November 17, 2019

Assignment 3. Employment Trends & Projections

1a. 1b.

Table 1: total employment by industry sector in Northern-Liberties, Philadelphia County and USA, 2005 and 2015

		ZC 19123, 2005	ZC 19123, 2015	Philadelphia, 2005	Philadelphia, 2015	USA, 2005	USA, 2015
All	**Total for all sectors**	**12,508**	**11,289**	**538,638**	**542,000**	**116,317,003**	**124,085,947**
11	Forestry, fishing, hunting, and agriculture support	0	0	30	17	168,744	160,144
21	Mining, quarrying, and oil and gas extraction	0	0	0	37	497,272	743,660
22	Utilities	0	0	1,232	1,676	633,106	639,234
23	Construction	238	278	13,251	12,482	6,781,327	6,008,286
31	Manufacturing	1,674	425	38,601	23,435	13,667,337	11,605,501
42	Wholesale trade	672	388	22,718	18,164	5,968,929	6,076,109
44	Retail trade	558	763	59,359	59,468	15,338,672	15,704,167
48	Transportation and warehousing	351	197	15,585	18,510	4,168,016	4,616,568
51	Information	283	253	16,784	15,026	3,402,599	3,394,317
52	Finance and insurance	252	141	41,156	30,454	6,431,837	6,135,914
53	Real estate and rental and leasing	144	214	11,386	12,154	2,144,077	2,065,427
54	Professional, scientific, and technical services	358	1,229	53,961	53,172	7,689,366	8,798,260
55	Management of companies and enterprises	47	1,118	12,365	13,588	2,856,418	3,308,759
56	Administrative and Support and Waste Mang and Remediation Srvs	984	239	26,701	26,957	9,280,282	11,112,465
61	Educational services	660	531	28,242	34,067	2,879,374	3,642,170
62	Health care and social assistance	3,989	2,667	102,100	113,789	16,025,147	19,221,864
71	Arts, entertainment, and recreation	251	416	10,966	15,326	1,936,484	2,230,822
72	Accommodation and food services	1,217	1,584	51,630	63,117	11,025,909	13,196,892

| 81 | Other services (except public administration) | 832 | 845 | 32,440 | 30,386 | 5,390,954 | 5,401,233 |
| 99 | Unclassified | 3 | 5 | 136 | 179 | 31,153 | 24,155 |

Note: 2005 and 2015 employment data from the *County Business Patterns* website

Based on the *County Business Patterns* establishment and employment information, we used the "midpoint" method to calculate total employment by 2-digit NAICS code sector in Northern Liberties (represented by zip code zone 19123), Philadelphia County and USA for 2005 and 2015.

Table 2: trend of employment by industry sector in Northern-Liberties, Philadelphia County and USA, 2005 to 2015

	percentage in terms of total 19123 employment, 2005	percentage in terms of total 19123 employment, 2015	percentage in terms of total Philadelphia County employment, 2005	percentage in terms of total Philadelphia County employment, 2015	19123 employment, 2005-2015	Philadelphia County employment, 2005-2015	US employment, 2005-2015
Total for all sectors	**1.00**	**1.00**	**1.00**	**1.00**	**-0.10**	**0.01**	**0.07**
Forestry, fishing, hunting, and agriculture support	0.00	0.00	0.00	0.00	NA	-0.42	-0.05
Mining, quarrying, and oil and gas extraction	0.00	0.00	0.00	0.00	NA	NA	0.50
Utilities	0.00	0.00	0.00	0.00	NA	0.36	0.01
Construction	0.02	0.02	0.02	0.02	0.17	-0.06	-0.11
Manufacturing	0.13	0.04	0.07	0.04	-0.75	-0.39	-0.15
Wholesale trade	0.05	0.03	0.04	0.03	-0.42	-0.20	0.02
Retail trade	0.04	0.07	0.11	0.11	0.37	0.00	0.02
Transportation and warehousing	0.03	0.02	0.03	0.03	-0.44	0.19	0.11
Information	0.02	0.02	0.03	0.03	-0.11	-0.10	0.00
Finance and insurance	0.02	0.01	0.08	0.06	-0.44	-0.26	-0.05

Industry							
Real estate and rental and leasing	0.01	0.02	0.02	0.02	0.49	0.07	-0.04
Professional, scientific, and technical services	0.03	0.11	0.10	0.10	2.44	-0.01	0.14
Management of companies and enterprises	0.00	0.10	0.02	0.03	23.03	0.10	0.16
Administrative and Support and Waste Mang and Remediation Srvs	0.08	0.02	0.05	0.05	-0.76	0.01	0.20
Educational services	0.05	0.05	0.05	0.06	-0.19	0.21	0.26
Health care and social assistance	0.32	0.24	0.19	0.21	-0.33	0.11	0.20
Arts, entertainment, and recreation	0.02	0.04	0.02	0.03	0.66	0.40	0.15
Accommodation and food services	0.10	0.14	0.10	0.12	0.30	0.22	0.20
Other services (except public administration)	0.07	0.07	0.06	0.06	0.02	-0.06	0.00
Unclassified	0.00	0.00	0.00	0.00	1.00	0.32	-0.22

Note: 2005 and 2015 employment data from the *County Business Patterns* website

From table 2, we can see that from 2005 to 2015, in Northern Liberties neighborhood (ZC 19123) there was a significant increase of jobs in Professional, scientific & technical services, Management of companies & enterprises and Arts, entertainment & recreation, while Manufacturing and Administrative & Support & Waste Managements & Remediation Services industries declined substantially. In other words, this area transformed from a manufacturing district to a third-industry-oriented district featuring professional services. Such employment change is in accordance with the conclusion we summarized from HW1 analysis: Northern Liberties neighborhood experienced a gentrification process in the 2000-2010s.

