Identifying shopping centers with high operating loss risk and potential redevelopment opportunities

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Background

At present, number of shopping centers opened or to be opened in Shanghai will be as high as 419. For 2020, The area of shopping centers per person is 0.97m^2. Both count and area of malls are dramatically increasing since 2009. Considering the climbing vacancy from 2019 to recent, the retail market in Shanghai is oversupplied, which follows with the high operating loss risk and value mismatch of location and operation.

Fig1. Booming of shopping centers since 2009

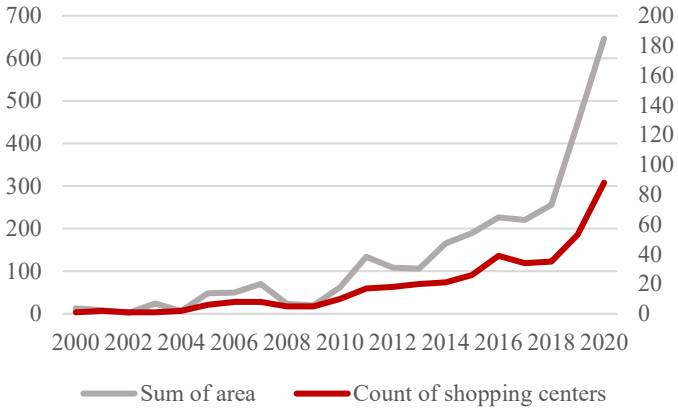
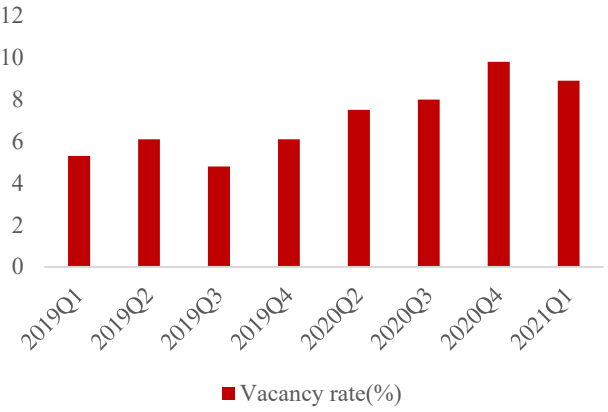


Fig2. Vacancy rate 2019Q1-2021Q1



Questions

1) Operating loss risk in an oversupplied market
2) Mismatch of operation value and location value

Since most of operation data is business secret, how can we quantify two questions above with accessible dataset and perhaps foresee the risk before construction?

Goals & Values

1) Finding out shopping centers with operating loss risk with gravity model and real estate finance formulas. The results are tested with social media data.2) Mismatch of operation value and location value.
2) Analyzing mismatch of operation and location value with entropy weight method and regression model

For the researcher, this paper explores a creative application of gravity model and fills a research gap in the area of quantifying operating loss risks. For the government, the quantified results can be considered as an influence factor before implementation of land use planning and urban regeneration.

Literature Review

Overbuilt is an urban issue that real estate supply beyond local demand. It's related with China's real estate dominated economic structure and may bring negative economic and social impacts. Wan Dong (2010) analyzes the behavior of local government and real estate development and believes real estate over-development does harm to social welfare and ring series of investment risks. J Li (2018) stated that over development has an inhibitory effect on private investment through vampire effect, raising

costs and reducing demand effect. In recent year, over development of residential market in China is validated by many researchers. There are variety methods to define the market stages. Mark Gallagher(1999) quantified the overbuilding risk with employment and space market index, which consider the vacancy rate. Robert M. Lillibridge(1952) came up with a function to estimate shopping center area income and population data, which gives an example of demand estimation using socioeconomical data. In 2019, MIT Civic Data Design Lab built a model to identify ghost cities (underused residential areas) using social media data. Noticeably, since there is not a standard definition of ghost city, this paper validate model based on subjective judgement. The article inspires the accuracy testing design of our research.

