DLI and Crime Science

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Mid-19th Century to early 20th Century

- During this time period
  - Much of the geography of crime research was undertaken by sociologists
  - John Glyde (United Kingdom)
  - Ernest Burgess (United States)

- Primary finding of this research
  - Spatial heterogeneity within larger units of analysis
  - This has actually been the trend of spatial criminology for 200 years…more to come

First "half" of the 20th Century

- Actually up to the late 1960s or early 1970s
- Clifford Shaw and Henry McKay
  - Social disorganization theory
- Analyzed spatially varying crime rates
  - But they were always looking for sociological explanations
  - → the sociological imagination

Geographical imagination and crime

- Began, in earnest, in 1969
  - C.R. Jeffery and crime prevention
  - Crime prevention through environmental design
- Oscar Newman
  - Crime prevention through urban design
- There has been previous geographical work
  - Mobility polygons and journey to crime, for example

Theories for the geography of crime

- Social disorganization theory
- Routine activity theory
- Geometric theory of crime
- Rational choice theory
- Pattern theory of crime

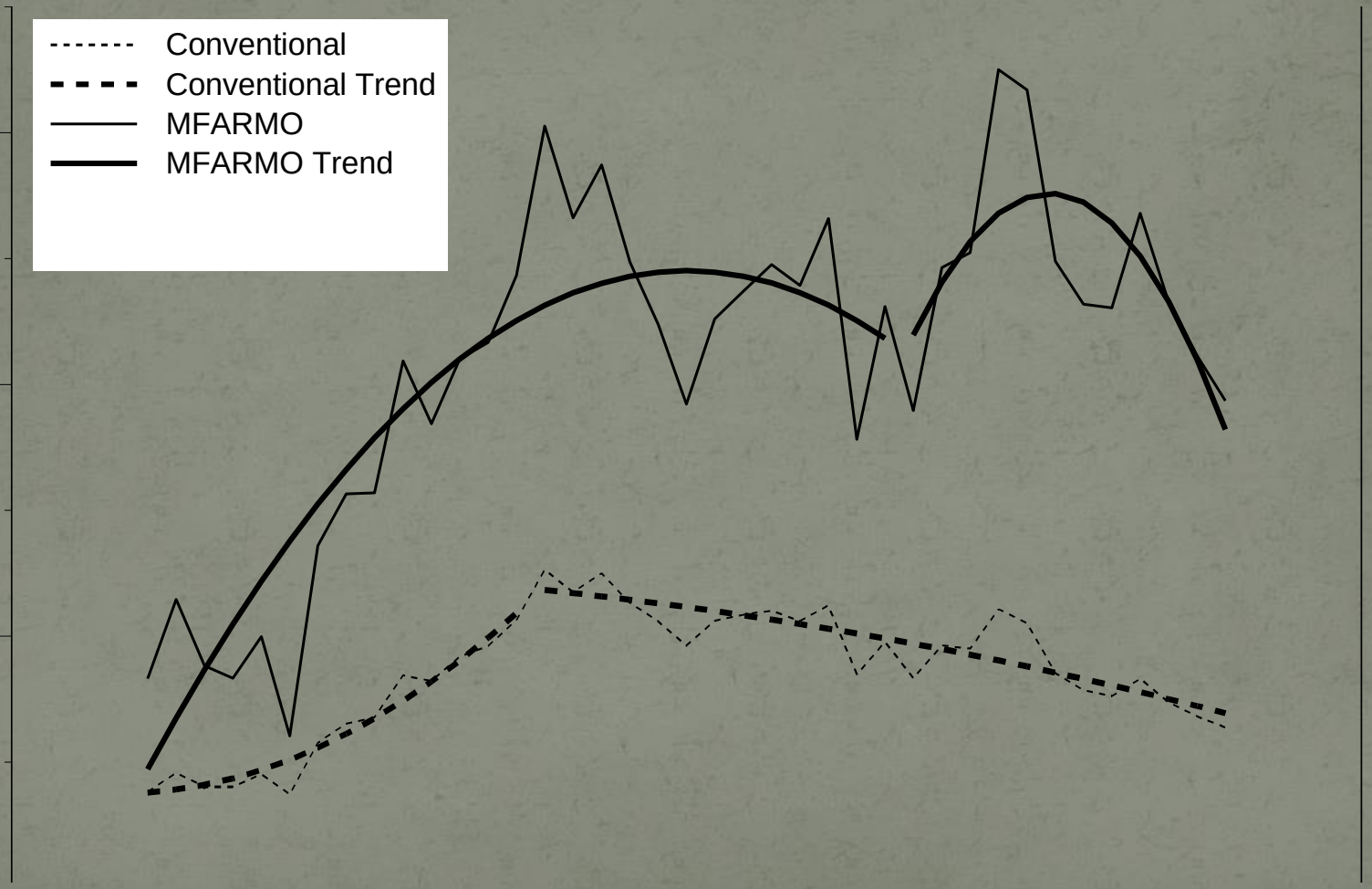
Spatially-varying crime rates

- Basically all crime rates!!
- [(Number of crimes)/(Population at risk)]* Scalar
- All too often
  - We do not change the population at risk when the crime type changes
  - Sometimes it is fine, but not always

But before we get to geography…

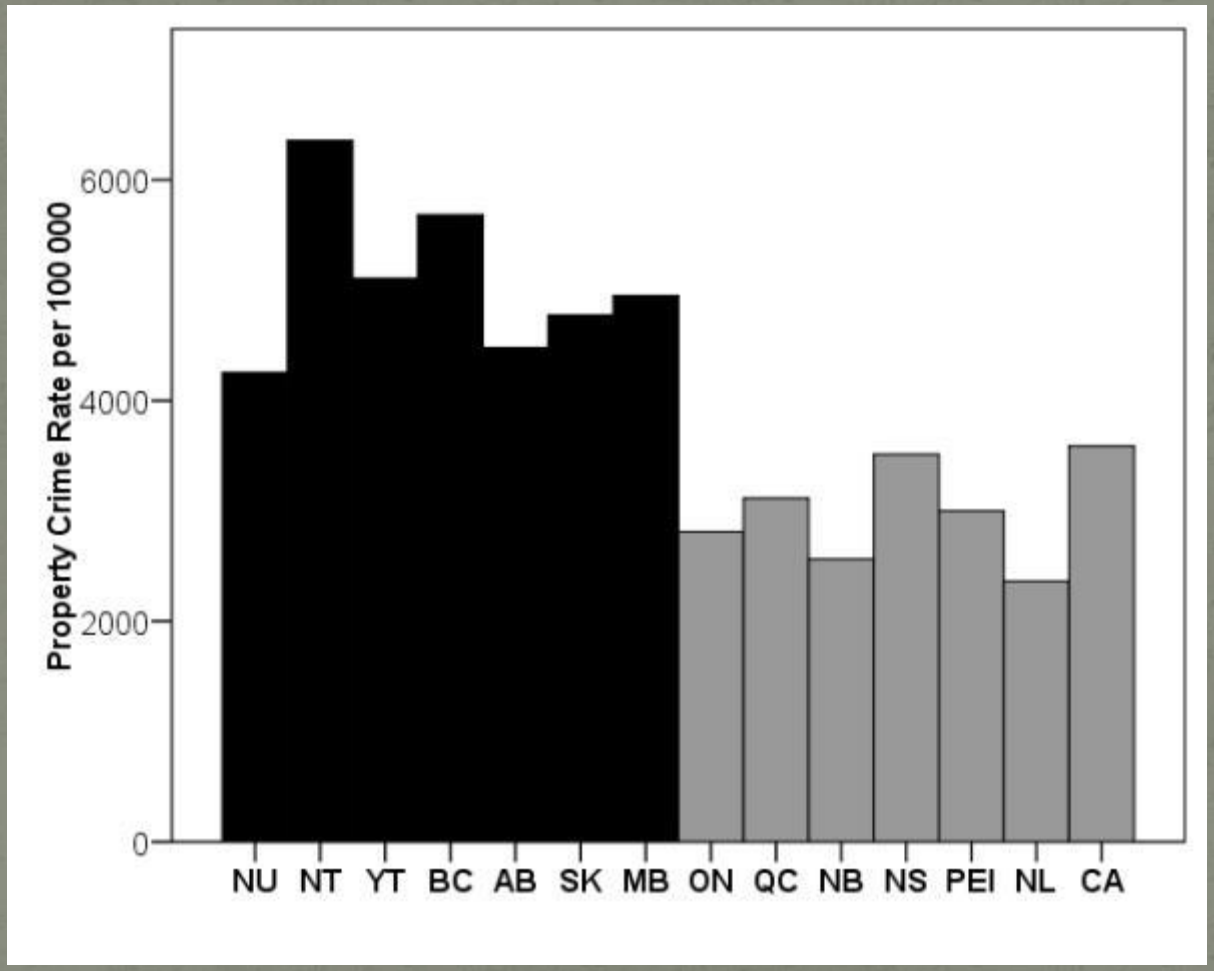
- How we calculate national level crime rates matters
- As with smaller units of geography
  - Resident population, total population
- But are all people equally likely of victimization?
- The elderly? The young? Males? Females?
- A story about homicide…