1c.

Table 3: employment location quotients by industry sector between Northern-Liberties, Philadelphia County and USA, 2005 and 2015

	2005 19123 vs. Philadelphia	2015 19123 vs. Philadelphia	2005 19123 vs. USA	2015 19123 vs. USA	2005 Philadelphia vs. USA	2015 Philadelphia vs. USA
Total for all sectors	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Forestry, fishing, hunting, and agriculture support	0.00	0.00	0.00	0.00	0.04	0.02
Mining, quarrying, and oil and gas extraction	NA	0.00	0.00	0.00	0.00	0.01
Utilities	0.00	0.00	0.00	0.00	0.42	0.60
Construction	0.77	1.07	0.33	0.51	0.42	0.48
Manufacturing	1.87	0.87	1.14	0.40	0.61	0.46
Wholesale trade	1.27	1.03	1.05	0.70	0.82	0.68
Retail trade	0.40	0.62	0.34	0.53	0.84	0.87
Transportation and warehousing	0.97	0.51	0.78	0.47	0.81	0.92
Information	0.73	0.81	0.77	0.82	1.07	1.01
Finance and insurance	0.26	0.22	0.36	0.25	1.38	1.14
Real estate and rental and leasing	0.54	0.85	0.62	1.14	1.15	1.35
Professional, scientific, and technical services	0.29	1.11	0.43	1.53	1.52	1.38
Management of companies and enterprises	0.16	3.95	0.15	3.71	0.93	0.94
Administrative and Support and Waste Mang and Remediation Srvs	1.59	0.42	0.99	0.24	0.62	0.56

Educational services	1.01	0.75	2.13	1.60	2.12	2.14
Health care and social assistance	1.68	1.13	2.31	1.53	1.38	1.36
Arts, entertainment, and recreation	0.98	1.30	1.20	2.05	1.22	1.57
Accommodation and food services	1.02	1.20	1.03	1.32	1.01	1.09
Other services (except public administration)	1.10	1.33	1.43	1.72	1.30	1.29
Unclassified	0.79	1.34	0.75	2.28	0.94	1.70

Note: 2005 and 2015 employment data from the *County Business Patterns* website

We considered three main indicators of local competitive advantage to decide the base industries in Northern Liberties (ZC 19123) and in Philadelphia County:
1. Location quotient (lq) > 1.5
2. High share of local economic activity(employment) and lq > 1.
3. Theory

From table 2 and table 3, we distinguish the following basic industries in Northern Liberties (ZC 19123), 2005:
1*Manufacturing* (high lq compared to Philadelphia County, relatively high lq compared to US, high share of total employment)
2*Wholesale trade* (relatively high lq compared to Philadelphia County and to US, relatively high share of total employment)
3*Administrative and Support and Waste Management and Remediation Services* (high lq compared to Philadelphia County, relatively high share of total employment)
4Educational services (relatively high lq compared to Philadelphia County, high lq compared to US, relatively high share of total employment)
5Health care and social assistance (high lq compared to Philadelphia County and to US, high share of total employment)
6Accommodation and food services (relatively high lq compared to Philadelphia County and to US, high share of total employment)
7Other services (except public administration) (relatively high lq compared to Philadelphia County and to US, relatively high share of total employment)

we distinguish the following basic industries in Northern Liberties (ZC 19123), 2015:
1*Professional, scientific, and technical services* (relatively high lq compared to Philadelphia County, high lq compared to US, high share of total employment)
2*Management of companies and enterprises* (high lq compared to Philadelphia County and to US, high share of total employment)

3*Arts, entertainment, and recreation* (relatively high lq compared to Philadelphia County, high lq compared to US)

4Educational services (relatively high lq compared to Philadelphia County, high lq compared to US, relatively high share of total employment)

5Health care and social assistance (relatively high lq compared to Philadelphia County, high lq compared to US, high share of total employment)

6Accommodation and food services (relatively high lq compared to Philadelphia County and to US, high share of total employment)

7Other services (except public administration) (relatively high lq compared to Philadelphia County, high lq compared to US, relatively high share of total employment)

we distinguish the following basic industries in Philadelphia County, 2005:

1Finance and insurance (relatively high lq compared to US, relatively high share of total employment)

2Professional, scientific, and technical services (high lq compared to US, high share of total employment)

3Educational services (high lq compared to US, relatively high share of total employment)

4Health care and social assistance (relatively high lq compared to US, high share of total employment)

5Accommodation and food services (relatively high lq compared to US, high share of total employment)

6Other services (except public administration) (relatively high lq compared to US, relatively high share of total employment)

we distinguish the same basic industries in Philadelphia County, 2015 as in 2005.