In conclusion, overbuilt brings negative economic and social risks. Current articles focus on the macro market analysis, but few deep into the risk brought the individual real estate asset. This paper fills the research gap of operating loss risk evaluation in an overbuilt cycle. Instead of using capital trading or the real business data, this project tries to build a calculation model with accessible open data, which is reproducible and practical.

Data

Table 1. Data resources and types

Categories	**Resources**	**Columns**	**Type**
Shopping centers	Wrangled from Yingshang.com	building_area	float
		rentable_area	float
		built_year	integer
	Baidu Map API	coordinate	geometry
Socioeconomics	Chinese socioeconomical year book (2020)	population	integer
		population density	float
		disposable_income	integer
		consumption expense	integer
Urban environment	Purchased from third party	road	geometry
		parks	geometry
		subway_station	geometry
		POIs	geometry
		building_outlines	geometry
Social Media	Dianping.com (March,2022)	number of comments	integer
		average consumption	integer

Methods

Step1: Use gravity model to estimate number of customers of each shopping mall

$$P_{ij} = \frac{W_j / D_{ij}^{\alpha}}{\sum_{i=1}^{n} \left(W_j / D_{ij}^{\alpha} \right)}$$

- Pij = the probability of consumer j shopping at store i.
- Wi = a measure of the attractiveness of each store or site i.
- Dij = the distance from consumer j to store or site i.

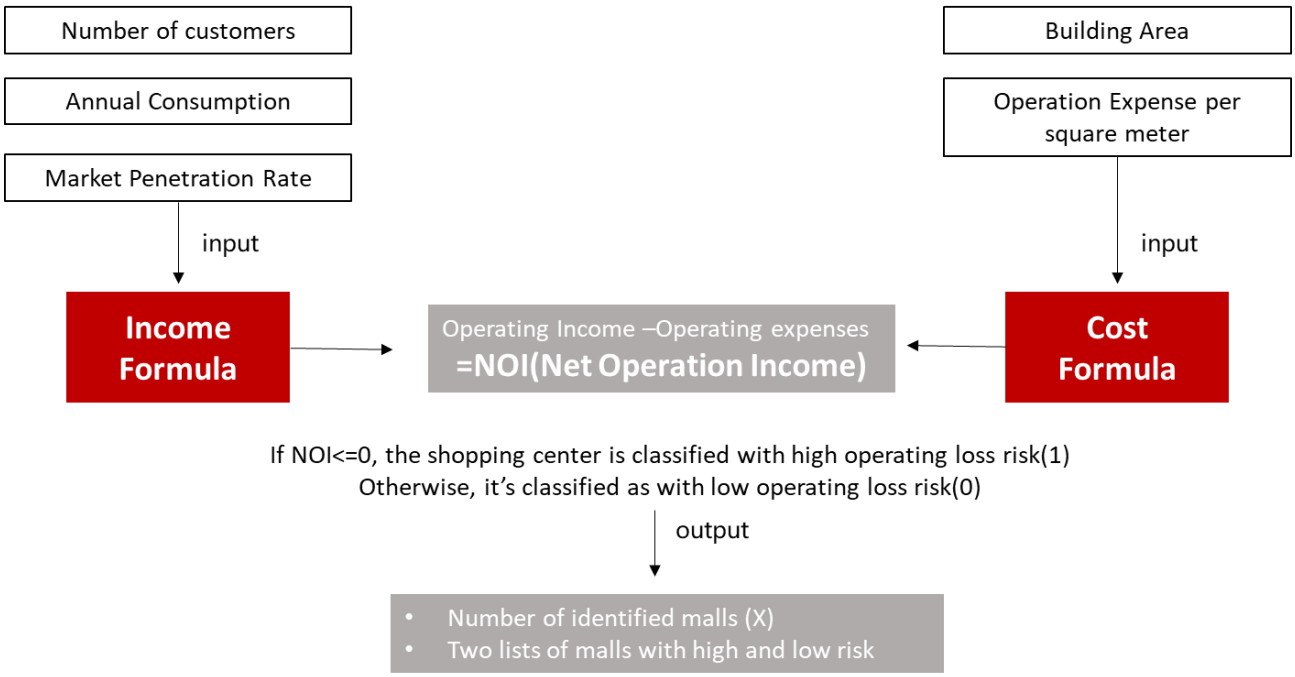
Step2: Calculate annual cost and income with real estate financial formulas