Homicide in Canada, 1960 – 2000



Crime in Canada, east to west

- Long standing fact
- Crime increases east to west
- Greatest levels of crime in the Territories
- Not well understood


Property Crime Rate per 100 000
6000
4000
2000
0
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YT
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QC
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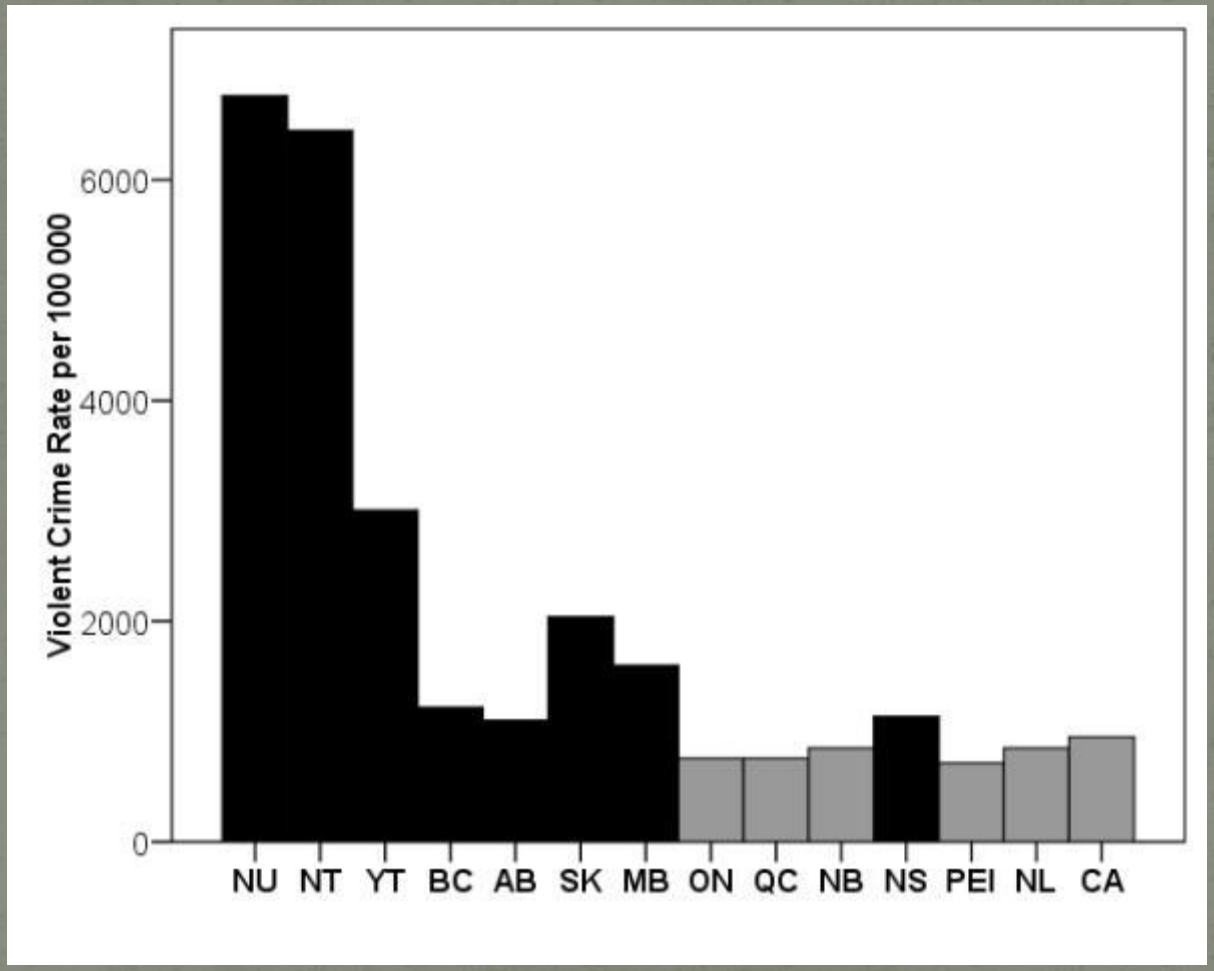
NS
PEI
NL
CA