The employment multipliers are as follows:

Table 4: employment multipliers for Northern-Liberties and Philadelphia County, 2005 and 2015

	Northern-Liberties (ZC19123)	Philadelphia County
2005	0.801566997	0.574648999
2015	0.742979892	0.599599262

Note: 2005 and 2015 employment data from the *County Business Patterns* website

As can been seen from table 3 and 4, compared to Philadelphia county as a whole, Northern Liberties neighborhood experienced more significant change in terms of base industries from 2005 to 2015, as well as featured a higher employment multiplier in both years. Philadelphia county's employment constitution remained stable in this decade, where base industries including Educational services, Health care & social assistance, Accommodation & food services, Other services (except public administration) provided nearly 60% of total employment. Northern liberties as a

neighborhood also featured the 4 main industries as the entire county, yet had some local specialization in different years (Manufacturing and Administrative & Support & Waste Management & Remediation Services in 2005, Management of companies & enterprises and Arts, entertainment & recreation in 2015). This neighborhood also relied heavily on its base industries, but the decreasing employment multiplier suggested such reliance is declining.

2a.

We used the annual data from *County Business Patterns* and the *Bureau of Labor Statistics* to develop 6 separate employment projections for Philadelphia County in 2025:

i.   total trend model

Table 5: total trend model for Philadelphia County, 2025

	Employment
2005	538637.5
2015	541999.5
2025 projection	545382.5

Note: 2005 and 2015 employment data from the *County Business Patterns* website

ii.   step-share model (compared to the U.S)

Table 6: step-share model for Philadelphia County (compared to the U.S), 2025

	STEP DOWN FROM: US Employment	STEP DOWN TO: Philadelphia County Employment	STEP DOWN RATIO: Philadelphia County Employment / USA Employment	Philadelphia County Employment Change / USA Employment Change	MULTIPLIER	PROJECTION
2005	116,317,003	538,638	0.5%			
2015	124,085,947	542,000	0.4%	0.0%		
2025 projection	163,955,550				recent constant share	716,147
					recent growth share	559,253

Note: 2005 and 2015 employment data from the *County Business Patterns* website, 2025 US employment projection from *Bureau of Labor Statistics* website

iii.   Population-based model

Table 7: population-based model for Philadelphia County, 2025

	Employment	Population
2015	541999.5	1,553,517
2025 projection	557423.5	1597726

iv. shift-share model (assuming a continuation of current economic growth, proportional shift, and differential shift factors)

Table 8: shift-share model (status quo) for Philadelphia County, 2025

		Philadelphia County Employment, 2015	Macro, or Economic Growth Factor	Industry mix, or Proportional Shift Factor	Local Competitiveness, or Differential Shift Factor	EGF+PSF+DSF	Philadelphia County Employment, 2025
All	**Total for all sectors**	**542,000**					**564,487**
11	Forestry, fishing, hunting, and agriculture support	17	0.07	-0.12	-0.37	-0.42	10
21	Mining, quarrying, and oil and gas extraction	38	0.07	0.43	36.50	37.00	1,444
23	Construction	1,676	0.07	-0.06	0.35	0.36	2,279
22	Utilities	12,482	0.07	-0.18	0.06	-0.06	11,758
31	Manufacturing	23,435	0.07	-0.22	-0.24	-0.39	14,228
42	Wholesale trade	18,164	0.07	-0.05	-0.22	-0.20	14,522
44	Retail trade	59,468	0.07	-0.04	-0.02	0.00	59,578
48	Transportation and warehousing	18,510	0.07	0.04	0.08	0.19	21,984
51	Information	15,026	0.07	-0.07	-0.10	-0.10	13,453
52	Finance and insurance	30,454	0.07	-0.11	-0.21	-0.26	22,534
53	Real estate and rental and leasing	12,154	0.07	-0.10	0.10	0.07	12,973
54	Professional, scientific, and technical services	53,172	0.07	0.08	-0.16	-0.01	52,394
55	Management of companies and enterprises	13,588	0.07	0.09	-0.06	0.10	14,933
56	Administrative and Support and Waste Mang and Remediation Srvs	26,957	0.07	0.13	-0.19	0.01	27,215
61	Educational services	34,067	0.07	0.20	-0.06	0.21	41,092
62	Health care and social assistance	113,789	0.07	0.13	-0.08	0.11	126,816
71	Arts, entertainment, and recreation	15,326	0.07	0.09	0.25	0.40	21,420
72	Accommodation and food services	63,117	0.07	0.13	0.03	0.22	77,158

81	Other services (except public administration)	30,386	0.07	-0.06	-0.07	-0.06	28,462
99	Unclassified	179	0.07	-0.29	0.54	0.32	236

Note: 2005 and 2015 employment data from the *County Business Patterns* website

v. shift-share model (assuming that the national economic growth and industry mix proportional shift factors are half their 2005 to 2015 values, but the local competitive differential shift factor remains the same)

