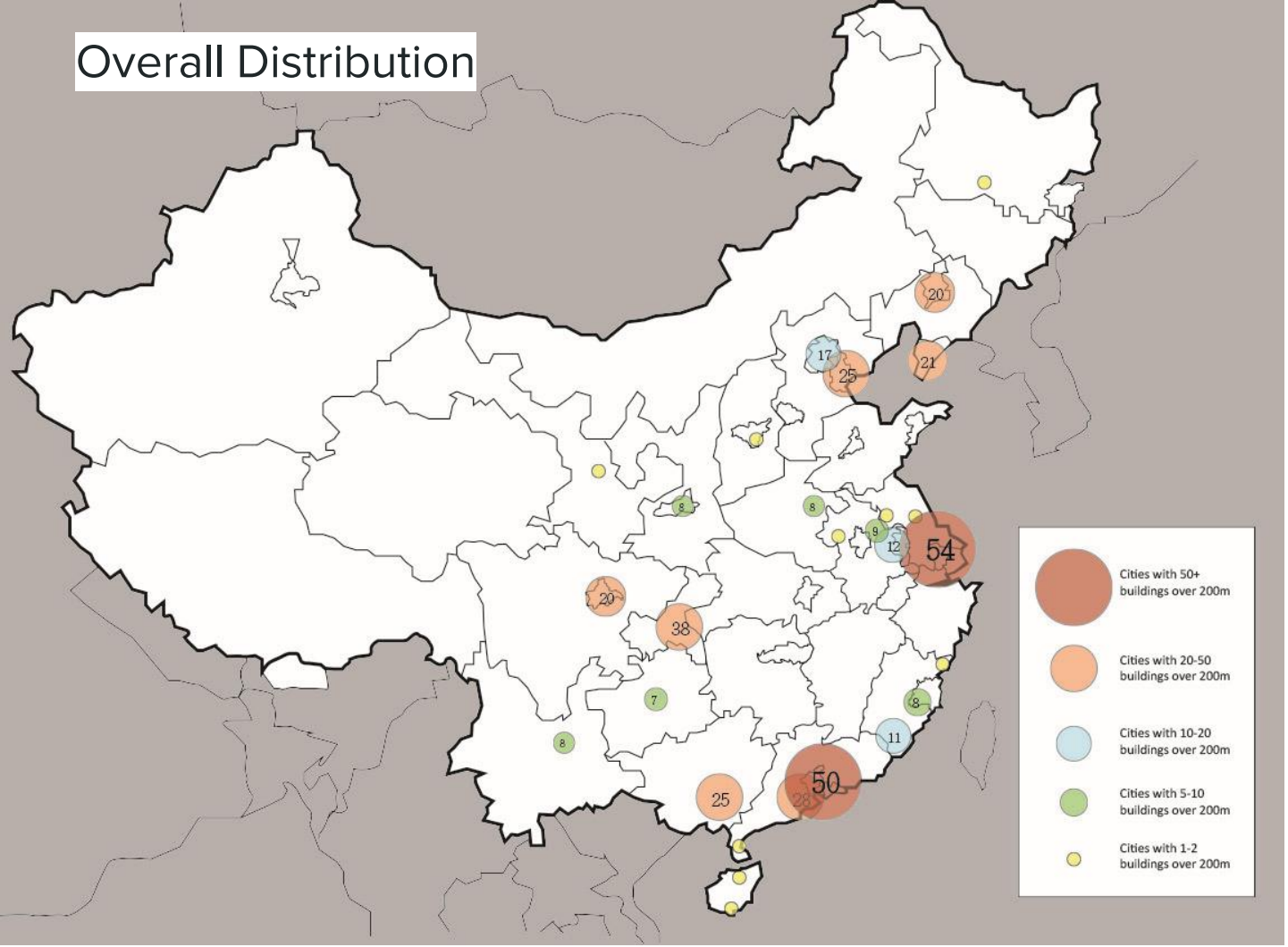

Governmental interventions
City Level
Urban Development Aspects
Economical Aspects
Urbanization rate
Population
Agglomertation
GDP
Industrial Sector Distribution & Structure
Possible Demand Of 200+ building
Skyscraper Height
Building Level
Design & Construction Aspects
Competition Aspects
Function
Design Efficiency
Preditction
Nationality of construction coalition
Preditction
Game theory and competitions
Possible Supply Of 200+ building Developer will construct

FINDING

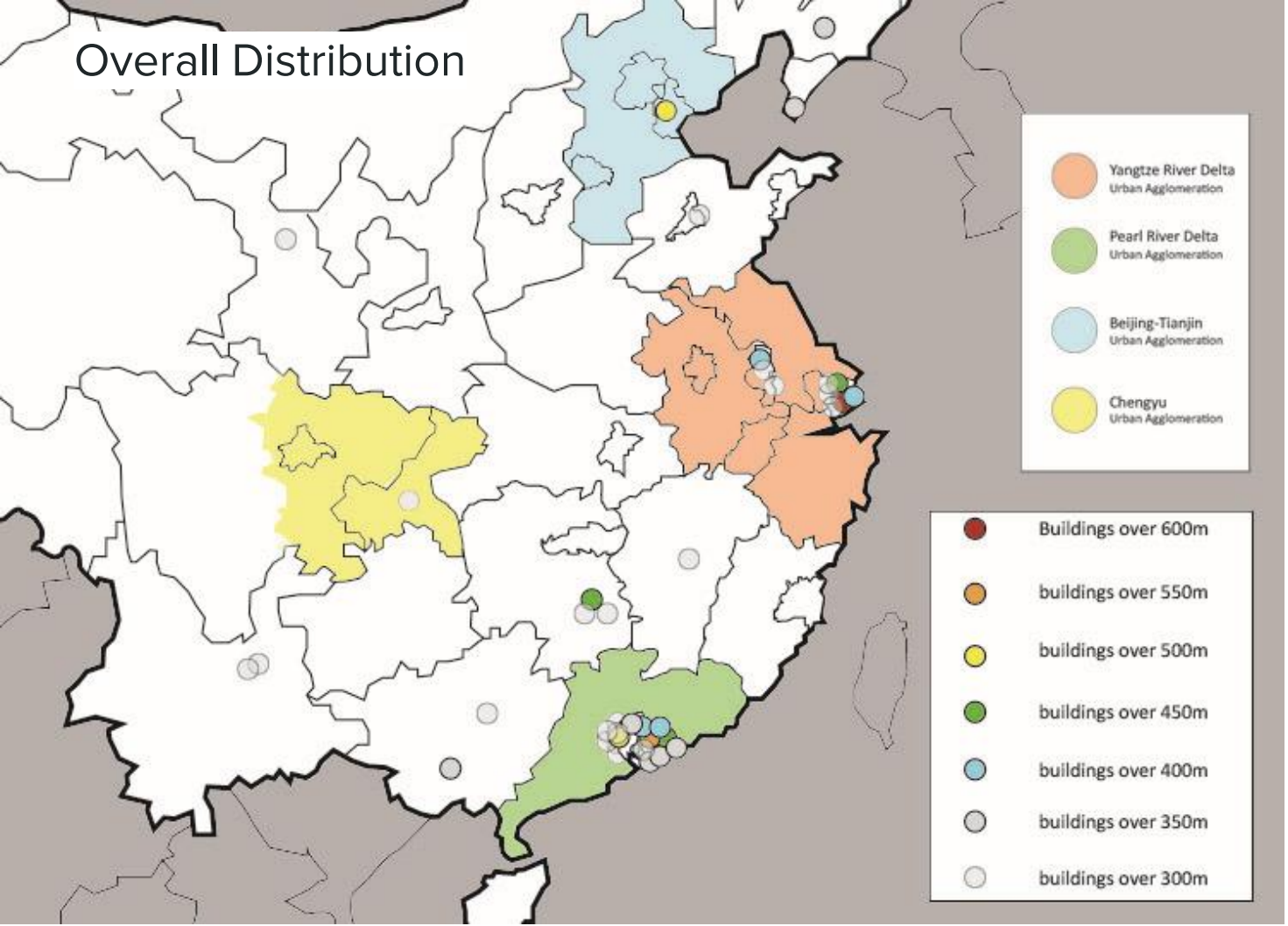
How does the height pattern of skyscrapers above 200m vary across China?

- Look into location of skyscraper and height distribution of skyscrapers in China
- Provide analysis on function, material, construction years and height ranges