Violent Crime Rate per 100 000
6000
4000
2000
0
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YT
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QC
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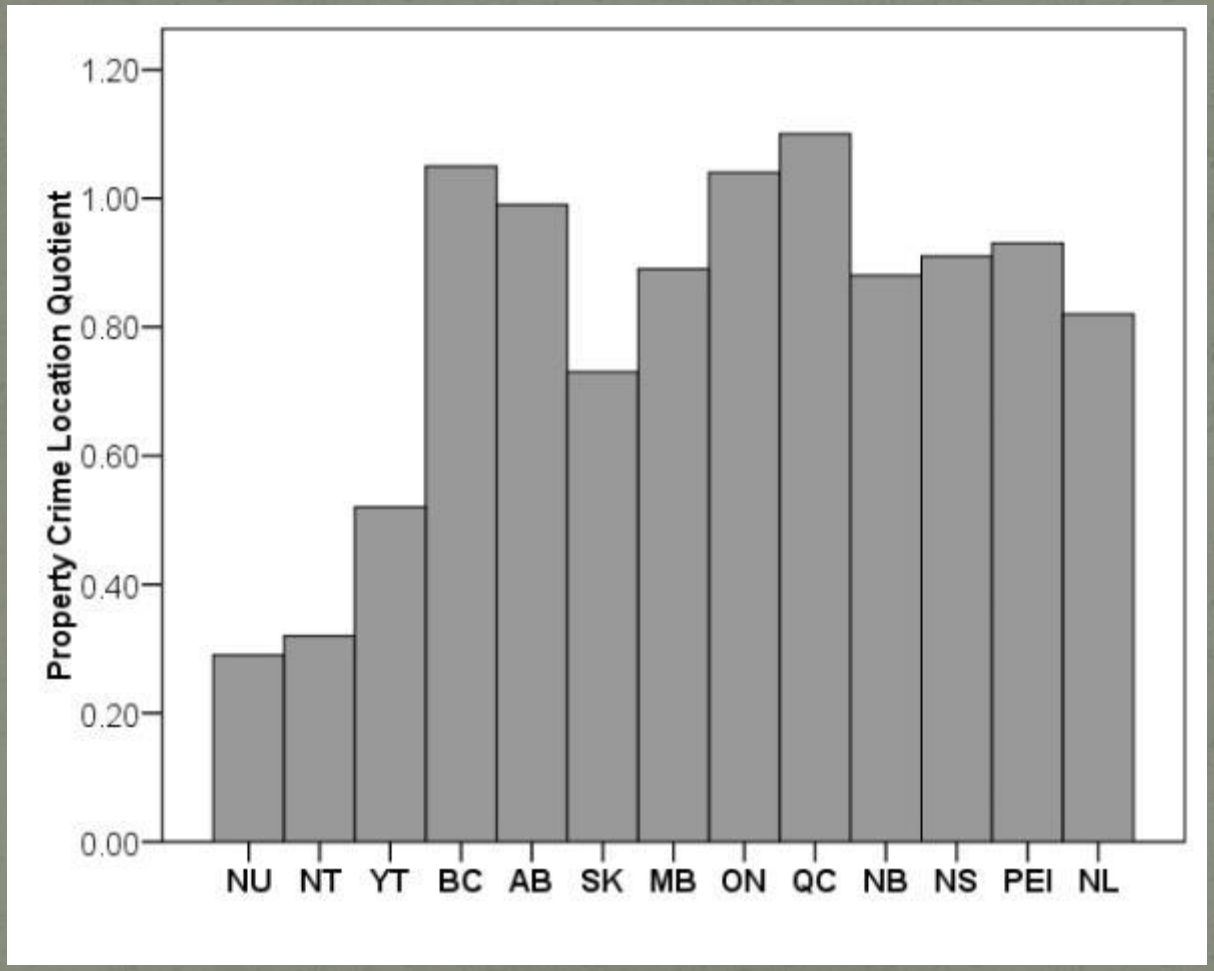
NS
PEI
NL
CA