Table 9: shift-share model (scenario one) for Philadelphia County, 2025

		Philadelphia County Employment, 2015	**Macro, or Economic Growth Factor**	**Industry mix, or Proportional Shift Factor**	Local Competitiveness, or Differential Shift Factor	**EGF+PSF+DSF**	**Philadelphia County Employment, 2025**
All	**Total for all sectors**	**542,000**					**535,204**
11	Forestry, fishing, hunting, and agriculture support	17	0.03	-0.06	-0.37	-0.40	10
21	Mining, quarrying, and oil and gas extraction	38	0.03	0.21	36.50	36.75	1,435
23	Construction	1,676	0.03	-0.03	0.35	0.36	2,271
22	Utilities	12,482	0.03	-0.09	0.06	0.00	12,470
31	Manufacturing	23,435	0.03	-0.11	-0.24	-0.32	15,995
42	Wholesale trade	18,164	0.03	-0.02	-0.22	-0.21	14,359
44	Retail trade	59,468	0.03	-0.02	-0.02	-0.01	58,869
48	Transportation and warehousing	18,510	0.03	0.02	0.08	0.13	20,988
51	Information	15,026	0.03	-0.03	-0.10	-0.10	13,471
52	Finance and insurance	30,454	0.03	-0.06	-0.21	-0.24	23,235
53	Real estate and rental and leasing	12,154	0.03	-0.05	0.10	0.09	13,196
54	Professional, scientific, and technical services	53,172	0.03	0.04	-0.16	-0.09	48,560
55	Management of companies and enterprises	13,588	0.03	0.05	-0.06	0.02	13,857
56	Administrative and Support and Waste Mang and Remediation Srvs	26,957	0.03	0.07	-0.19	-0.09	24,554
61	Educational services	34,067	0.03	0.10	-0.06	0.07	36,580
62	Health care and social	113,789	0.03	0.07	-0.08	0.01	115,467

	assistance					
71	Arts, entertainment, and recreation	15,326	0.03	0.04	0.25	0.32	20,255
72	Accommodation and food services	63,117	0.03	0.07	0.03	0.12	70,945
81	Other services (except public administration)	30,386	0.03	-0.03	-0.07	-0.06	28,433
99	Unclassified	179	0.03	-0.15	0.54	0.43	256

Note: 2005 and 2015 employment data from the *County Business Patterns* website

vi. shift-share model (assuming that the national economic growth and industry mix proportional shift factors are the same as their 2005 to 2015 values, but the local competitive differential shift factor = 0)

Table 10: shift-share model (scenario two) for Philadelphia County, 2025

		Philadelphia County Employment, 2015	Macro, or Economic Growth Factor	Industry mix, or Proportional Shift Factor	**Local Competitiveness, or Differential Shift Factor**	EGF+PSF+DSF	Philadelphia County Employment, 2025
All	**Total for all sectors**	**542,000**					**600,568**
11	Forestry, fishing, hunting, and agriculture support	17	0.07	-0.12	0.00	-0.05	16
21	Mining, quarrying, and oil and gas extraction	38	0.07	0.43	0.00	0.50	57
23	Construction	1,676	0.07	-0.06	0.00	0.01	1,692
22	Utilities	12,482	0.07	-0.18	0.00	-0.11	11,059
31	Manufacturing	23,435	0.07	-0.22	0.00	-0.15	19,900
42	Wholesale trade	18,164	0.07	-0.05	0.00	0.02	18,490
44	Retail trade	59,468	0.07	-0.04	0.00	0.02	60,885
48	Transportation and warehousing	18,510	0.07	0.04	0.00	0.11	20,502
51	Information	15,026	0.07	-0.07	0.00	0.00	14,989
52	Finance and insurance	30,454	0.07	-0.11	0.00	-0.05	29,052
53	Real estate and rental and leasing	12,154	0.07	-0.10	0.00	-0.04	11,708
54	Professional, scientific, and technical services	53,172	0.07	0.08	0.00	0.14	60,839
55	Management of companies and enterprises	13,588	0.07	0.09	0.00	0.16	15,740
56	Administrative and Support and Waste Mang and Remediation Srvs	26,957	0.07	0.13	0.00	0.20	32,278

61	Educational services	34,067	0.07	0.20	0.00	0.26	43,091
62	Health care and social assistance	113,789	0.07	0.13	0.00	0.20	136,488
71	Arts, entertainment, and recreation	15,326	0.07	0.09	0.00	0.15	17,655
72	Accommodation and food services	63,117	0.07	0.13	0.00	0.20	75,544
81	Other services (except public administration)	30,386	0.07	-0.06	0.00	0.00	30,443
99	Unclassified	179	0.07	-0.29	0.00	-0.22	139

Note: 2005 and 2015 employment data from the *County Business Patterns* website

2b.

Despite different methodologies and assumptions, most models generated similar 2025 Philadelphia county employment projection results (shown as red in the above tables). We decided that model iv is a preferred forecast. The reasons are as follows:

A. It reflects the "industry cycle" theory. Compared to the simple total trend model, it considers the growth tendency of each industry sector in nation and in local on top of the general economic growth trend.

B. It is an independent employment projection theory. Compared to the step-share model and population-based model, it does not rely on previous projection results such as population projection or macro projection, as well as the assumptions of a constant relationship between parent and child projections.