$$I=N*E*R$$

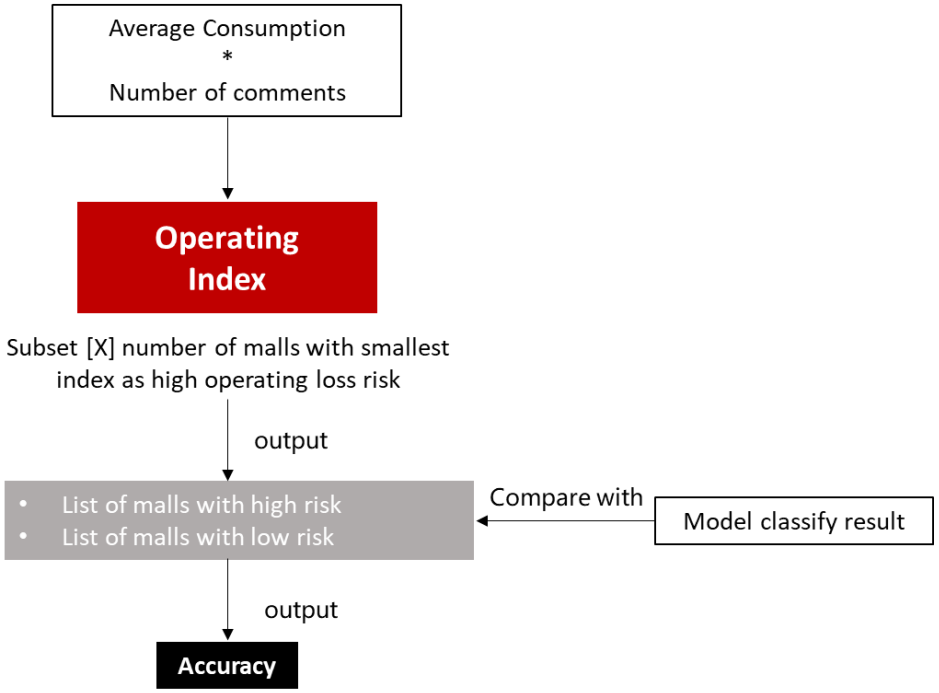
- N = count of customers in market area(based on gravity model matrix)
- E = average consumption expense
- R = market penetration rate

$$C_{min}=A*S$$

- A = rentable area
- S= minimum sales income per sqm to pay off the building and operation fees within 40 years mortgage(assuming 10,000 RMB/m^2/year)