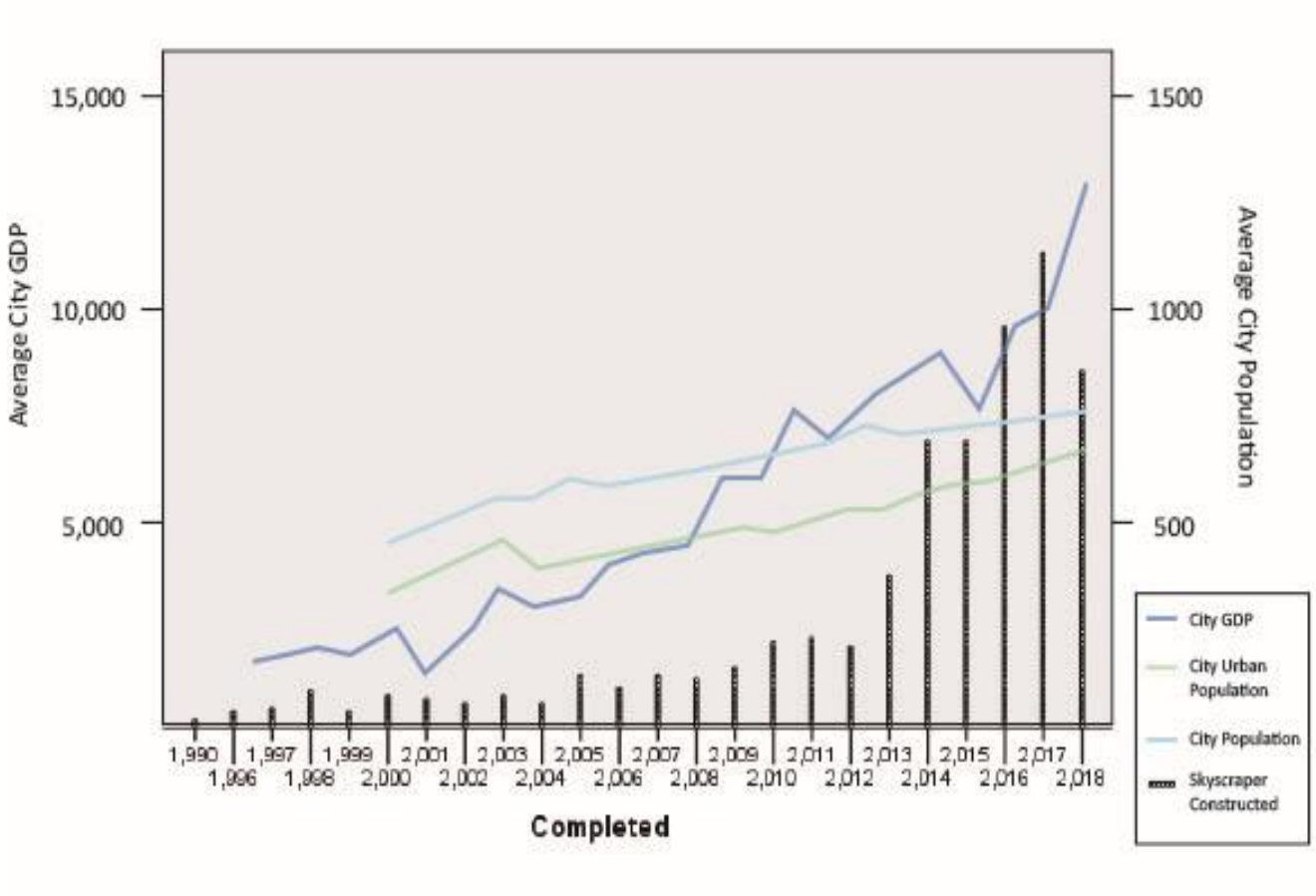
Overall Distribution



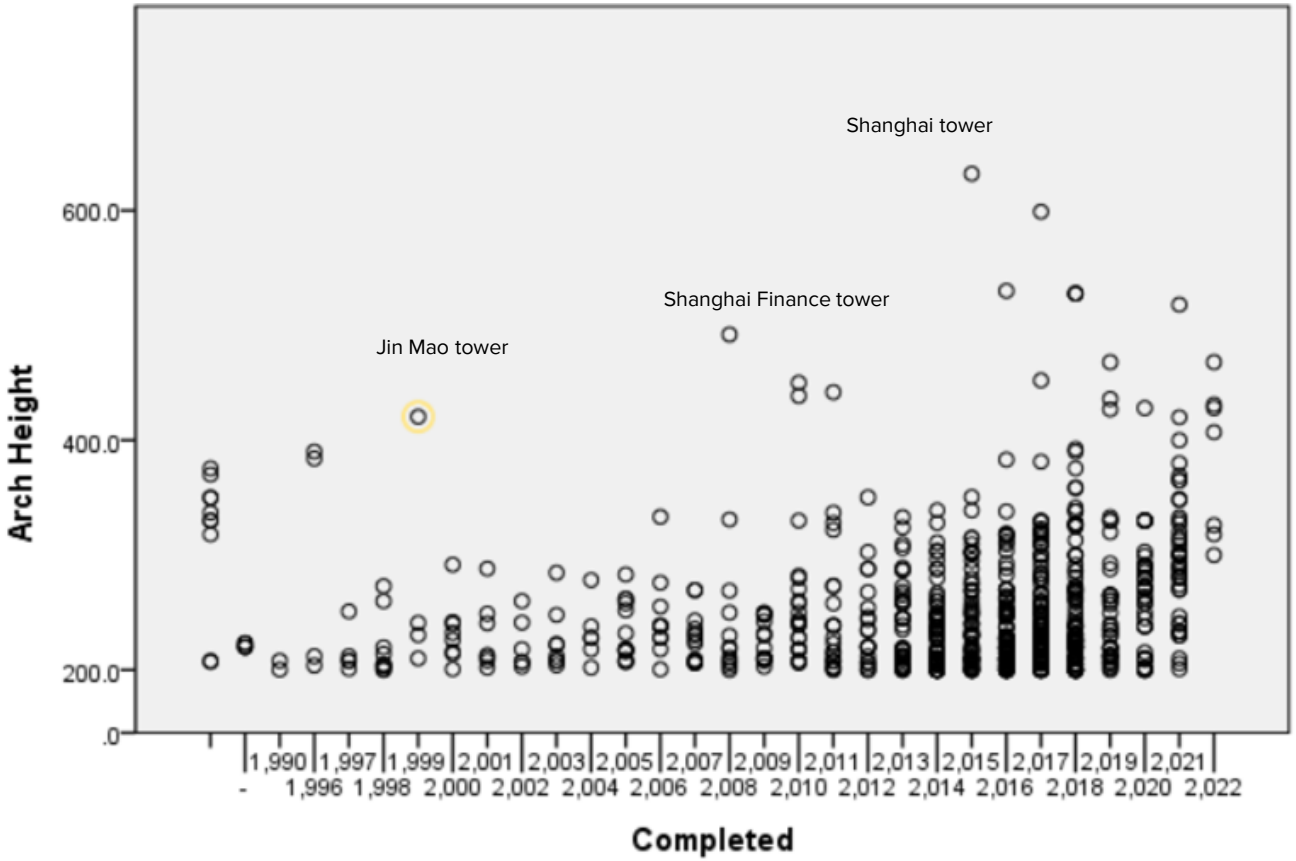
Overall Distribution



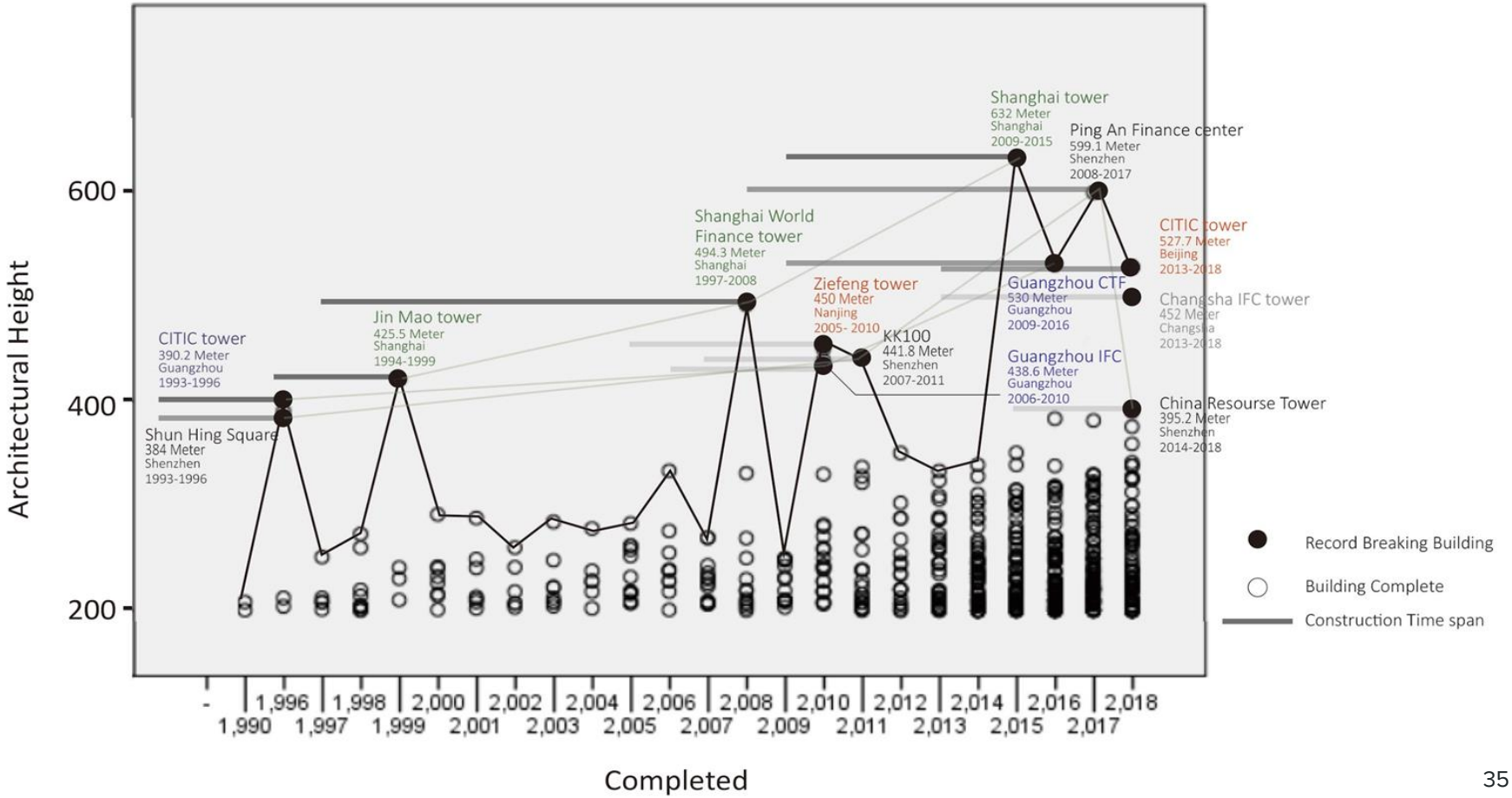
Amount of skyscrapers constructed each Year