C. It is in accordance with the current developing trend of Philadelphia county. As analyzed in HW2, Philadelphia county has entered an era of changes since 2000s, thus the economic growth, proportional shift, and differential shift factors will continue to influence local economy and employment. It is wise to assume that the growth and shift factors will remain status quo as their 2005-2015 values, and it is hard to imagine that the economic growth and industry mix will slow down, or the local competitiveness will disappear in the next decade. Besides, this model result is in line with 2 additional model that we found useful, i.e. the 2005 to 2015 Growth Share Step-Down model and the population-based model.

3.

Using data on the number and type of jobs in each zip code in Pennsylvania in 2005, we predicted the jobs in each zip code in Pennsylvania in 2015 by regression (model 1). We then further examined which types of jobs are statistically correlated with more or fewer jobs in 2015 (model 2 and 3). The results of the 3 models are listed as follows using stargazer.[1]

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[1] Hlavac, Marek (2018). stargazer: Well-Formatted Regression and Summary Statistics Tables. R package version 5.2.2. https://CRAN.R-project.org/package=stargazer

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=================================================================================
                                    Dependent variable:
                        ----------------------------------------------
                              jobs_plus10          jobs_plus10 - jobs.tot
                            (1)          (2)               (3)
---------------------------------------------------------------------------------

jobs.23                  1.577***     0.577***          0.577***
                         (0.119)      (0.119)           (0.119)


jobs.31                  0.966***     -0.034            -0.034
                         (0.042)      (0.042)           (0.042)


jobs.42                  1.285***     0.285**           0.285**
                         (0.120)      (0.120)           (0.120)


jobs.44                  0.954***     -0.046            -0.046
                         (0.060)      (0.060)           (0.060)


jobs.48                  0.862***     -0.138            -0.138
                         (0.087)      (0.087)           (0.087)


jobs.51                  1.097***     0.097             0.097
                         (0.147)      (0.147)           (0.147)


jobs.52                  0.913***     -0.087            -0.087
                         (0.068)      (0.068)           (0.068)


jobs.53                  1.883***     0.883***          0.883***
                         (0.324)      (0.324)           (0.324)


jobs.54                  1.406***     0.406***          0.406***
                         (0.062)      (0.062)           (0.062)


jobs.56                  0.157*       -0.843***         -0.843***
                         (0.091)      (0.091)           (0.091)


jobs.61                  1.325***     0.325***          0.325***
                         (0.115)      (0.115)           (0.115)


jobs.62                  0.839***     -0.161***         -0.161***
                         (0.044)      (0.044)           (0.044)


jobs.71                  0.559**      -0.441*           -0.441*
                         (0.236)      (0.236)           (0.236)
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jobs.72	1.463***	0.463***	0.463***
	(0.112)	(0.112)	(0.112)
jobs.81	0.311	-0.689***	-0.689***
	(0.196)	(0.196)	(0.196)
jobs.99	26.865***	25.865***	25.865***
	(8.834)	(8.834)	(8.834)
jobs.21	1.134***	0.134	0.134
	(0.421)	(0.421)	(0.421)
jobs.11	3.887	2.887	2.887
	(2.460)	(2.460)	(2.460)
jobs.22	0.527**	-0.473*	-0.473*
	(0.245)	(0.245)	(0.245)
jobs.55	0.966***	-0.034	-0.034
	(0.112)	(0.112)	(0.112)
Constant	22.903	22.903	22.903
	(25.674)	(25.674)	(25.674)

Observations	2,075	2,075	2,075
R2	0.973	0.973	0.105
Adjusted R2	0.972	0.972	0.097
Residual Std. Error (df = 2054)	1,004.483	1,004.483	1,004.483
F Statistic (df = 20; 2054)	3,634.245***	3,634.245***	12.076***

Note: $p<0.1$; $**p<0.05$; $***p<0.01$

The regression results indicate that the number of jobs by industry in 2005 can explain more than 97.2% of the variation in the total jobs in 2015 (model 1 and 2). However, the job type composition only claims to explain 9.7% (model 3). In other words, most explanation power of model 1 comes from the total job number in 2005, since zip zones with many jobs in 2005 are likely to have more jobs in 2015.

Still, in the Pennsylvania zip code zones, seven independent variables (job types) are significantly related more jobs in 2015 (correlation parameters are statistically different from 1 in model 1, or from 0 in model 2 and 3):
1 Construction (jobs.23): each 1% increase leads to 0.577% increase in total jobs.

2 Wholesale trade (jobs.42): each 1% increase leads to 0.285% increase in total jobs.
3 Real estate and rental and leasing (jobs.62): each 1% increase leads to 0.161% increase in total jobs.
4 Professional, scientific, and technical services (jobs.54): each 1% increase leads to 0.406% increase in total jobs.
5 Educational services (jobs.61): each 1% increase leads to 0.325% increase in total jobs.
6 Accommodation and food services (jobs.72): each 1% increase leads to 0.463% increase in total jobs.
7 Unclassified (jobs.99): each 1% increase leads to 25.865% increase in total jobs.

On the other hand, five independent variables (job types) are significantly related less jobs in 2015:
1 Administrative and Support and Waste Management and Remediation Services (jobs.56): each 1% increase leads to 0.843% decrease in total jobs.
2 Health care and social assistance (jobs.62): each 1% increase leads to 0.161% decrease in total jobs.
3 Arts, entertainment, and recreation (jobs.71): each 1% increase leads to 0.441% decrease in total jobs.
4 Other services (except public administration) (jobs.81): each 1% increase leads to -0.689% decrease in total jobs.
5 Utilities (jobs.22): each 1% increase leads to 0.473% decrease in total jobs.