But is this "true"?

- In a pure sense, yes
- Territories and crime rates are a problem
- But the rate is the rate
- We can look at another measure, the location quotient
- A measure of specialization

An alternative measure, the location quotient

- Long history in economic geography
- A measure of specialization
- Introduced to the geography of crime by the Brantingham in the 1990s
- Under-utilized, but most instructive


Property Crime Location Quotient
1.20
1.00
0.80
0.60
0.40
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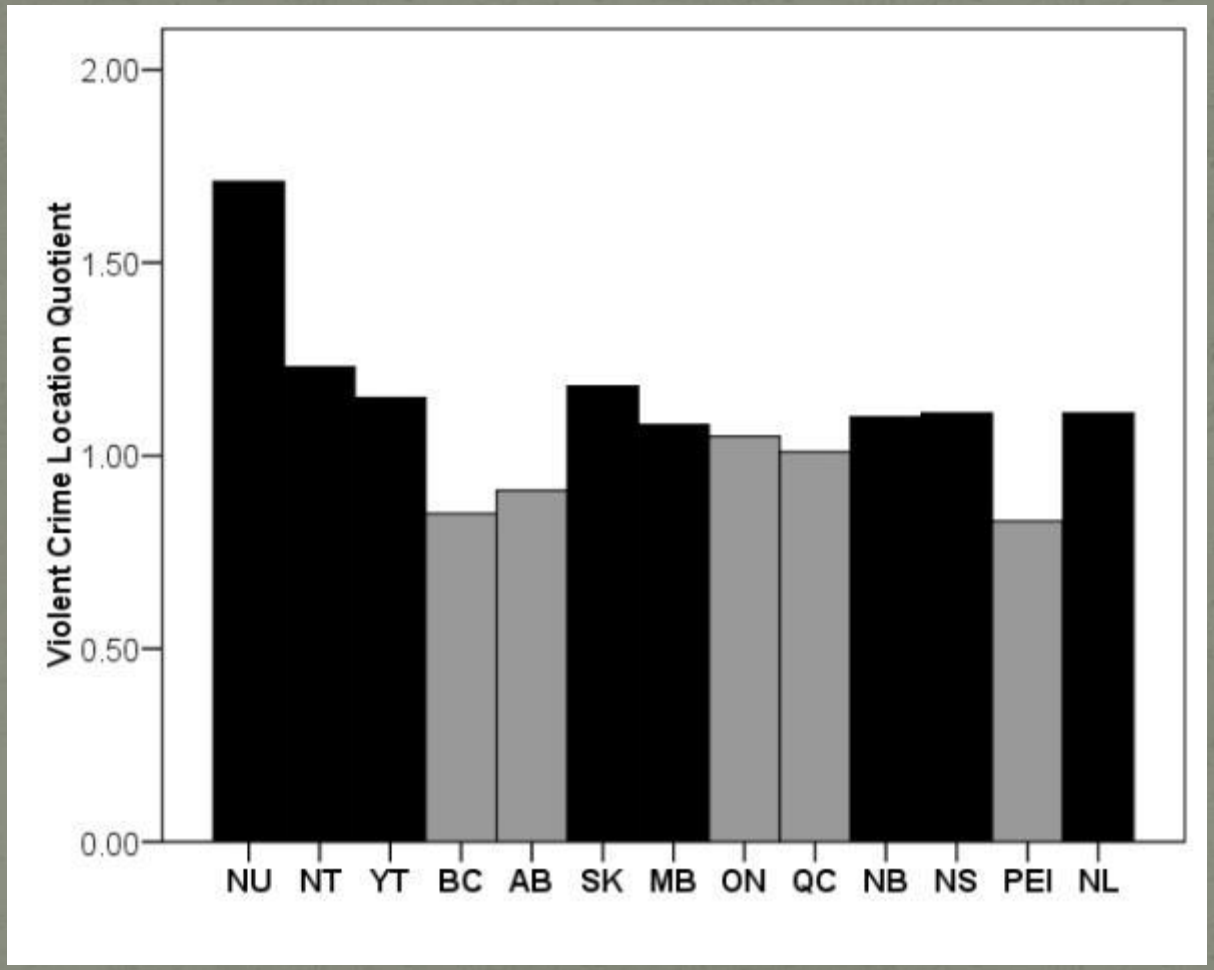
Violent Crime Location Quotient
2.00
1.50