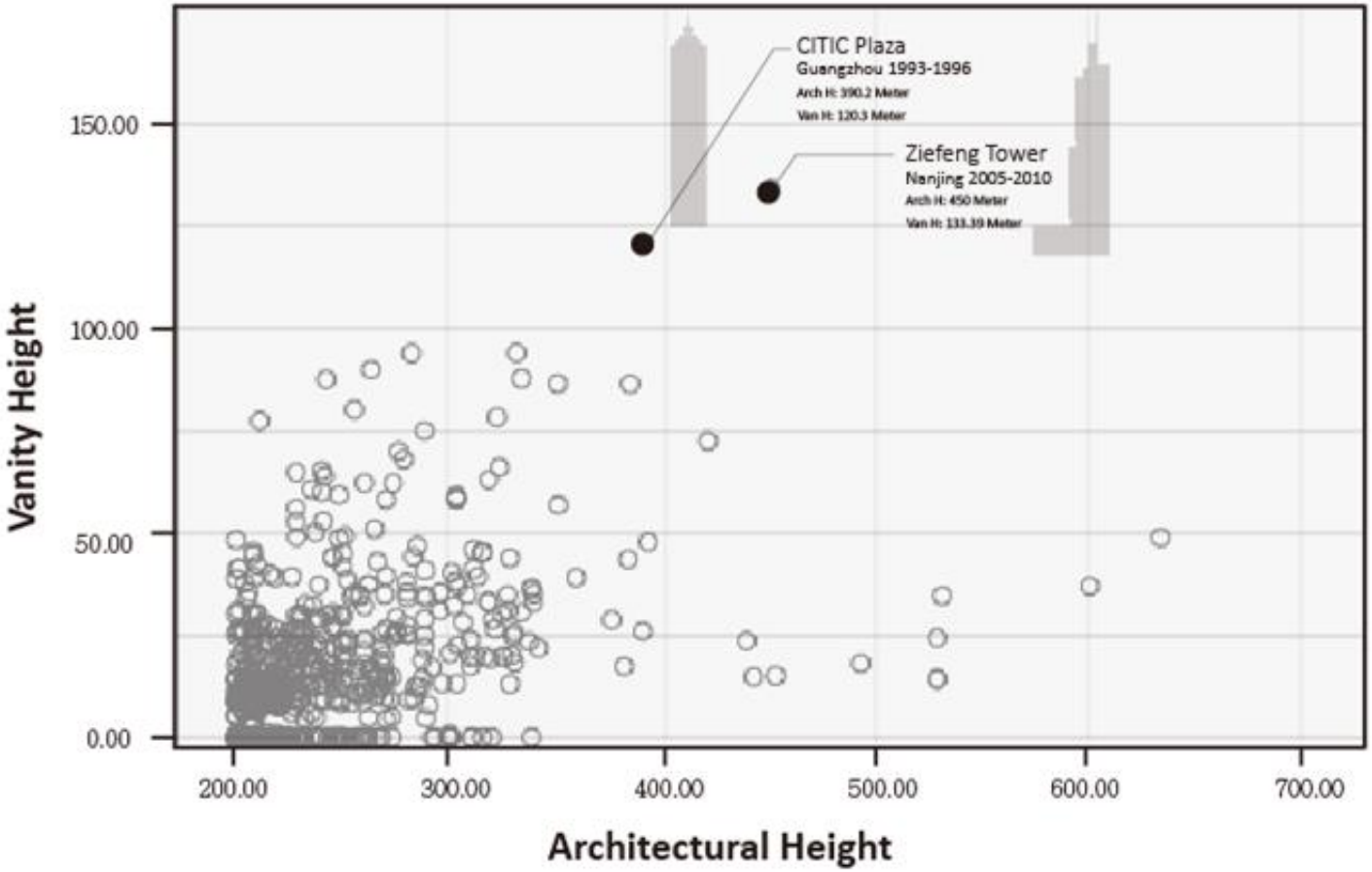
Height distribution Each Year



Record Breaking sksycrapers



Regarding Vanity Height



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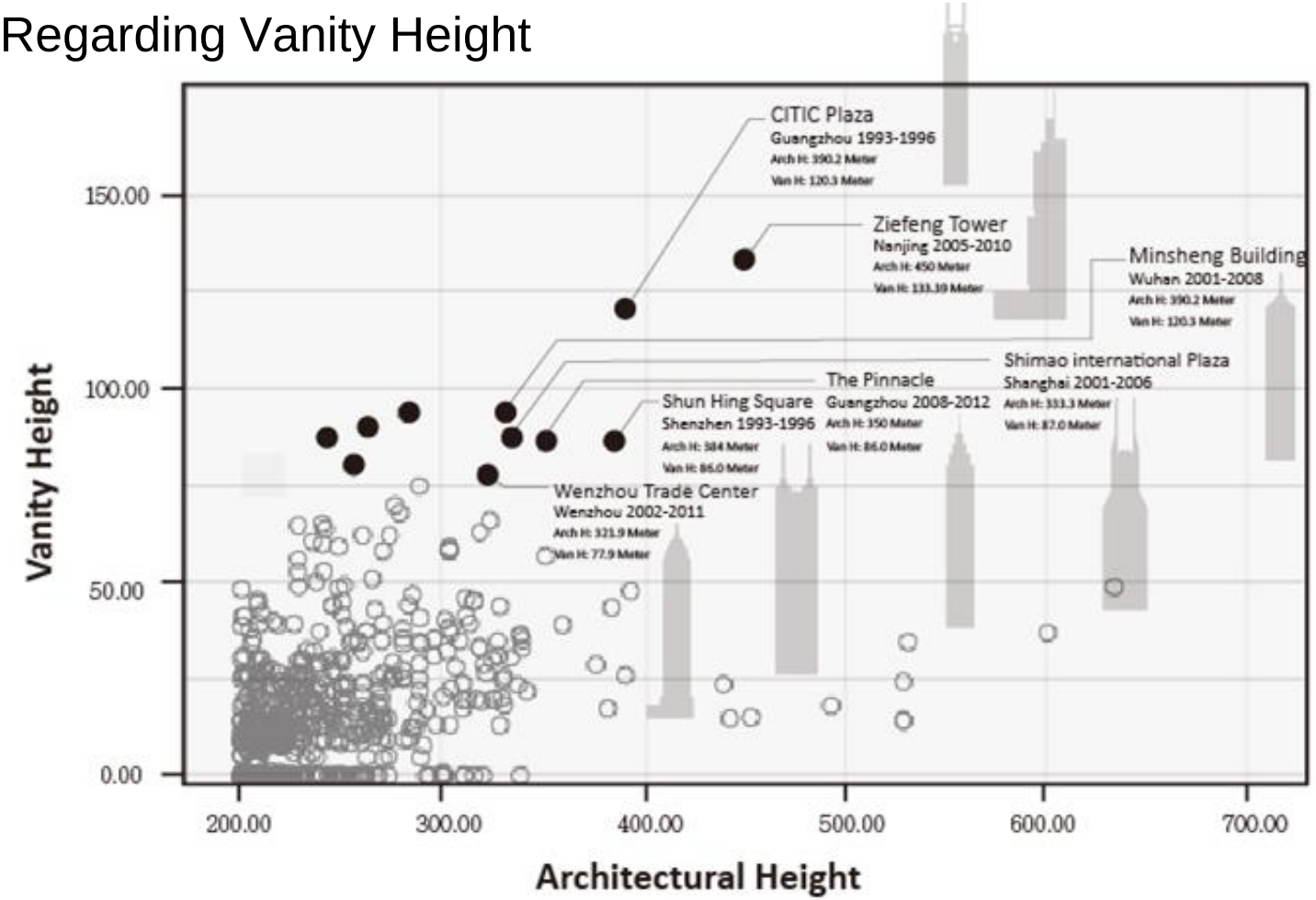
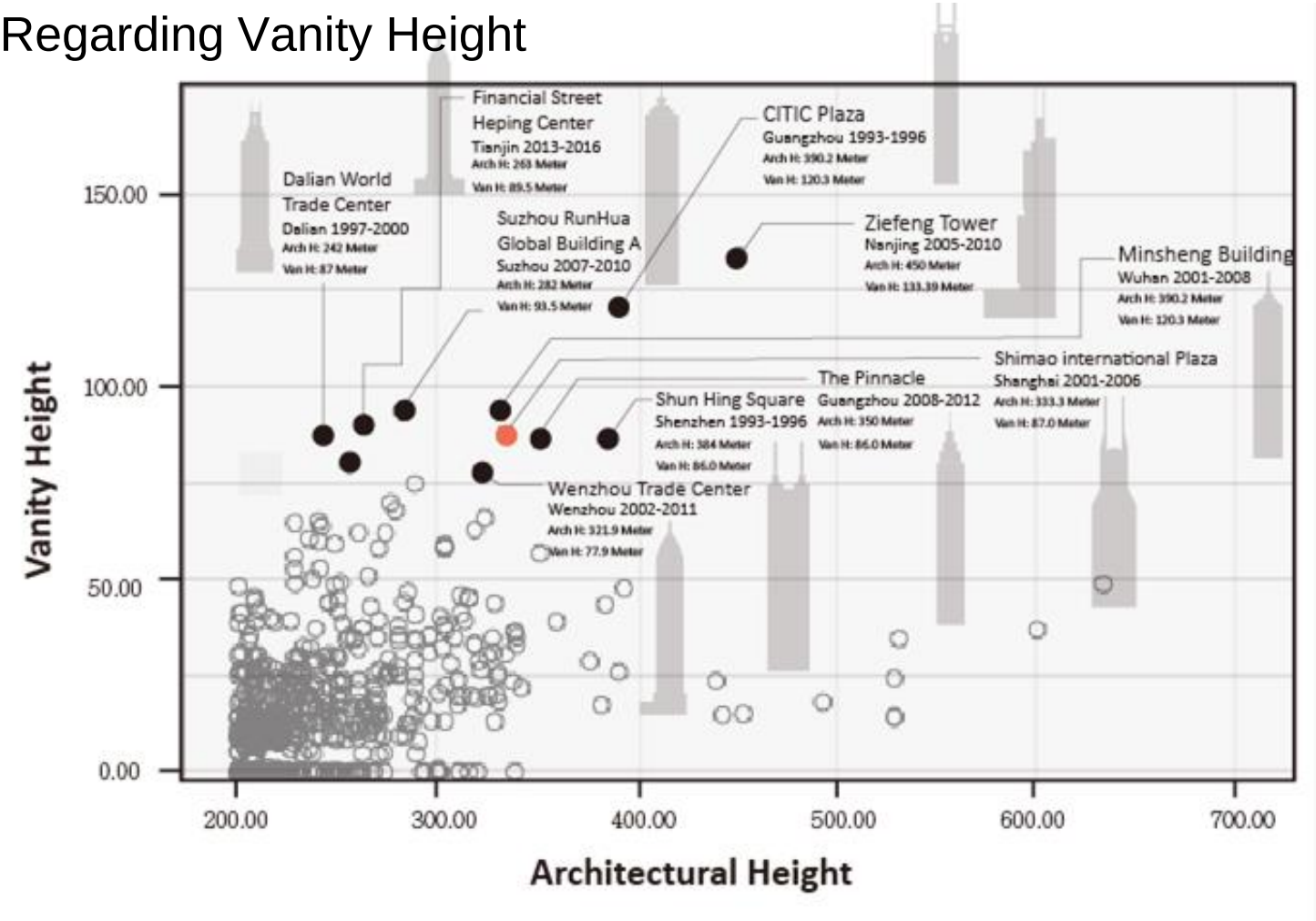
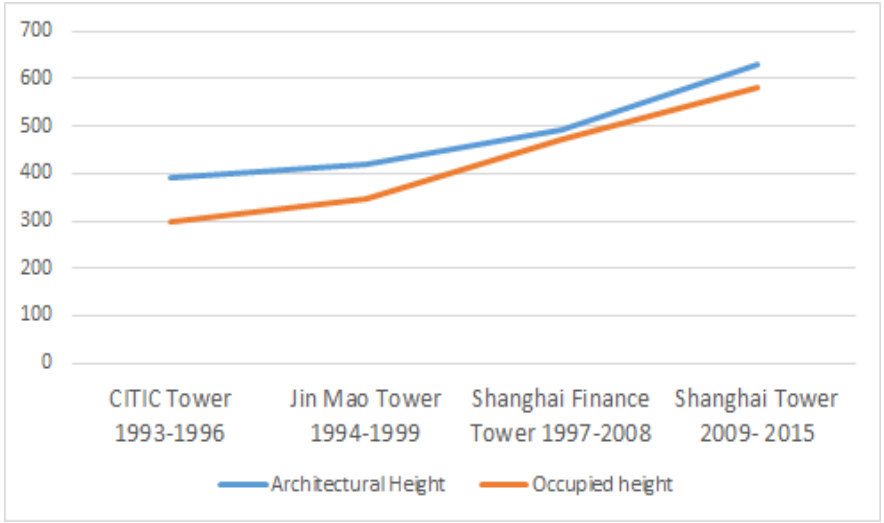
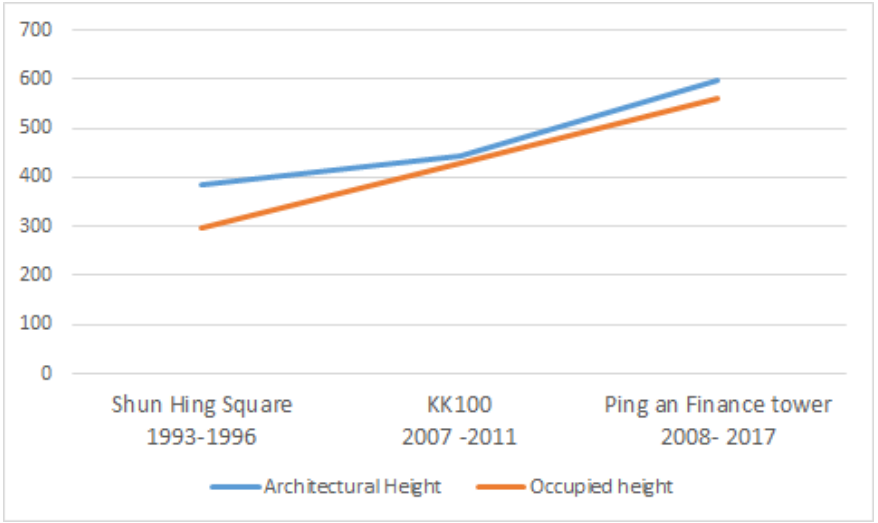


Regarding Vanity Height



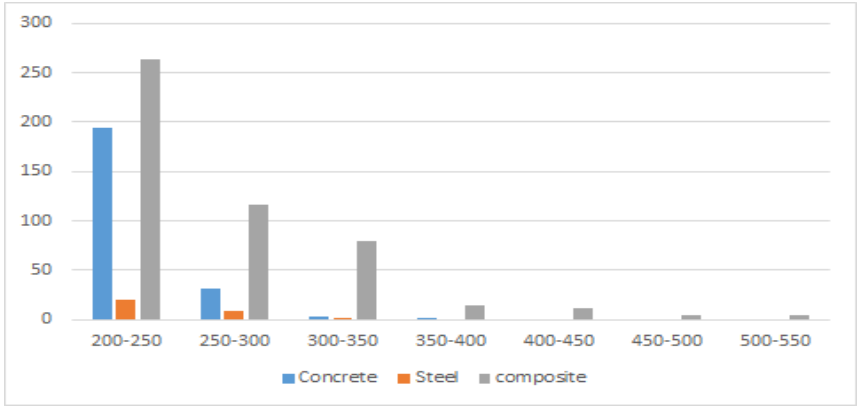
Vanity height of record breaking building

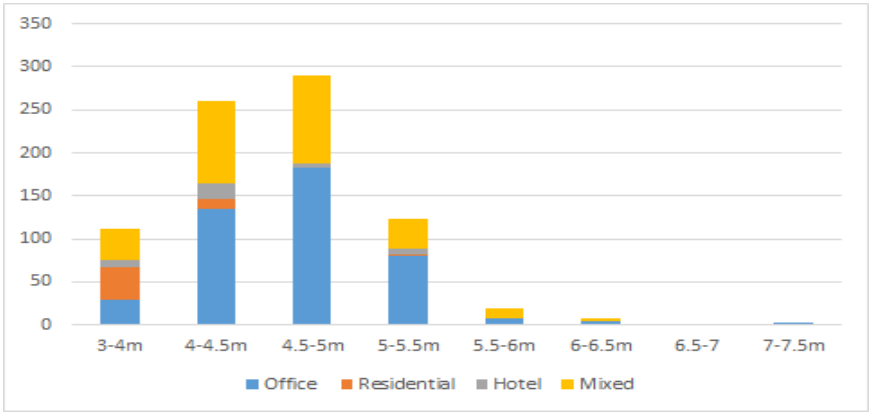


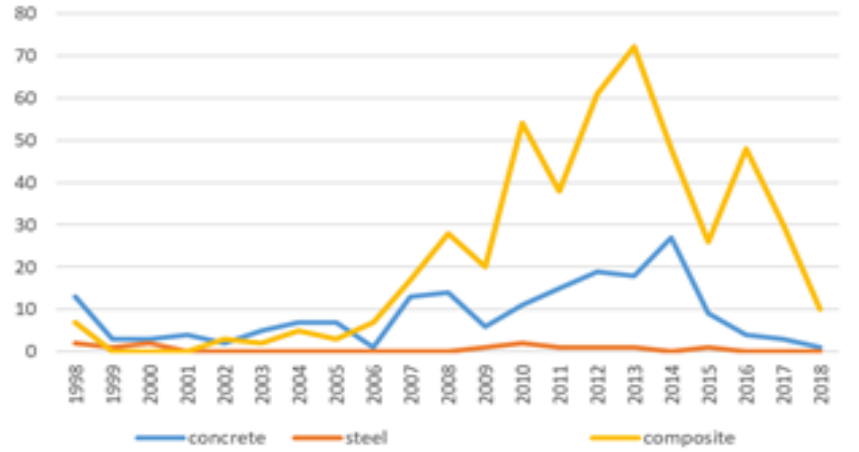


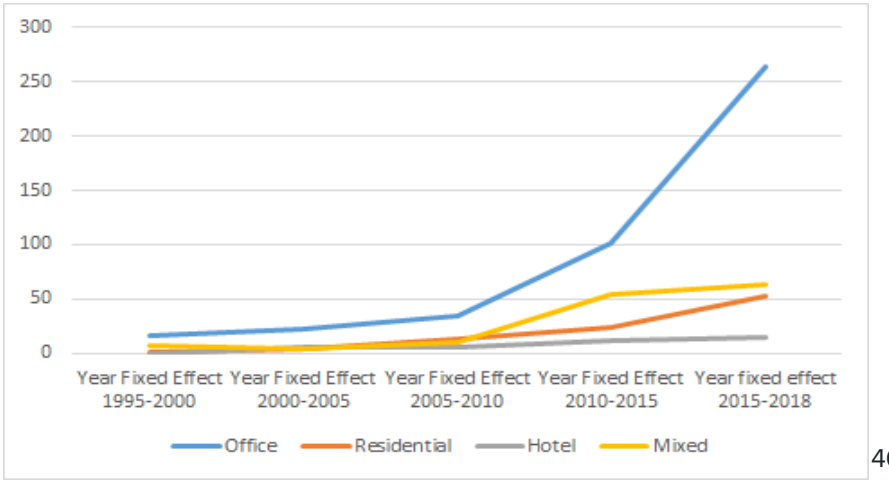
Vanity height is the difference between architectural height and occupied height. According to the graph, the gap between the two lines shows the amount of vanity height

Distribution of building Material and Function Each Year









Finding for first question

- There are **more skyscraper developments around the coast** compared to cities in the middle part and western part of China
- There is an **un-even distribution of skyscraper** and height in China
- Cities like Shanghai and Shenzhen contain a **wide range of skyscraper height**
- **Amount** of skyscraper constructed increases each year, and the **range of skyscraper height increase each year**
- **Vanity height** decreases after year 2010, also vanity height in general decrease as year increase

What is the factor that causes the specific height pattern across the country?

- Perform regression analysis and spot variables that have significant effect on each Dependent variables
- Compare the Regression models and analyse the different between them

Models for Heights

The model consiste of
/.....