The residual plots of both kinds of regressions look a bit homoscedastic.
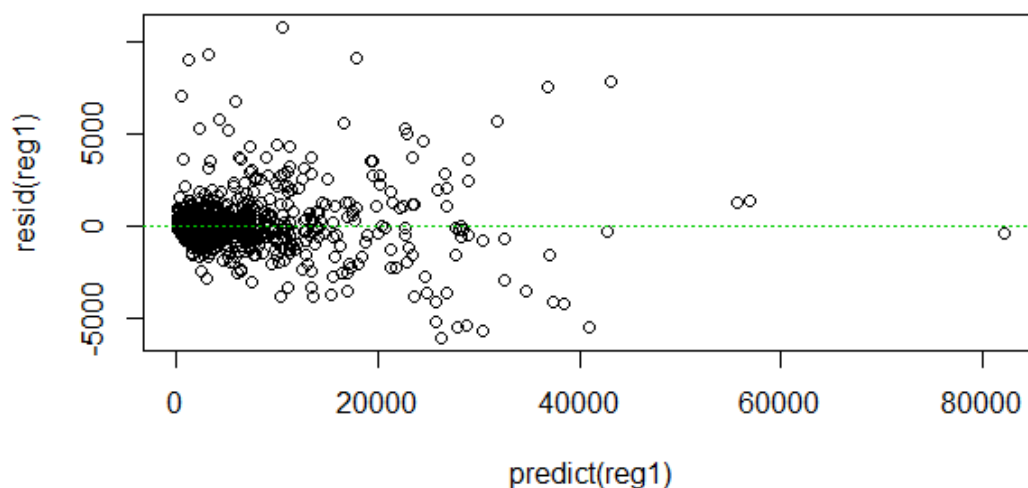

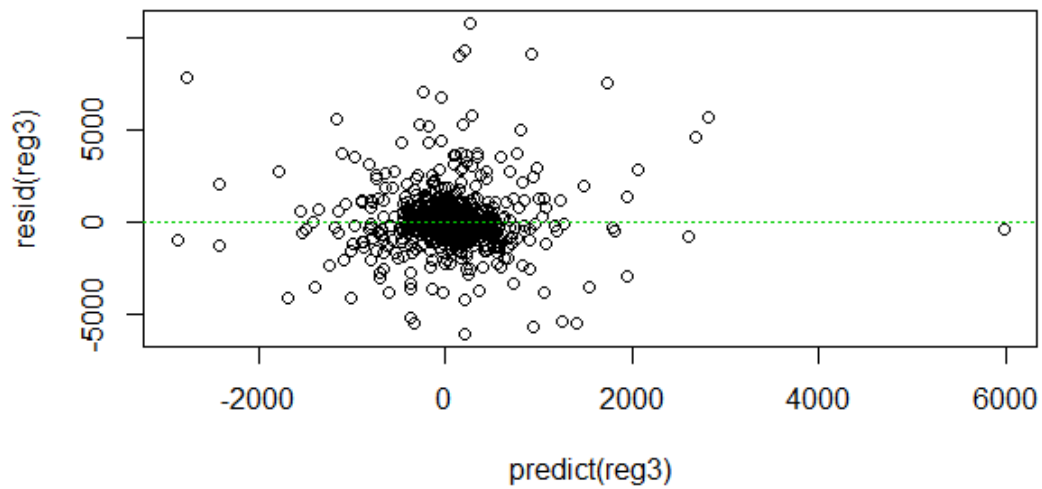**Figure 1:** Error in the job prediction model

Figure 2: Error in the job change prediction model

We repeated the same process for the subset of zip codes between 19019 and 19255, which is a subset including most of Philadelphia county. The results of the subset models are listed as follows using stargazer.[2]

```
=======================================================================
                              Dependent variable:
                    -------------------------------------------
                        jobs_plus10      jobs_plus10 - jobs.tot
                        (1)       (2)            (3)
-----------------------------------------------------------------------
jobs.23               0.509     -0.491          -0.491
                     (0.464)   (0.464)         (0.464)


jobs.31              1.257***   0.257           0.257
                     (0.246)   (0.246)         (0.246)


jobs.42               0.254     -0.746          -0.746
                     (0.535)   (0.535)         (0.535)


jobs.44              1.040***   0.040           0.040
                     (0.215)   (0.215)         (0.215)


jobs.48              1.312***   0.312           0.312
                     (0.344)   (0.344)         (0.344)
```