1.00
0.50
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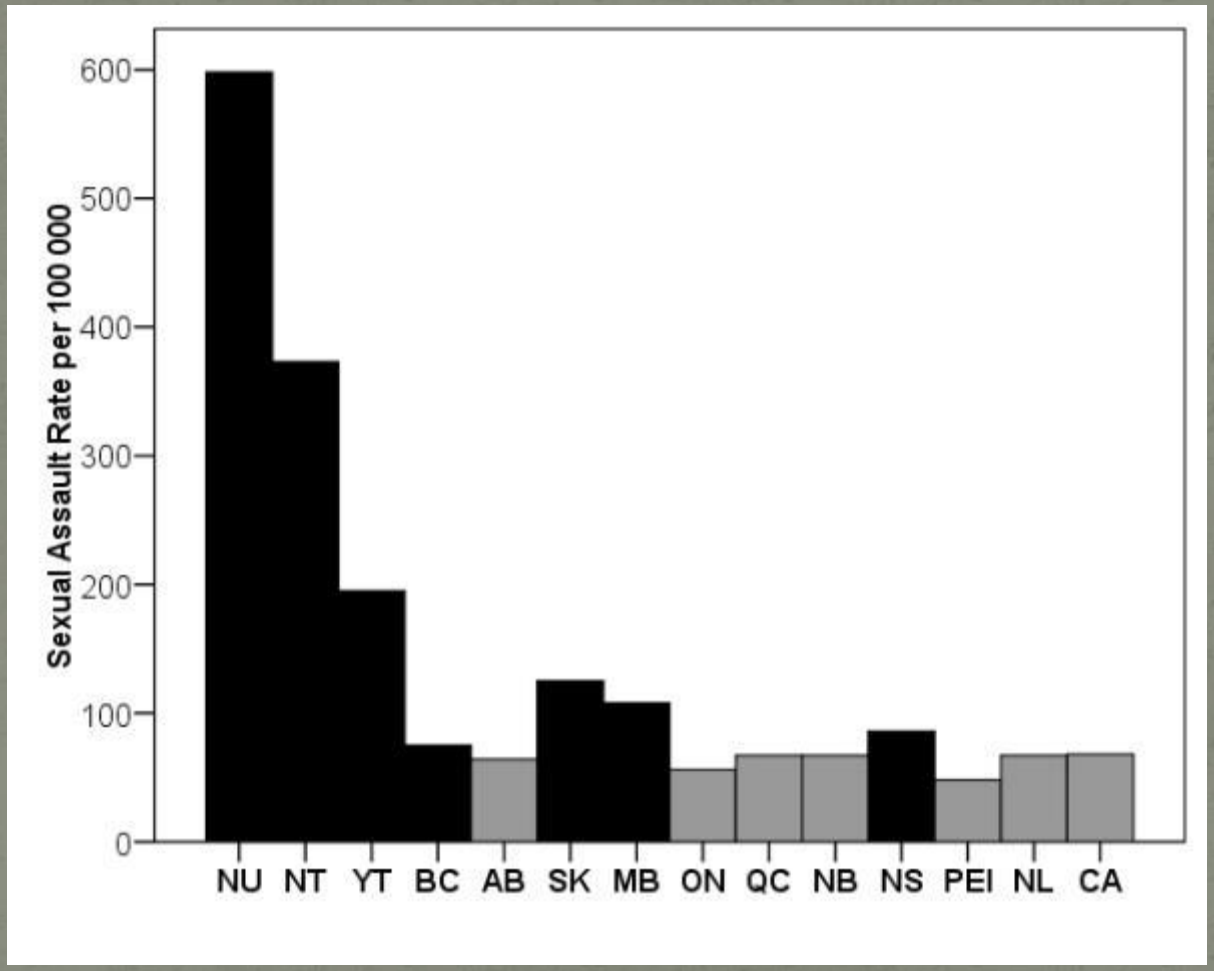
Sexual Assault Rate per 100 000
600
500
400
300
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PEI
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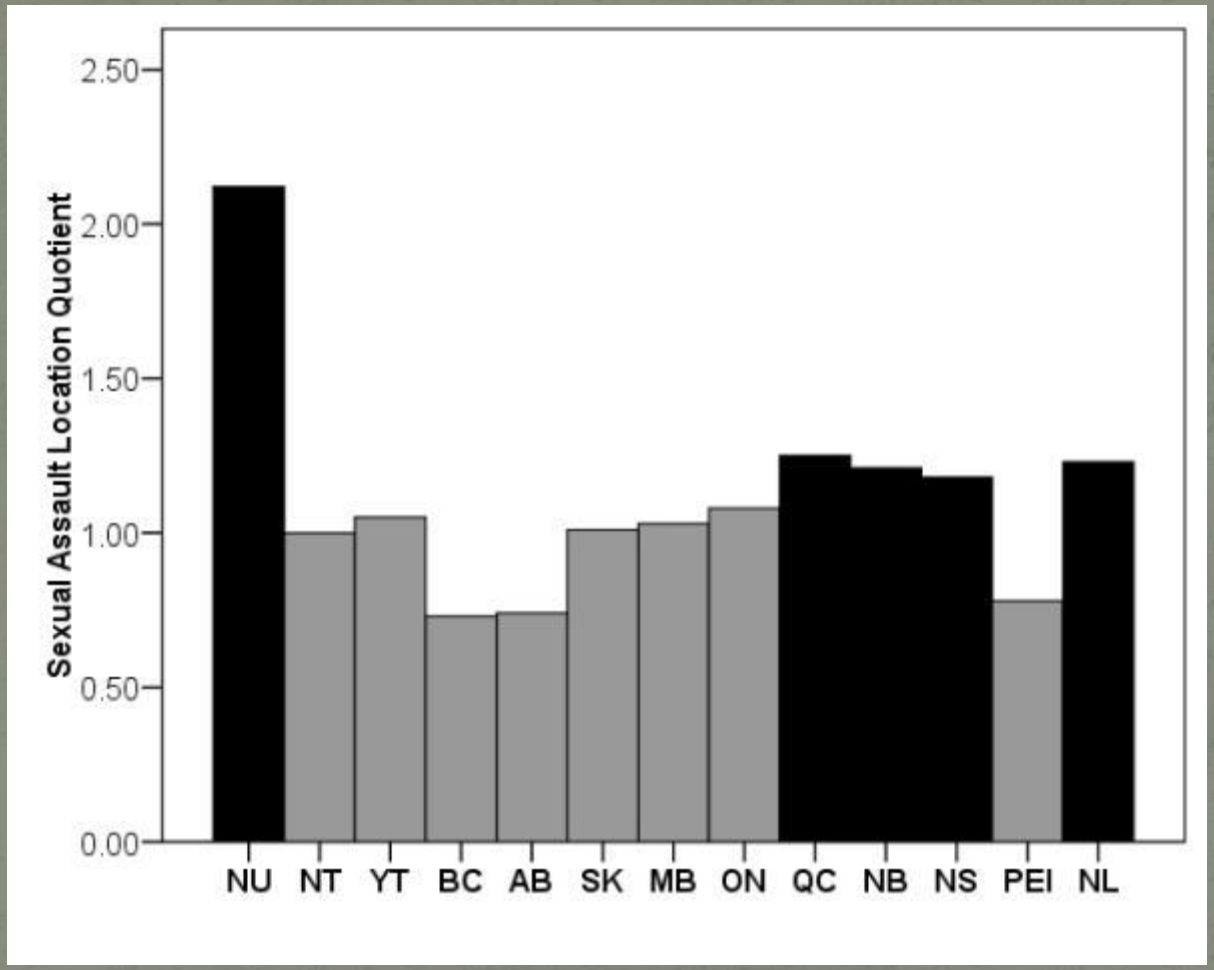
CA