Step3: Test the accuracy using actual operating data from social media



Results

- **Model result**

Table 2. Result of Step1: Estimate number of customers

ID	name	0	1	2	3	4	5	6	7	8	9	10
1	上海百联南方购物中心二区	41131.0529	93451.54	30145.45	86833.07	69597.13	44329.55	35117.67	50996.16	156087.7	259683	2437.993
2	上海中信泰富广场	9321.67953	22784.69	3625.271	17389.76	11742.48	5780.515	7228.44	7262.301	16787.34	65354.99	182.0093
3	上海陆悦坊	8020.88663	18104.16	6668.023	16084.03	13841.77	15676.16	8129.632	8739.151	18657.11	45147.23	256.9031
4	上海松江印象城	56509.9159	136024.4	21098	110800.4	73247.29	29328.41	41198.83	48182.88	125326.8	412312	693.2007
5	上海普陀绿地缤纷城	26853.962	62943.28	15763.91	52874.05	40124.86	27230.89	23021.56	26287.63	64786.22	171927	2199.994
7	上海爱琴海购物公园	126766.123	293380.2	80088.71	258456.6	198853.7	125102.4	106559.5	138052.8	381637.5	818001.8	9407.622
8	上海仲盛世界商城	186888.429	425421.1	124939.8	395867.3	310487.4	174883.9	155543	228437.3	713649.9	1199690	6524.853
9	上海百盛(淮海店)	17626.2748	40219.39	14216.97	36013.73	29663.29	26302.3	16108.63	20329.8	52531.98	106867.7	11095.31
10	上海万科2049城花	3367.83916	7865.244	1857.874	6812.765	5050.565	2783.239	2730.168	3472.738	9558.903	22382.7	133.2135
11	上海百联世纪购物中心	48226.5388	108678.9	44874.19	98585.52	85315.29	99394.03	47345.36	56887.44	134195	277566.7	4565.827
13	上海崧泽华城生活汇	12247.4477	29976.68	4306.023	23255.61	15108.51	6254.541	8920.596	9590.934	23469.79	90384.32	157.8735
14	上海久金广场	39410.9771	89359.27	30225.53	78214.48	66290.71	69737.78	39808.8	41114.26	85858.42	222362.5	1051.508
16	上海君欣时代广场	24437.3132	56414.27	16674.39	48110.39	38654.33	33707.21	22821.41	24591.33	55513.2	146328.2	1396.854
17	上海港城新天地	431923.733	3452074	7027.356	303460.4	72423.68	8963.074	83887.6	28649.94	39833.35	22026944	61.04104
18	上海ist艾尚天地	15390.0608	35477.4	10922.41	30643.66	24647.51	21185.42	14121.87	16111.18	38306.21	93341.1	1716.176
19	上海汇宝购物广场	15167.0974	35257.23	8836.624	30864.71	23229.94	13324.41	12448.75	16104.72	44835.24	99685.77	710.234
20	上海前滩太古里	101542.424	223926.3	127465.4	221115	201148.2	218089.8	96883.96	154043.5	478423.4	589036.8	19764.76

Note: Columns represent each neighborhood, row index is the ID of each shopping center

Table 3. Result of Step2: Identify shopping centers with high operating loss risk

ID	name	prediction	area	grading	year	penatration	income	cost	income-cost
1	上海百联南方购物中心二区	0	6.4	4.5	1	0.3375	4209595.59	384000000	-379790404.4
2	上海中信泰富广场	0	3.45	4.7	1	0.4125	3481007	207000000	-203518993
3	上海陆悦坊	0	1	4.3	2	0.2625	490085.549	60000000	-59509914.45
4	上海松江印象城	0	15.5	4.5	1	0.3375	16968029.9	930000000	-913031970.1
5	上海普陀绿地缤纷城	0	5.7	3.9	1	0.1875	1917141.58	342000000	-340082858.4
7	上海爱琴海购物公园	0	24	4.7	2	0.4125	21996996.1	1440000000	-1418003004
8	上海仲盛世界商城	0	29.2	4.6	2	0.3375	20861091.9	1752000000	-1731138908
9	上海百盛(淮海店)	0	2.8	4.5	2	0.3375	1569833.78	168000000	-166430166.2
10	上海万科2049城花	0	0.7	3.6	1	0.1875	277961.539	42000000	-41722038.46
11	上海百联世纪购物中心	0	6.4	4.7	1	0.4125	4779621.08	384000000	-379220378.9
13	上海崧泽华城生活汇	1	4.5	3.6	1	0.1875	2370307.18	270000000	-267629692.8
14	上海久金广场	0	5	3.8	1	0.1875	1847495.43	300000000	-298152504.6
16	上海君欣时代广场	0	4	4.1	3	0.2625	1927854.3	240000000	-238072145.7
17	上海港城新天地	0	5	4	3	0.2625	8158276.95	300000000	-291841723.1
18	上海ist艾尚天地	0	2.6	4	14	0.2625	1199008.51	156000000	-154800991.5
19	上海汇宝购物广场	0	3	3.9	13	0.1875	1169600.1	180000000	-178830399.9
20	上海前滩太古里	0	12	4.7	1	0.4125	9243534.75	720000000	-710756465.2