Architectural Height

$$\mathbf{ArchH_i} = \beta_0 + \beta_1 \mathbf{VH_i} + \beta_2 \mathbf{GDP_i} + \beta_3 \mathbf{F_i} + \beta_4 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

Occupied Height

$$\mathbf{OccH_i} = \beta_0 + \beta_1 \mathbf{GDP_i} + \beta_2 \mathbf{F_i} + \beta_3 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

Vanity Height

$$\mathbf{VanH_i} = \beta_0 + \beta_1 \mathbf{F_i} + \beta_1 \mathbf{M_i} + \beta_5 \mathbf{Tot_i} + \varepsilon_i$$

Models for Heights

Architectural Height

$$\mathbf{ArchH_i} = \beta_0 + \beta_1 \mathbf{VH_i} + \beta_2 \mathbf{GDP_i} + \beta_3 \mathbf{F_i} + \beta_4 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

Occupied Height

$$\mathbf{OccH_i} = \beta_0 + \beta_1 \mathbf{GDP_i} + \beta_2 \mathbf{F_i} + \beta_3 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

Vanity Height

$$\mathbf{VanH_i} = \beta_0 + \beta_1 \mathbf{F_i} + \beta_1 \mathbf{M_i} + \beta_5 \mathbf{Tot_i} + \varepsilon_i$$

City GDP of the Year

Both model contains city GDP, this can show that skyscraper development is highly correlated to City Economic situation

Models for Heights

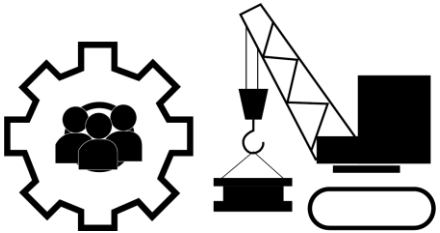
Architectural Height

$$\mathbf{ArchH_i} = \beta_0 + \beta_1 \mathbf{VH_i} + \beta_2 \mathbf{GDP_i} + \beta_3 \mathbf{F_i} + \beta_4 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

City GDP of the Year

Occupied Height

$$\mathbf{OccH_i} = \beta_0 + \beta_1 \mathbf{GDP_i} + \beta_2 \mathbf{F_i} + \beta_3 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$



Function and Material

Vanity Height

$$\mathbf{VanH_i} = \beta_0 + \beta_1 \mathbf{F_i} + \beta_1 \mathbf{M_i} + \beta_5 \mathbf{Tot_i} + \varepsilon_i$$

Models for Heights

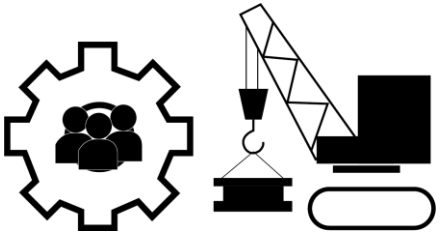
Architectural Height

$$\mathbf{ArchH_i} = \beta_0 + \beta_1 \mathbf{VH_i} + \beta_2 \mathbf{GDP_i} + \beta_3 \mathbf{F_i} + \beta_4 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

City GDP of the Year

Occupied Height

$$\mathbf{OccH_i} = \beta_0 + \beta_1 \mathbf{GDP_i} + \beta_2 \mathbf{F_i} + \beta_3 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$



Function and Material

Vanity Height

$$\mathbf{VanH_i} = \beta_0 + \beta_1 \mathbf{F_i} + \beta_1 \mathbf{M_i} + \beta_5 \mathbf{Tot_i} + \varepsilon_i$$

Type of building Top Finishing

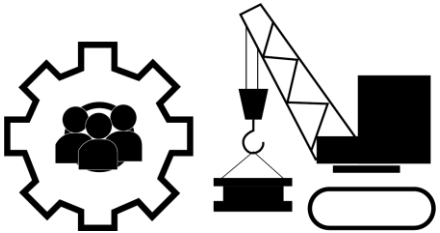
Models for Heights

According to the definition of height, Architectural Height equals to occupied height plus vanity Height

City GDP of the Year

Architectural Height

$$ArchH_i = \beta_0 + \beta_1 VH_i + \beta_2 GDP_i + \beta_3 F_i + \beta_4 M_i + \beta_4 Tot_i + \lambda_L + \varepsilon_i$$



Function and Material

Occupied Height

$$OccH_i = \beta_0 + \beta_1 GDP_i + \beta_2 F_i + \beta_3 M_i + \beta_4 Tot_i + \lambda_L + \varepsilon_i$$

Vanity Height

$$VanH_i = \beta_0 + \beta_1 F_i + \beta_1 M_i + \beta_5 Tot_i + \varepsilon_i$$

Type of building Top Finishing

Models for Heights

Architectural Height

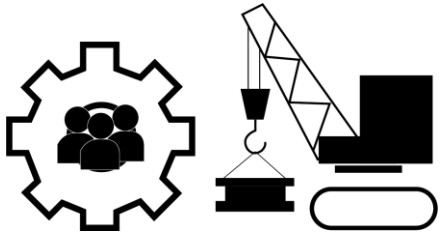
$$\mathbf{ArchH_i} = \beta_0 + \beta_1 \mathbf{VH_i} + \beta_2 \mathbf{GDP_i} + \beta_3 \mathbf{F_i} + \beta_4 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

Occupied Height

$$\mathbf{OccH_i} = \beta_0 + \beta_1 \mathbf{GDP_i} + \beta_2 \mathbf{F_i} + \beta_3 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

Vanity Height

$$\mathbf{VanH_i} = \beta_0 + \beta_1 \mathbf{F_i} + \beta_1 \mathbf{M_i} + \beta_5 \mathbf{Tot_i} + \varepsilon_i$$

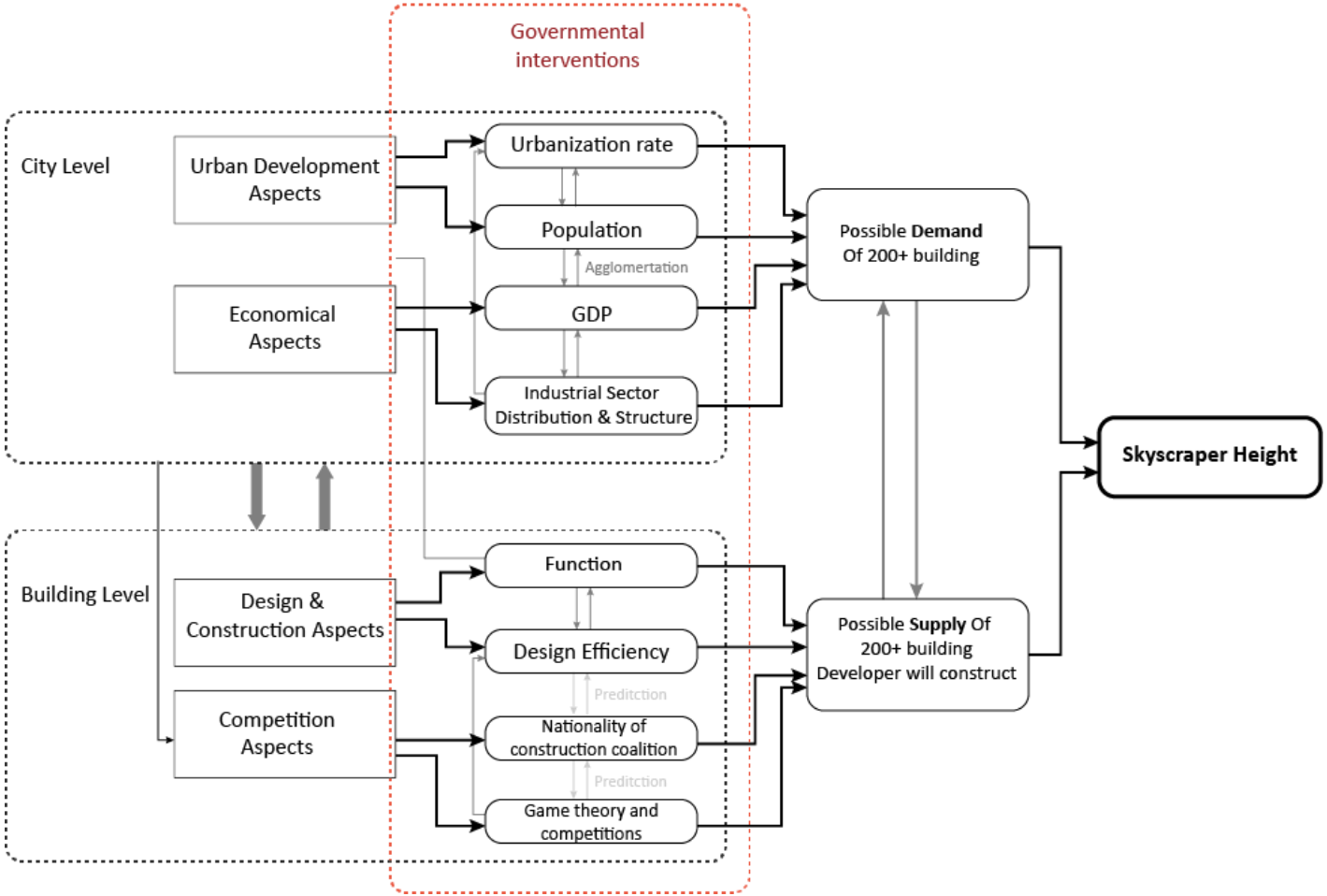


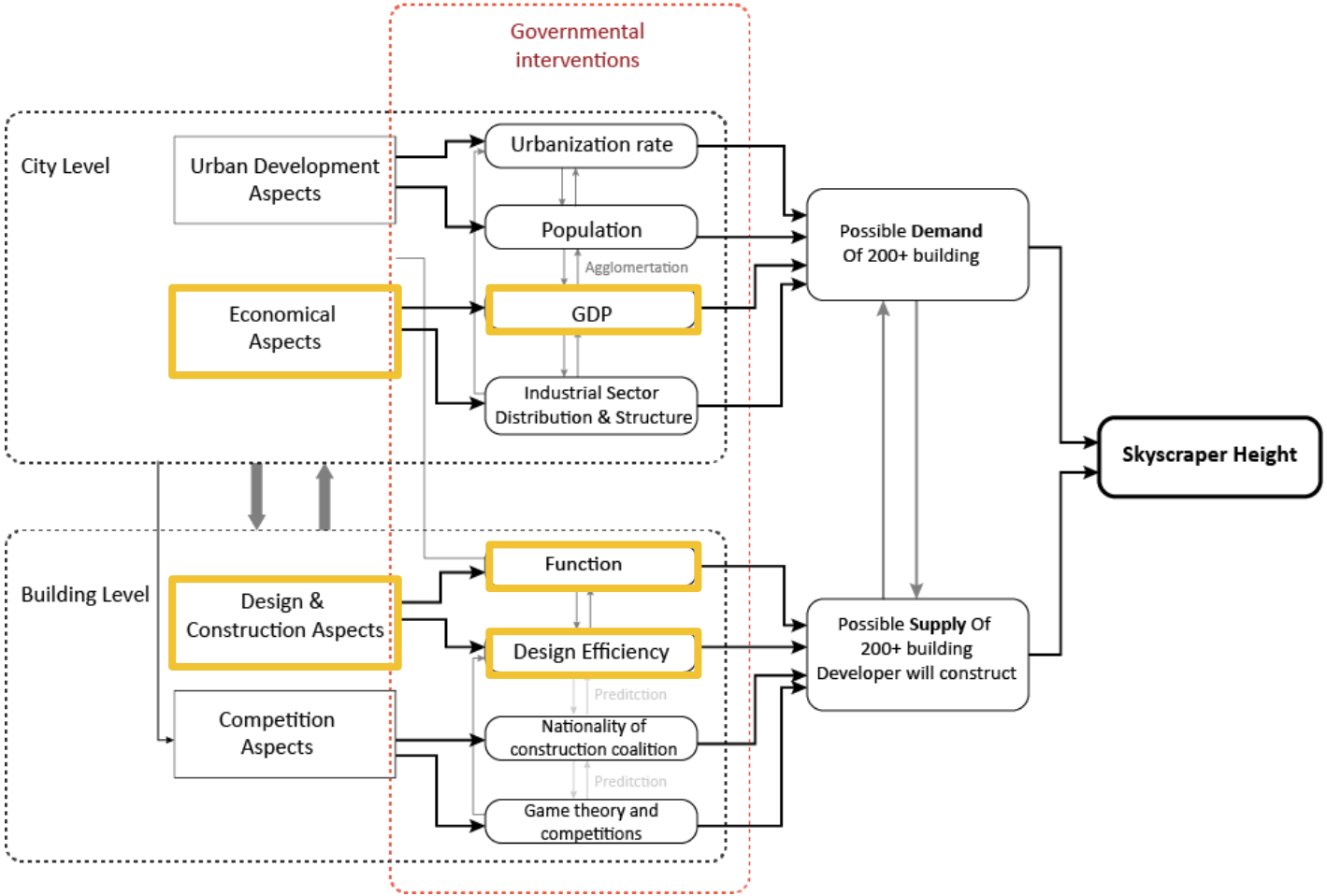
Function and Material

Type of building Top Finishing

Finding for Second question

- **Most City Level factors dont have significant relationship** with Architectural height and occupied height, which means that they don't have much influence on skyscraper height
- **More Building level factors are significant** on height compare to city level, including Function, Material and design of the skyscraper
- **Vanity Height has significant relationship with architectural height**, which means that it does provide increase in height
- **Location & Time fixed effect** doesn't have large effect on skyscraper height


Governmental interventions
City Level
Urban Development Aspects
Economical Aspects
Urbanization rate
Population
Agglomertation
GDP
Industrial Sector Distribution & Structure
Possible Demand Of 200+ building
Skyscraper Height
Building Level
Design & Construction Aspects
Competition Aspects
Function
Design Efficiency
Preditction
Nationality of construction coalition
Preditction
Game theory and competitions
Possible Supply Of 200+ building Developer will construct


Governmental interventions
City Level
Urban Development Aspects
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Urbanization rate
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Nationality of construction coalition
Preditction
Game theory and competitions
Possible Demand Of 200+ building
Possible Supply Of 200+ building Developer will construct
Skyscraper Height

To what extent do these factors affect height pattern?