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[2] Hlavac, Marek (2018). stargazer: Well-Formatted Regression and Summary Statistics Tables. R package version 5.2.2. https://CRAN.R-project.org/package=stargazer

jobs.51	2.397***	1.397**	1.397**
	(0.610)	(0.610)	(0.610)
jobs.52	1.039***	0.039	0.039
	(0.208)	(0.208)	(0.208)
jobs.53	2.767**	1.767	1.767
	(1.173)	(1.173)	(1.173)
jobs.54	1.172***	0.172	0.172
	(0.239)	(0.239)	(0.239)
jobs.56	0.743*	-0.257	-0.257
	(0.395)	(0.395)	(0.395)
jobs.61	1.524***	0.524*	0.524*
	(0.288)	(0.288)	(0.288)
jobs.62	1.008***	0.008	0.008
	(0.150)	(0.150)	(0.150)
jobs.71	1.017	0.017	0.017
	(0.727)	(0.727)	(0.727)
jobs.72	0.797**	-0.203	-0.203
	(0.373)	(0.373)	(0.373)
jobs.81	-1.701**	-2.701***	-2.701***
	(0.808)	(0.808)	(0.808)
jobs.99	151.182***	150.182***	150.182***
	(49.151)	(49.151)	(49.151)
jobs.21	0.175	-0.825	-0.825
	(8.436)	(8.436)	(8.436)
jobs.11	13.752	12.752	12.752
	(83.911)	(83.911)	(83.911)
jobs.22	6.450**	5.450*	5.450*
	(2.929)	(2.929)	(2.929)
jobs.55	1.359***	0.359	0.359

	(0.504)	(0.504)	(0.504)
Constant	216.078	216.078	216.078
	(200.870)	(200.870)	(200.870)

Observations	117	117	117
R2	0.987	0.987	0.397
Adjusted R2	0.985	0.985	0.272
Residual Std. Error (df = 96)	1,341.019	1,341.019	1,341.019
F Statistic (df = 20; 96)	371.961***	371.961***	3.164***

==

Note: *p<0.1; **p<0.05; ***p<0.01

Similarly, the number of jobs by industry in 2005 can explain more than 98.5% of the variation in the total jobs in 2015 (model 1 and 2). The job type composition claims to explain 27.2% (model 3), which is much higher than in Pennsylvania state as a whole.

In the Pennsylvania zip code zones, three independent variables (job types) are significantly related to more jobs in 2015 (correlation parameters are statistically different from 1 in model 1, or from 0 in model 2 and 3):
1 Information (jobs.51): each 1% increase leads to 1.397% increase in total jobs.
2 Educational services (jobs.61): each 1% increase leads to 0.524% increase in total jobs.
3 Unclassified (jobs.99): each 1% increase leads to 150.182% increase in total jobs.

One independent variable (job types) is significantly related to less jobs in 2015:
1 Other services (except public administration) (jobs.81): each 1% increase leads to 2.701% decrease in total jobs.

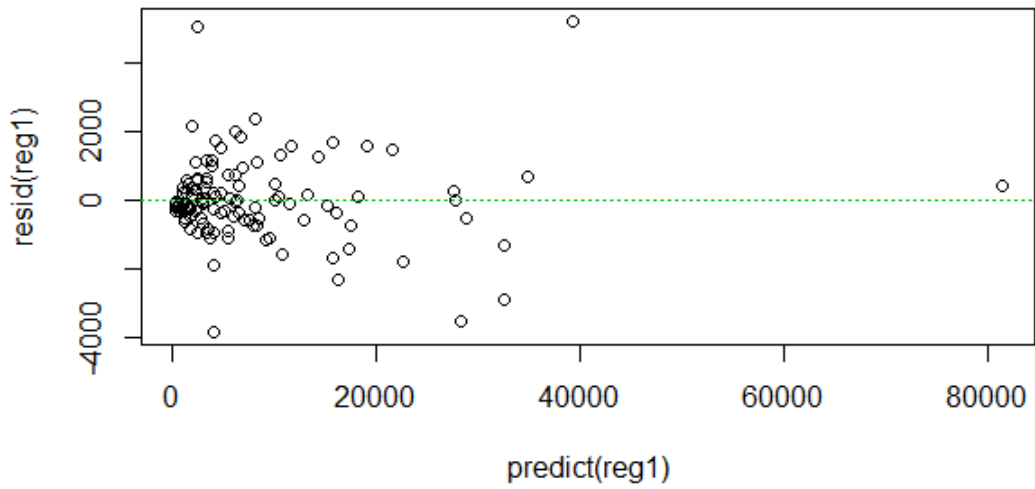Likely, the residual plots of both kinds of subset regressions look a bit homoscedastic.

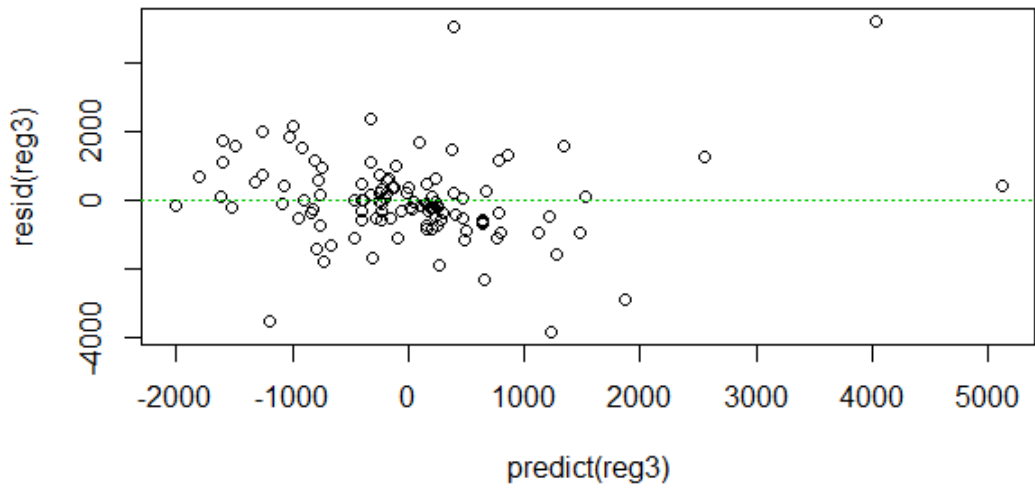**Figure 3:** Error in the job prediction model (zip codes between 19019 and 19255)