· **Result Exploration**

Fig 4. Characteristic of identified malls with high loss risk (red point)

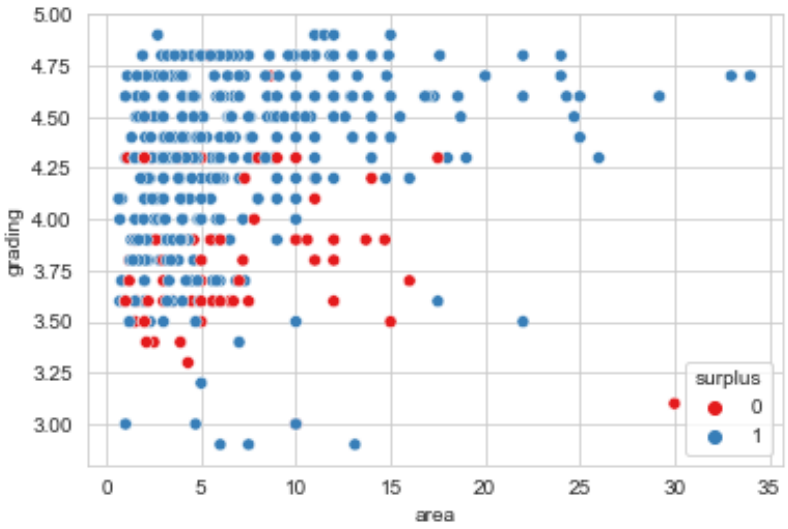
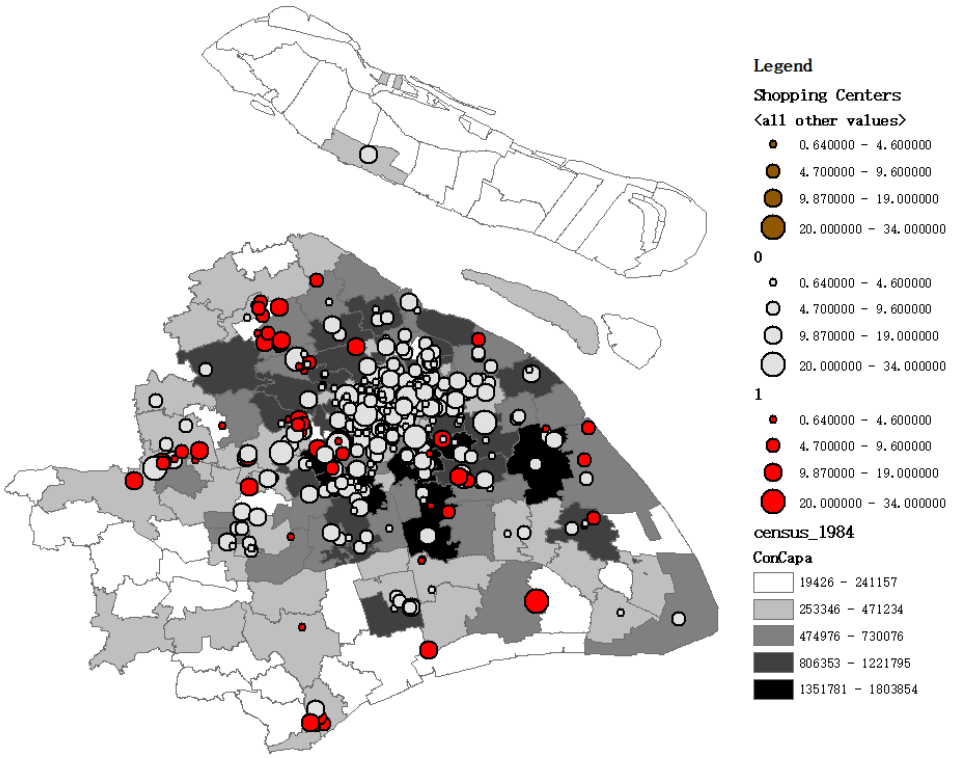


Fig 5. Spatial distribution of malls (red point for high loss risk)



With current model, 68 out of 419 shopping centers are identified as surplus property which accounts for 15% of total area. Seeing from the Fig 4. low graded and median-scale malls are identified.