- Look into the Coefficient of each model and compare them between models
- Understand each coefficient and provide defenitions to it
- They will be explained in categories of height related variables

Height related variables

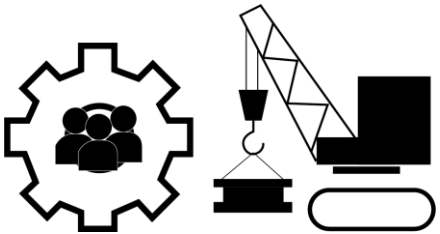
$$\mathbf{ArchH_i} = \beta_0 + \beta_1 \mathbf{VH_i} + \beta_2 \mathbf{GDP_i} + \beta_3 \mathbf{F_i} + \beta_4 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

$$\mathbf{OccH_i} = \beta_0 + \beta_1 \mathbf{GDP_i} + \beta_2 \mathbf{F_i} + \beta_3 \mathbf{M_i} + \beta_4 \mathbf{Tot_i} + \boldsymbol{\lambda}_L + \varepsilon_i$$

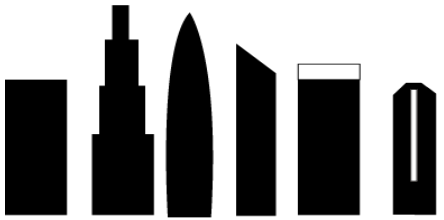
City Level Determinant

City GDP of the Year

Building Level Determinant

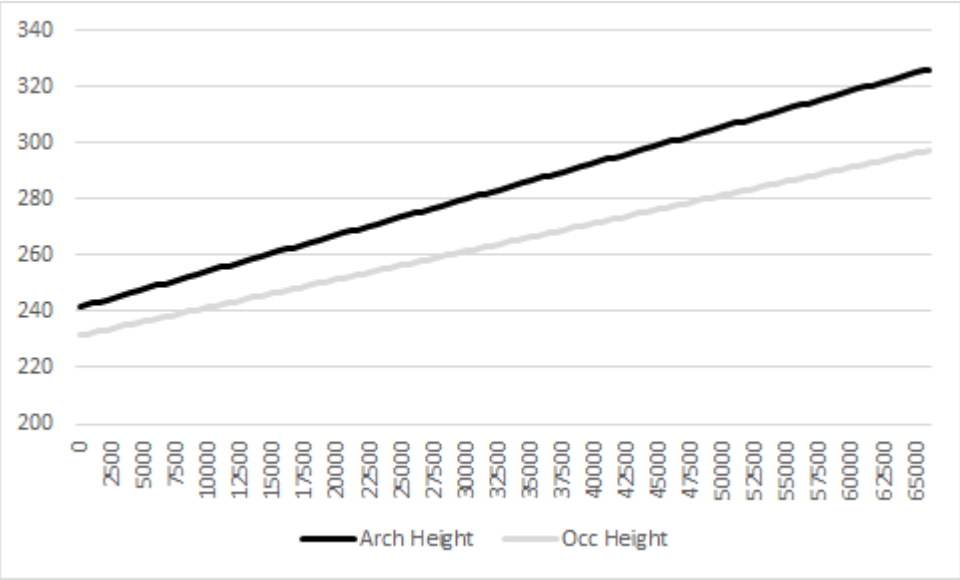


Function and Material



Type of building Top Finishing

City Economical aspects→ Height

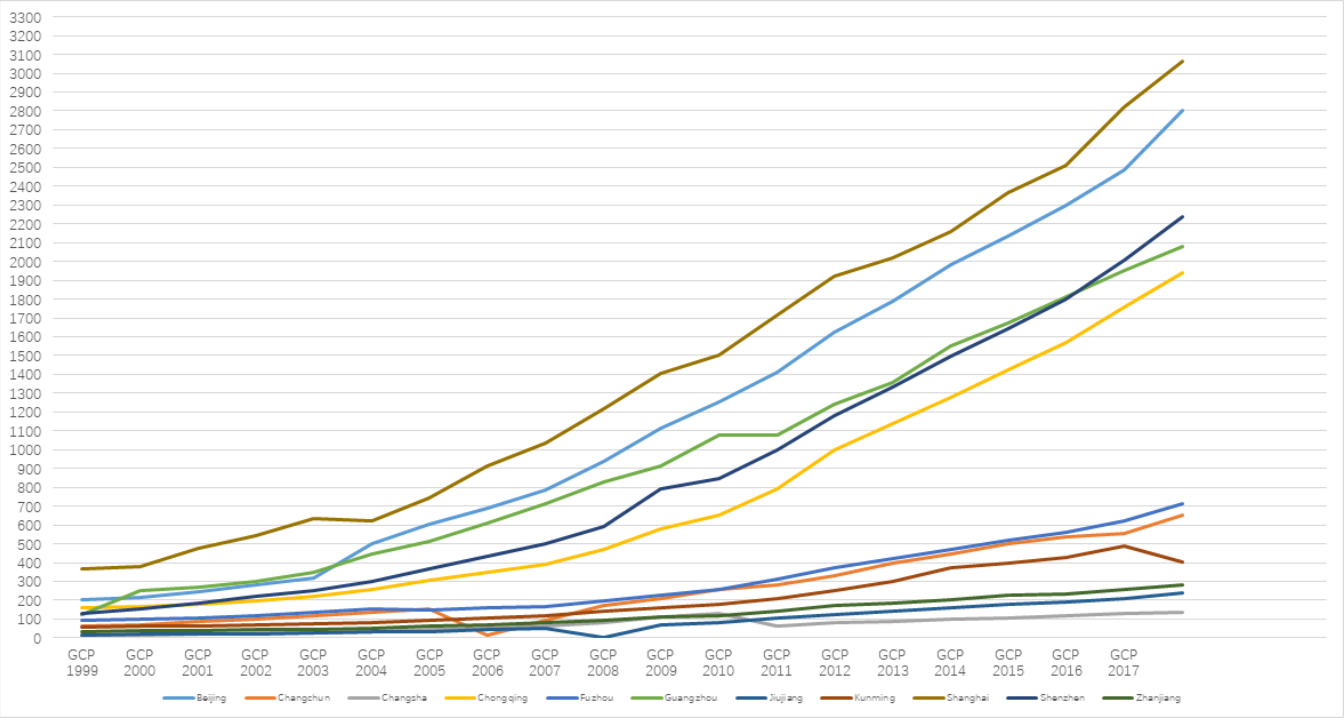


City GDP to Height

City GDP Coefficient B=0.001
GDP Unit: 100 Million

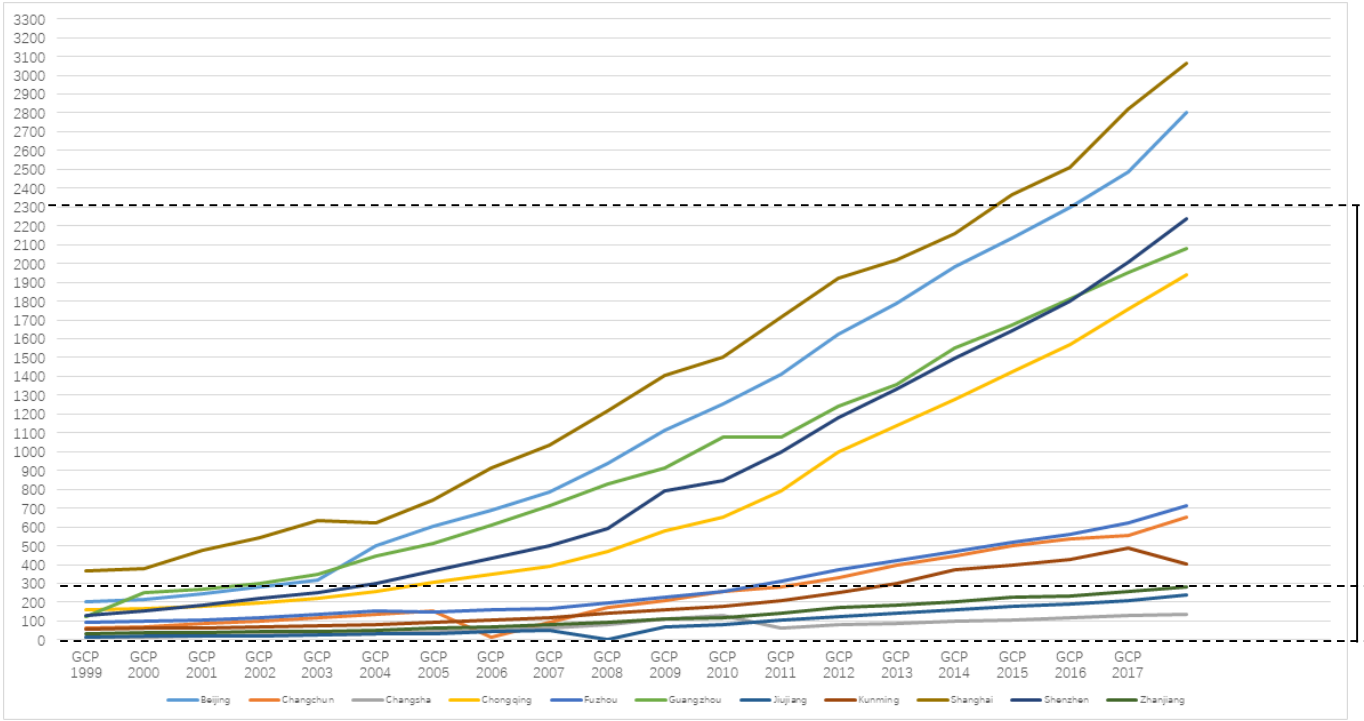
- Every increase in 100 Billion RMB in GDP, height of buildings will in general increase 1m
- The effect of City GDP on Architectural height and Occupied height have similar slope
- As GDP increase Height also increase

City Economical aspects→ Height



City GDP Growth

City Economical aspects→ Height



These cities takes Should have building that in general is 23m taller then the cities at the bottom