Figure 4: Error in the job change prediction model (zip codes between 19019 and 19255)

From the above analysis, we can see that in Philadelphia county, a few job types have a much stronger driving effect to future total jobs compared to Pennsylvania state. Philadelphia county also features some very strong local drivers including information and education industries.

4.
MEMO

Dear Mayor and Economic Development Team,

The city of Philadelphia is in its greatest period of transformation in several decades. As we have presented in the previous report, there is a consistent growth in Philadelphia population since 2000 and we expect this trend to continue in the near future. In this report, we projected and explained the employment trend in Philadelphia from 2015 to 2025 to depict a more detailed developing vision for the city. Based on the 2015 employment data, we presented a series of forecast models to predict Philadelphia's employment in 2025, and selected what we believe to be the best reflection of current economic trends. We also investigated the causes of the city's recent employment change by identifying the local basic industries in 2005 and 2015, as well as by examining which types of jobs are statistically correlated with more or fewer future jobs at zip code zone level. In short, we expect Philadelphia's current employment increase to continue in the next decade, and that this increase will continue to be driven by a few local basic industries including education services and information industry.

Our Forecast

Using annual data from the *County Business Patterns* website and the *Bureau of Labor Statistics* database, we prepared six separate employment projections for 2025 Philadelphia. Despite different methodologies and assumptions, most models projected similar results. Among all 6 models, we decided that the status quo shift-share model is a preferred forecast. This model disassembles the historical rate of each industry sector's employment growth into 3 parts: the macro economic growth effect, an industry mix effect, and a local competitiveness effect. Thus, its result reflects the growth tendency of each industry sector in US and in Philadelphia on top of the general economic growth trend, which is crucial for predicting the employment future of this changing city. In addition, this method does not rely on the accuracy of previous projection results such as population projection or macro employment projection, as well as the assumptions of a constant relationship between these parent and child projections. Among all 3 shift-share models, we chose the status quo scenario in view of a consistent trend of current economic growth, proportional shift, and differential shift factors.

We predict a moderate increase in employment for the city of Philadelphia for the next decade. While the 2015 total employment was 542,000, we forecast the 2025 total employment to be 564,487 (4.15% increase from 2015). This result is in line with our population projection, as well as 2 additional employment models that we found useful, i.e. the growth-share step-down model (compared to US, 2005-2015)

and the population-based model (using our preferred population projection from the last report).

The Drivers Behind Change

To determine what were the underlying causes of the recent employment growth in Philadelphia, we used the data on the number & type of jobs in each zip code zone in 2005 to predict the corresponding total number of jobs in each zone in 2015. The regression result indicates that the number and types of jobs in 2005 can explain more than 98.5% of the variation in the total number of jobs in 2015 at zip code zone level. It is not surprising that most explanation power of the model comes from the number of jobs factor, since zip zones with many jobs in 2005 are likely to have more jobs in 2015. Still, in Philadelphia the types of job factor alone can explain 27.2% of future number of jobs, which is much higher than in Pennsylvania state as a whole. Among all job types, three are found significantly related to more jobs in 2015:

1 Information: each 1% increase leads to 1.397% increase in total jobs.
2 Educational services: each 1% increase leads to 0.524% increase in total jobs.
3 Unclassified: each 1% increase leads to 150.182% increase in total jobs.

Although the last type is too opaque to draw a sound conclusion, the driving effect of Educational services and information industry to Philadelphia employment is beyond doubt. To further investigate the potential of these driving industries, we conducted location quotient(lq) analysis and distinguished the following basic industries in Philadelphia County, both in 2005 and in 2015:

1Finance and insurance (relatively high lq compared to US, relatively high share of total employment)
2Professional, scientific, and technical services (high lq compared to US, high share of total employment)
3Educational services (high lq compared to US, relatively high share of total employment)
4Health care and social assistance (relatively high lq compared to US, high share of total employment)
5Accommodation and food services (relatively high lq compared to US, high share of total employment)
6Other services (except public administration) (relatively high lq compared to US, relatively high share of total employment)

Since the two driving industries are of good fit to local economic structure, we believe that they will continue to drive future employment and economy growth in Philadelphia.

Conclusion

We project that Philadelphia will continue to grow both in population and in employment for the next decade, following a new trajectory started since 2000. This moderate employment increase will continue to be driven by a few sunrise industries, which appear to create more total jobs on top of their own growth. In Philadelphia, the educational services and information industries appear to be driving the overall employment growth, and we expect this trend to continue given their good fit to local economic structure. Thus, we recommend you to pay more attention to these industries if you are interested in sustaining the employment and economy growth of the city.