From the perspective of spatial distribution, most of surplus malls locate at suburban area where the total consumption capacity is small.Some surplus malls located at urban center periphery where the market is competitive.

Validation

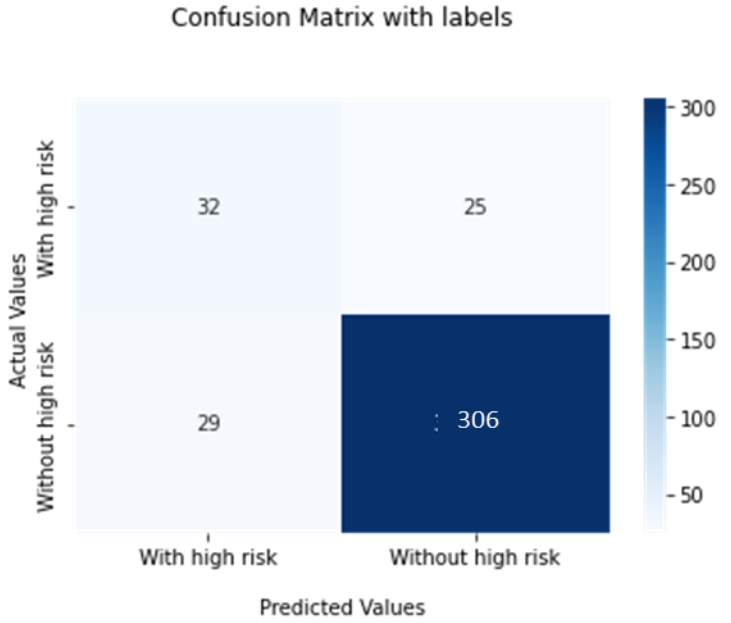


Table 5. Accuracy of different classes

Class	Accuracy
Overall	86.22%
High operating loss risk	56.14%
Low operating loss risk	91.34%

The model identified 57 shopping centers with high risk out of almost 400, which accounts for 15 percent. Seeing from the confusion matrix, the overall accuracy is 86%. Since input data is before 2020 and accuracy test data is up to data. It seems that the model could predict loss risk before the construction of a new project. However, it has limited accuracy to identify shopping centers with high loss risk.

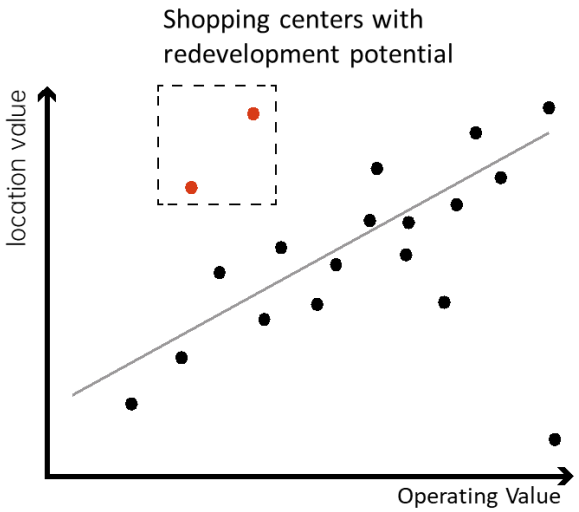
Next Steps

1) Model improvement

Consider location effects in gravity model by Wi adjustment and compare the accuracy of different models

2) Identify shopping centers with redevelopment potential

Try Entropy weight method to quantify location value. Run a regression model to identify outliers with high location value but low operating value(high risk of operating loss).



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