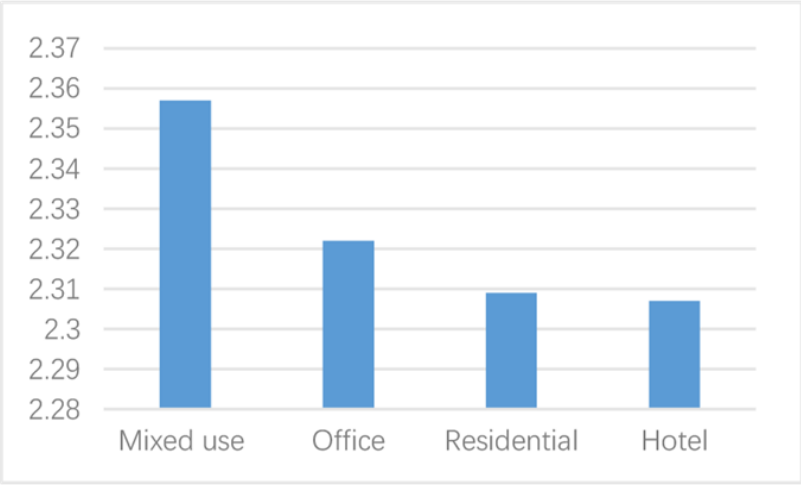
Increase in 2300 Billion in GDP

These cities takes 18 years to reach GDP increase in 300 Billion

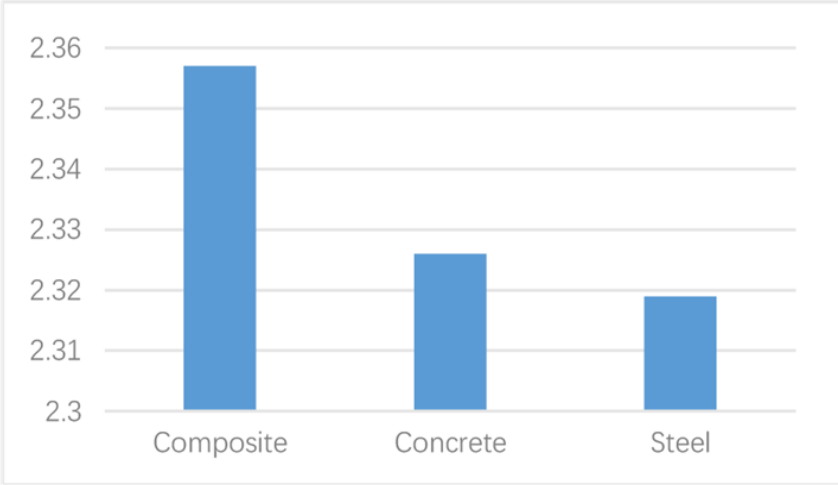
Increase in 300 Billion in GDP

City GDP Growth

Function and Material

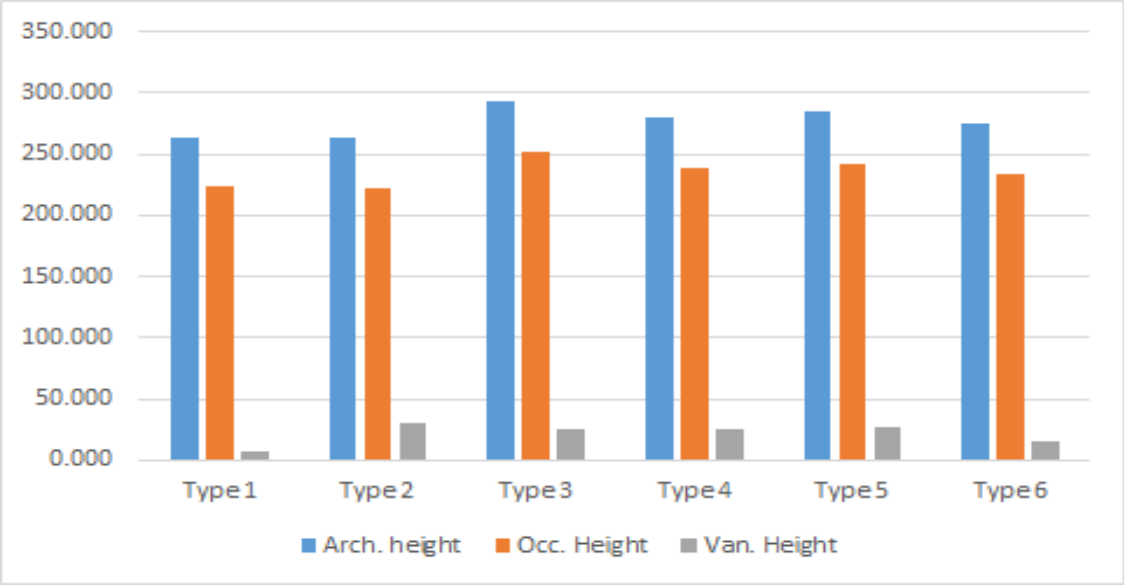


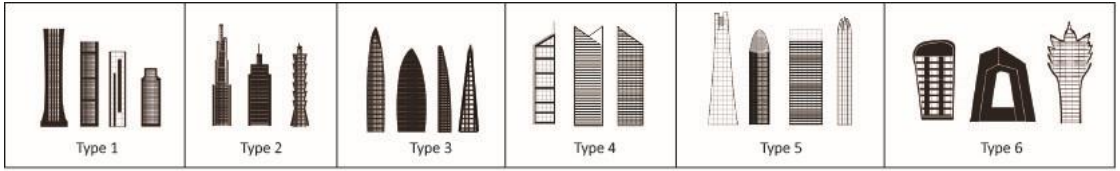
Mixed Use > Office > Residential > Hotel



Composite > Concrete > Steel

Building Finshing design





Architectural height

Type 1< 2< 6<4< 5<3

Occupied height

Type 2 < 1< 4<5<6 < 3

Vanity Height

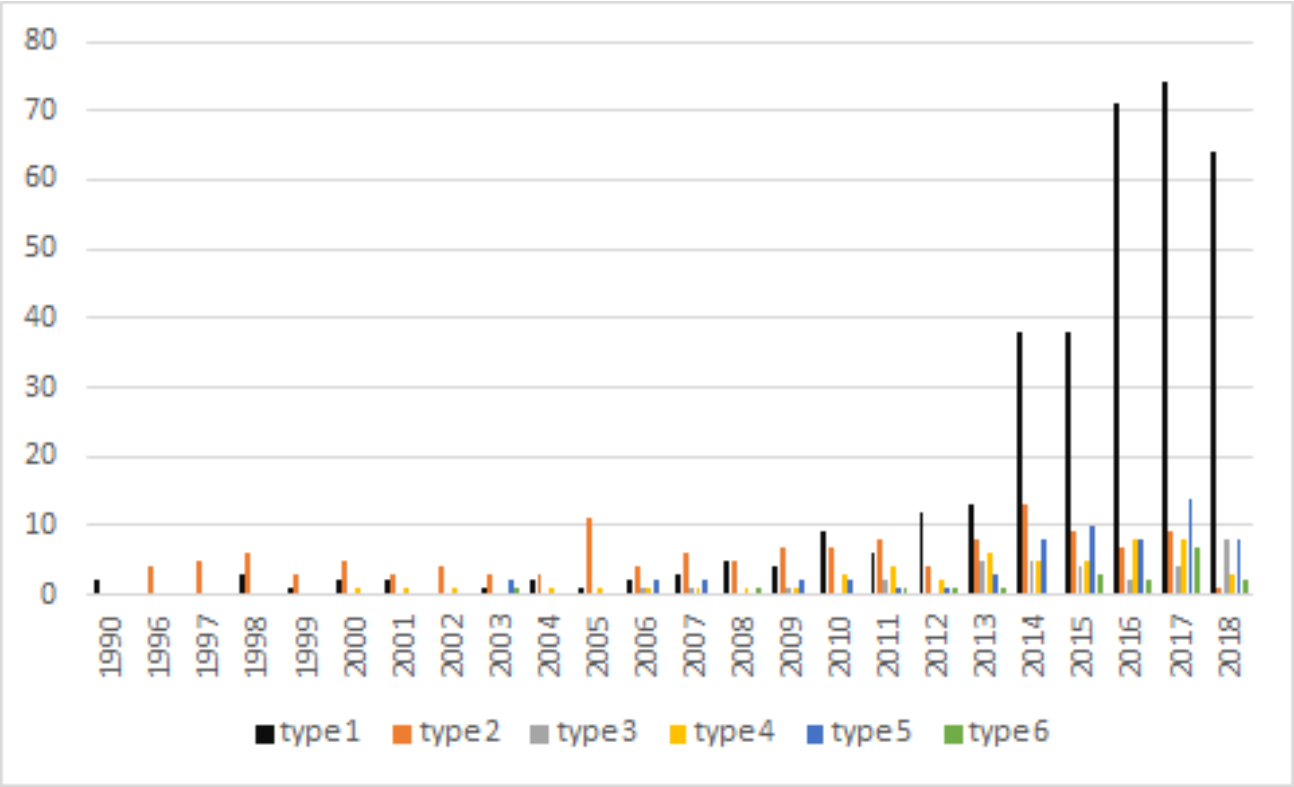
Type 1< 6 < 3 < 4 < 5 < 2

Type 3 have the most architectural height in general

Type 1 have the least vanity Height in general

Type 2 have the most vanity height but it has the least architectural and occupied height

Building Finshing design



Architectural height

Type 1< 2< 6<4< 5<3

Occupied height

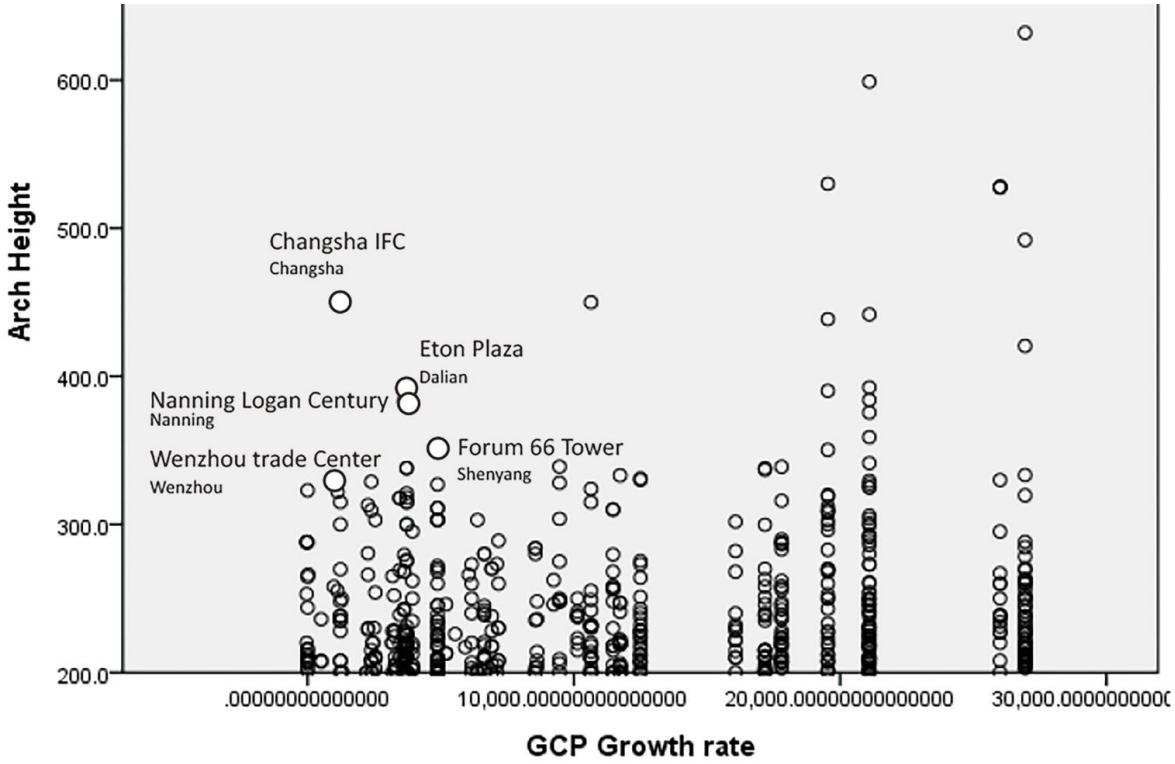
Type 2 < 1< 4<5<6 < 3

Vanity Height

Type 1< 6 < 3 < 4 < 5 < 2

- There are more **type 1** and **type 5** building constructed after year 2010
- The amount of **type 2** building constructed remains stable

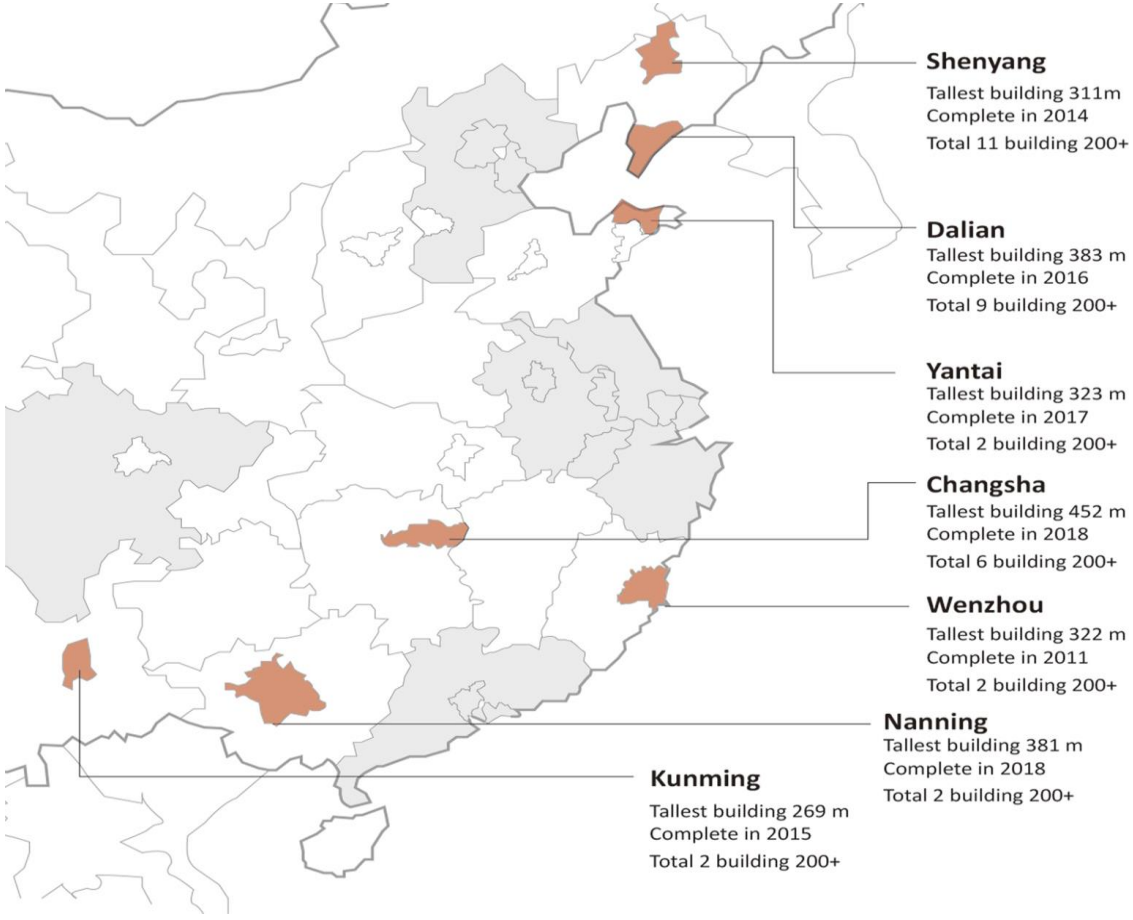
Other Finding



City GDP and Building Height

- There are some cities with low GDP growth rate, but also contain buildings over 400m
- But these building does not exceed 500m

Other Finding



City GDP and Building Height

- There are some cities with low GDP growth rate, but also contain buildings over 400m
- But these building does not exceed 500m
- These cities does not located in the clusters

CONCLUSION AND SUGGESTION

Conclusion

- Regarding height determinant factor
  - The factors that affected skyscraper height are more the building level factors including building function, material and design
  - But in general Skyscraper development have correlation with economic situation of the city regarding to skyscraper height

Conclusion

- The result suggested that **building in China is constructed according to economic reasons** rather than competition due to following reasons
    - Building architectural height have significant relationship with city GDP
    - Type one building design in general contains more occupied height and less vanity height, it is also the typology most constructed after year 2013
    - There are more skyscraper located around 200m, and only small amount of building is over 400m

Conclusion

- Regarding to Height distribtution
  - There are uneven skyscraper distribution, and each city contains wide range of building height. In city with limited land for example Hong kong currently develop building over 400m, but not the ones around 200m
  - There is also an increase in city size in the major cities including Beijing, Shanghai and shenzhen, and it took more than 1 hr to move from the out-skirt of the city to city center, which is considered a long time. This shows that lands are not used efficiently
  - Suggested to look into the efficient building height and set lower height limit accordingly

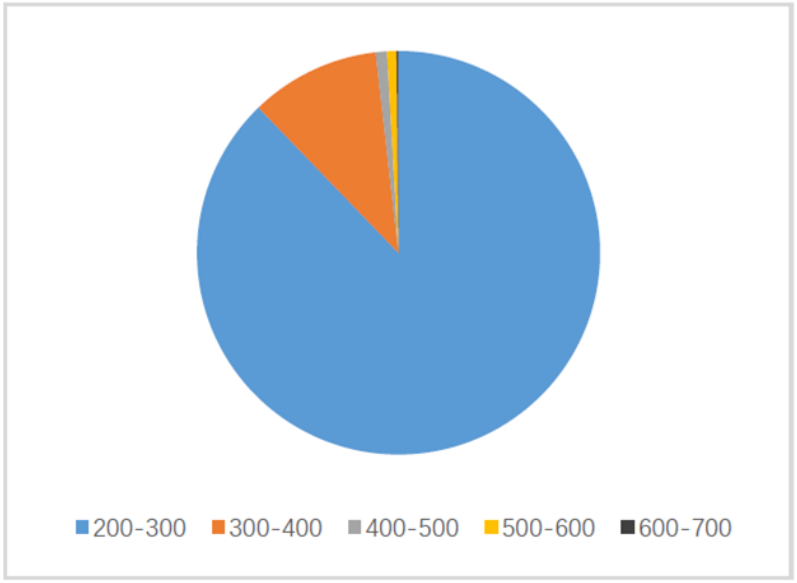
Possible Further research

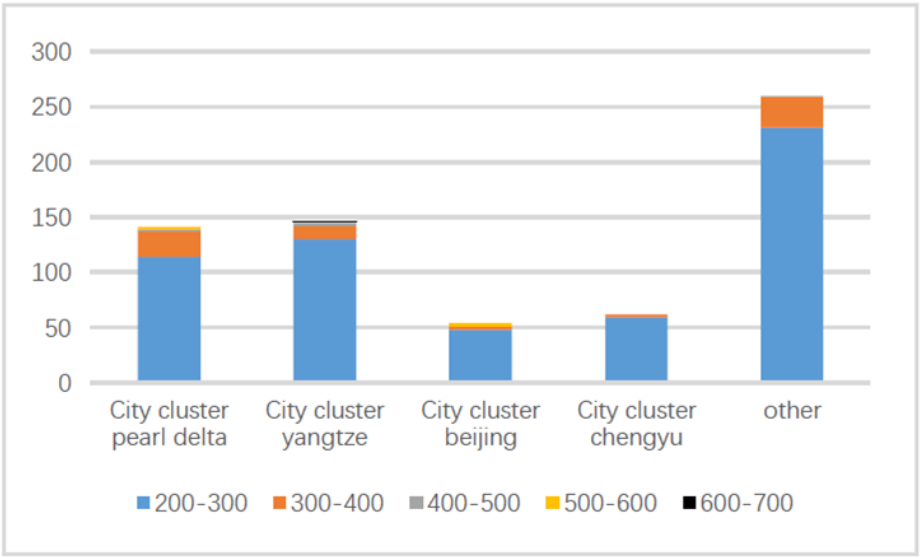
- Due the difference in culture and other aspect, development pattern may vary, Thus, the study on skyscraper height could also be done in other countries to see if they yield similar results

- The variable used in the research does not explain vanity height well, so more research could be done on determinants of vanity height

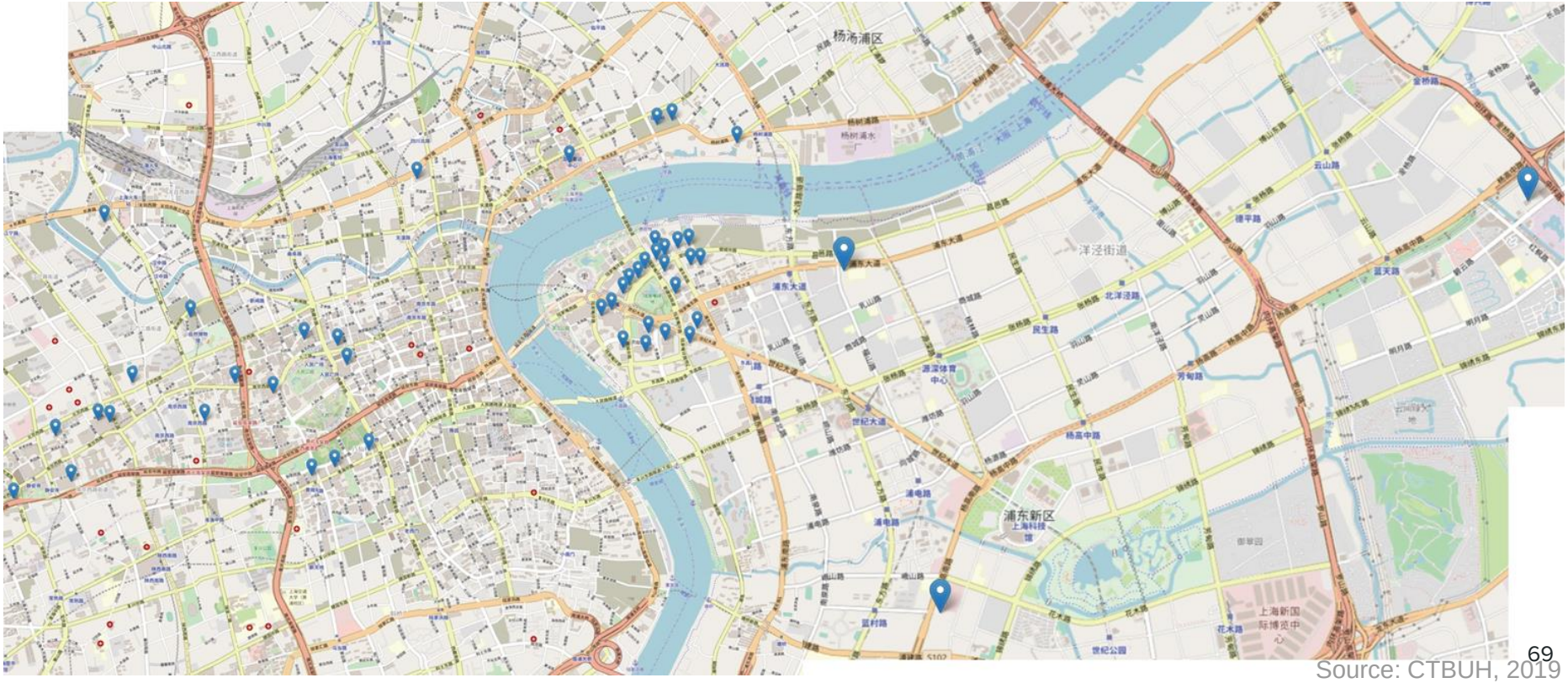
- The correlation tables shows relationship between the variables and number of skyscraper in a city, so a study could be done on the connection between amount of skyscraper constructed and height

Question?


200-300
300-400
400-500
500-600
600-700

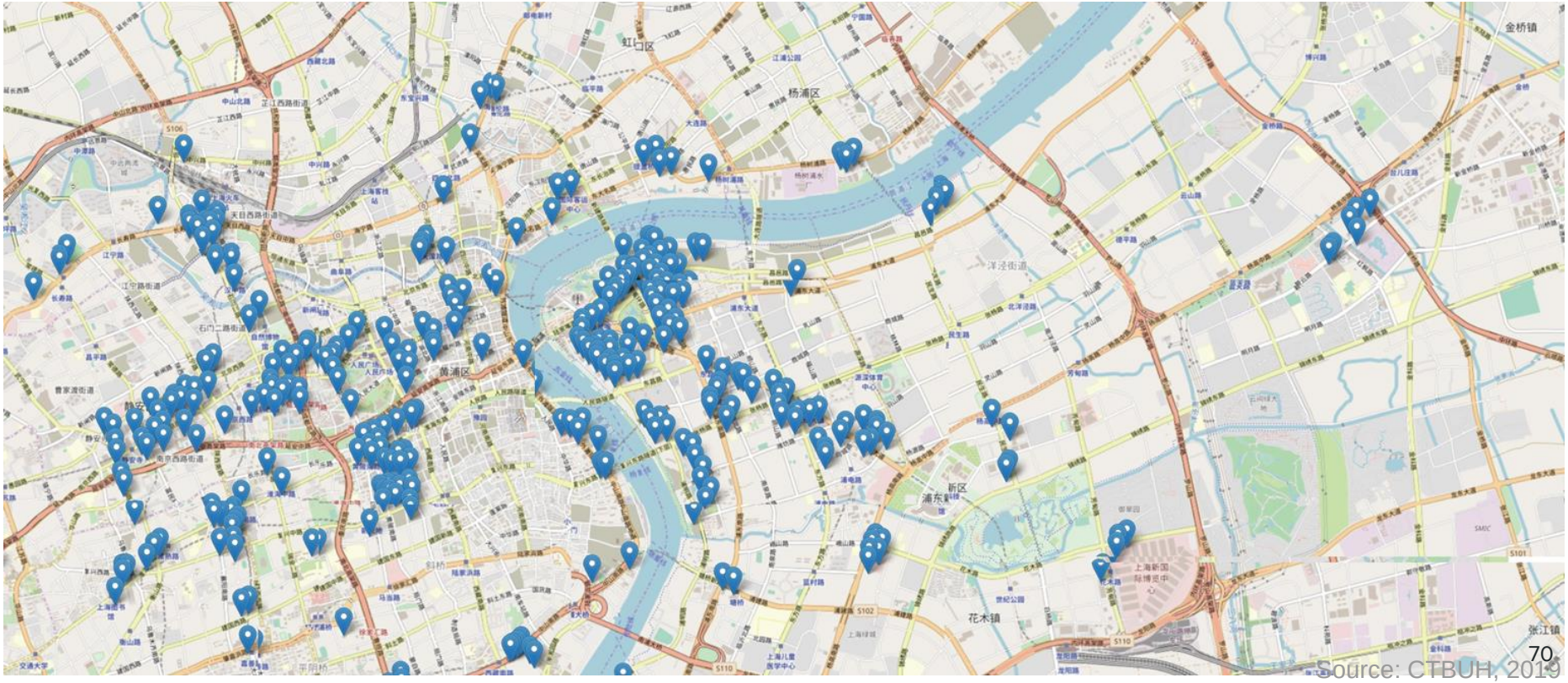

300
250
200
150
100
50
0
City cluster pearl delta
City cluster yangtze
City cluster beijing
City cluster chengyu
other
200-300
300-400
400-500
500-600
600-700

Distribution of 200m plus skyscraper in Shanghai



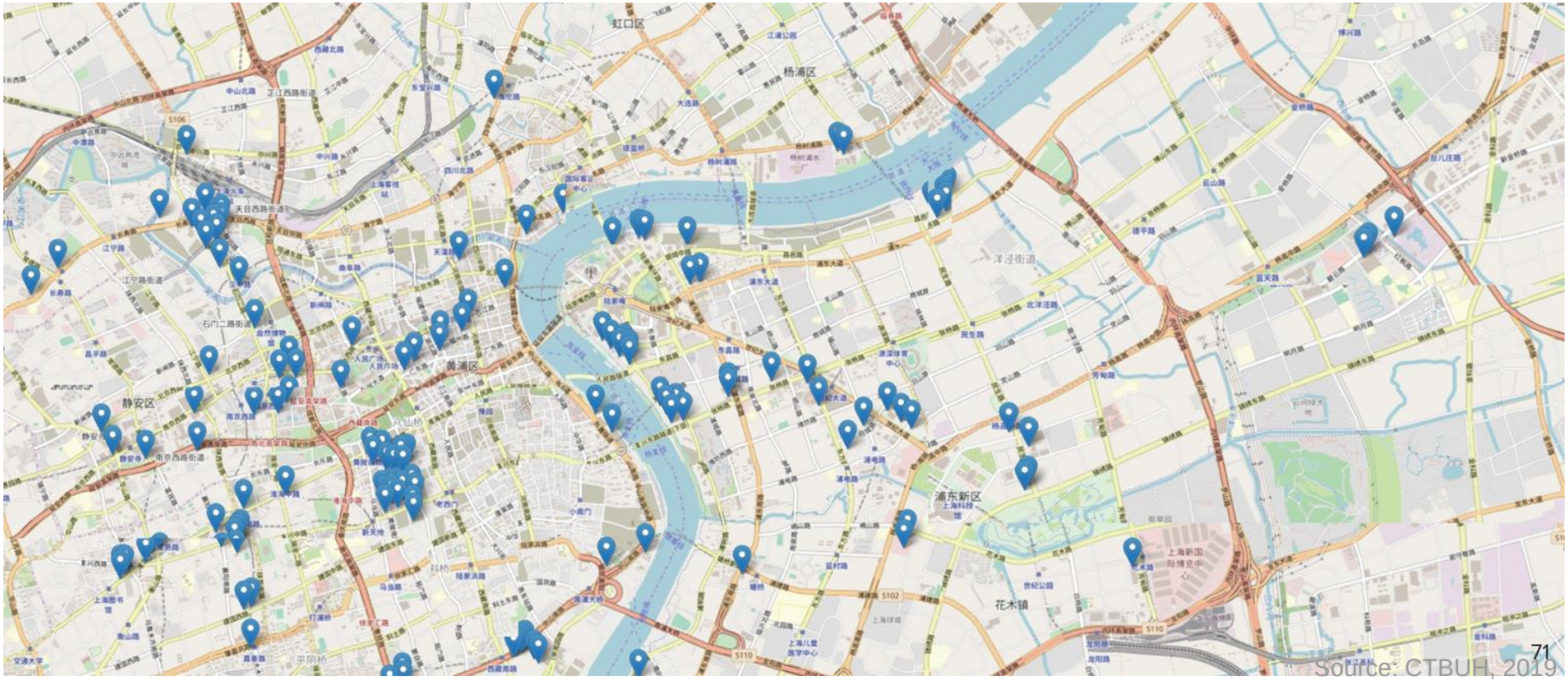
Source: CTBUH, 2019

Distribution of All skyscraper in Shanghai



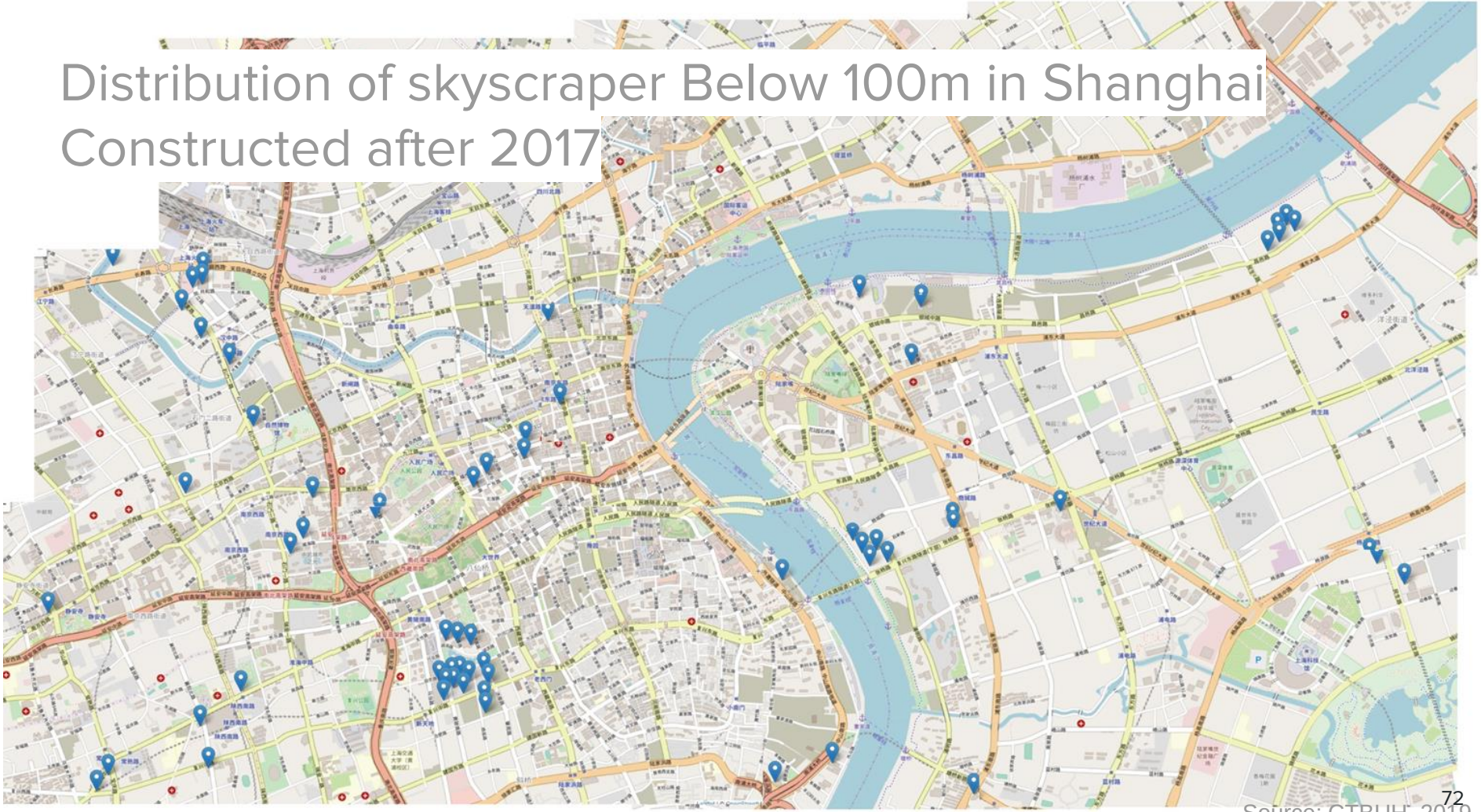
Source: CTBUH, 2019

Distribution of skyscraper Below 100m in Shanghai



Source: CTBUH, 2019

Distribution of skyscraper Below 100m in Shanghai Constructed after 2017



Source: CTBUH, 2019

226	Longguang Royal Lake Sunshine 16	Nanning (CN)	68.3	224	21	2018		residential
226	Longguang Royal Lake Sunshine 17	Nanning (CN)	68.3	224	21	2018		residential
226	Longguang Royal Lake Sunshine 19	Nanning (CN)	68.3	224	21	2018		residential
226	Longguang Royal Lake Sunshine 20	Nanning (CN)	68.3	224	21	2018		residential
230	Shenzhen Fourth People's Hospital IMC Ward	Shenzhen (CN)	64.8	213	15	2017		hospital
231	Rong and Banyan Mountain #5B	Nanning (CN)	61.3	201	19	2017	concrete	residential
232	Nanxun #19	Liuzhou (CN)	60	197	18	2019	concrete	residential
233	Hangzhou Gateway	Hangzhou (CN)	59.9	197	16	2017	concrete	office
234	Huashang International #13	Yulin (CN)	58.7	193	19	2018		residential
234	Huashang International #16	Yulin (CN)	58.7	193	19	2018		residential
236	Rong and Banyan Mountain #1A	Nanning (CN)	58.4	192	18	2017	concrete	residential
236	Rong and Banyan Mountain #2A	Nanning (CN)	58.4	192	18	2017	concrete	residential
236	Rong and Banyan Mountain #3A	Nanning (CN)	58.4	192	18	2017	concrete	residential
239	Beihai First City 1#	Beihai (CN)	57.3	188	18	2017		residential
240	Huashang International #11	Yulin (CN)	57.1	187	18	2018		residential
240	Huashang International #12	Yulin (CN)	57.1	187	18	2018		residential
240	Huashang International #17	Yulin (CN)	57.1	187	18	2018		residential
243	Nanxun #1	Liuzhou (CN)	56	184	18	2018	concrete	residential
243	Nanxun #18	Liuzhou (CN)	56	184	18	2019	concrete	residential
243	Nanxun #2	Liuzhou (CN)	56	184	18	2018	concrete	residential
246	Huangshan Mountain Village 8	Huangshan (CN)	51	167	12	2017	concrete	residential
247	Hong Kong Housing Authority Headquarters	Hong Kong (CN)	50.9	167	11	-		office
248	Longguang Royal Lake Sunshine 15	Nanning (CN)	47.6	156	14	2018		residential
248	Longguang Royal Lake Sunshine 18	Nanning (CN)	47.6	156	14	2018		residential
250	Huangshan Mountain Village 4	Huangshan (CN)	45	148	12	2017	concrete	residential

Regression Analysis for Year Fixed Effect

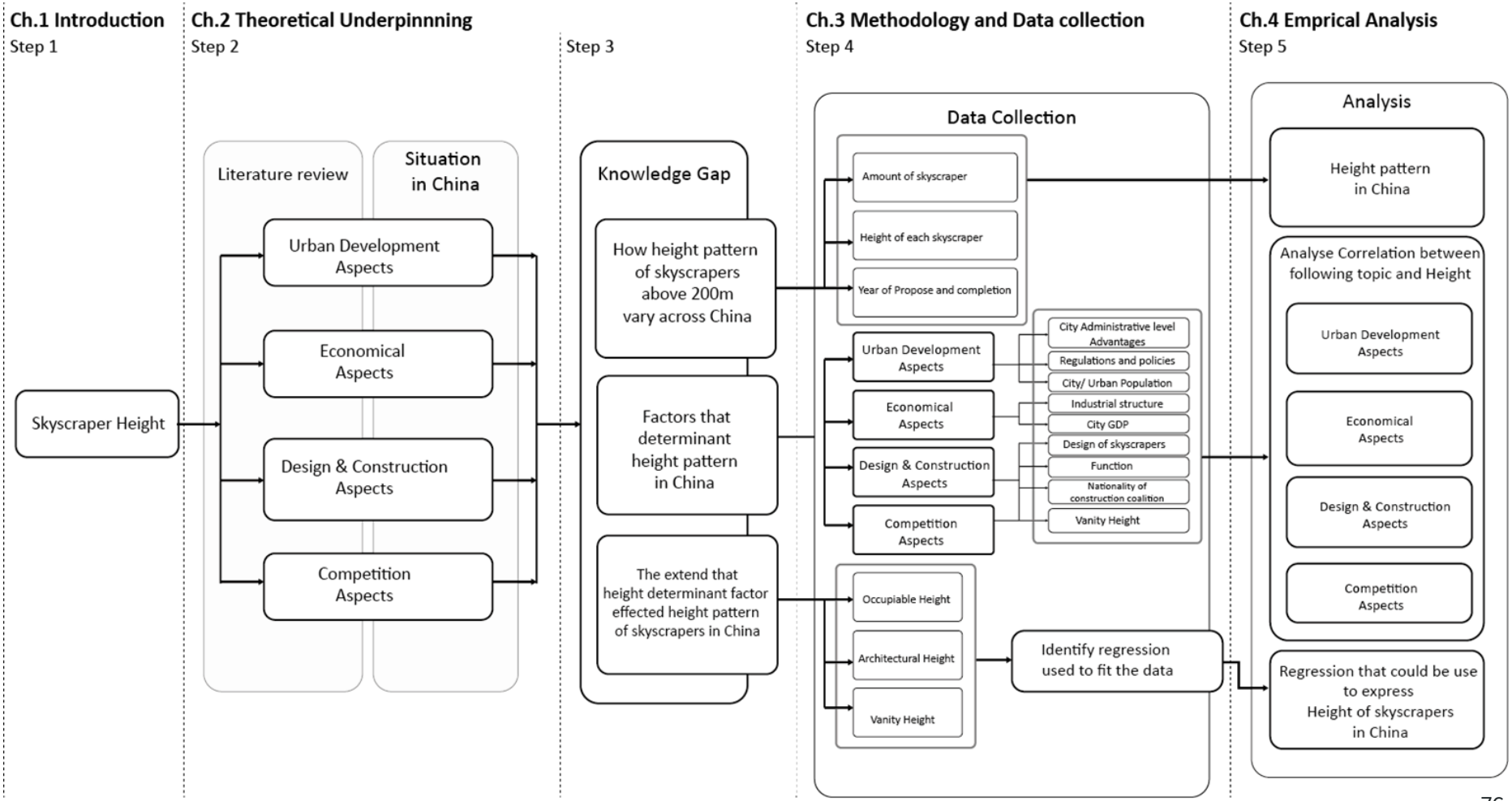
	Architectural height		Occupied height		Vanity Height	
	B	Sig.	B	Sig.	B	Sig.
(Constant)	240.017	.000	210.226	.000	29.791	.000
Completed 2011	8.742	.578	20.365	.150	-11.618	.037
Completed 2012	.893	.956	7.118	.623	-6.225	.277
Completed 2013	2.545	.855	16.487	.189	-13.941	.005
Completed 2014	-7.131	.572	8.469	.455	-15.847	.000
Completed 2015	8.865	.482	21.144	.062	-12.279	.006
Completed 2016	-2.318	.849	15.615	.153	-16.851	.000
Completed 2017	5.825	.626	22.321	.038	-16.497	.000
Completed 2018	15.691	.202	33.980	.002	-18.414	.000

Regression Analysis for Location Fixed Effect

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.361	.010		238.500	0.000
	City cluster pearl delta	.038	.012	.199	3.224	.001
	City cluster yangze	.020	.012	.103	1.653	.099
	City cluster beijing	.027	.015	.093	1.854	.064
	other	.007	.011	.044	.647	.518

a. Dependent Variable: logarchheight


Ch.1 Introduction
Step 1
Ch.2 Theoretical Underpinnning
Step 2
Step 3
Ch.3 Methodology and Data collection
Step 4
Ch.4 Emprical Analysis
Step 5
Skyscraper Height
Literature review
Situation in China
Urban Development Aspects
Economical Aspects
Design & Construction Aspects
Competition Aspects
Knowledge Gap
How height pattern of skyscrapers above 200m vary across China
Factors that determinant height pattern in China
The extend that height determinant factor effected height pattern of skyscrapers in China
Data Collection
Amount of skyscraper
Height of each skyscraper
Year of Propose and completion
Urban Development Aspects
Economical Aspects
Design & Construction Aspects
Competition Aspects
City Administrative level Advantages
Regulations and policies
City/ Urban Population
Industrial structure
City GDP
Design of skyscrapers
Function
Nationality of construction coalition
Vanity Height
Occupiable Height
Architectural Height
Vanity Height
Identify regression used to fit the data
Analysis
Height pattern in China
Analyse Correlation between following topic and Height
Urban Development Aspects
Economical Aspects
Design & Construction Aspects
Competition Aspects
Regression that could be use to express Height of skyscrapers in China