Sexual Assault Location Quotient
2.50
2.00
1.50
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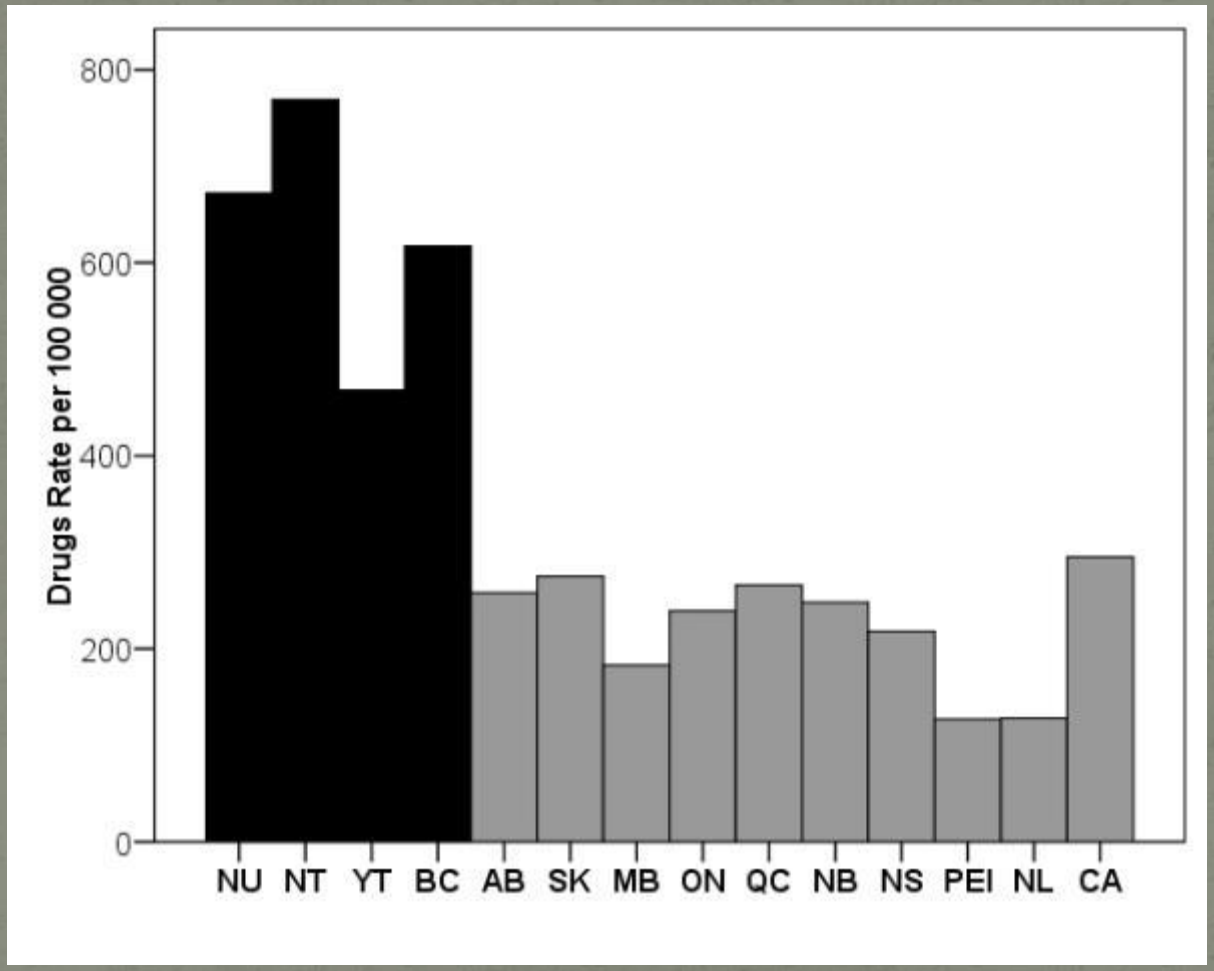
Drugs Rate per 100 000
800
600
400
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PEI
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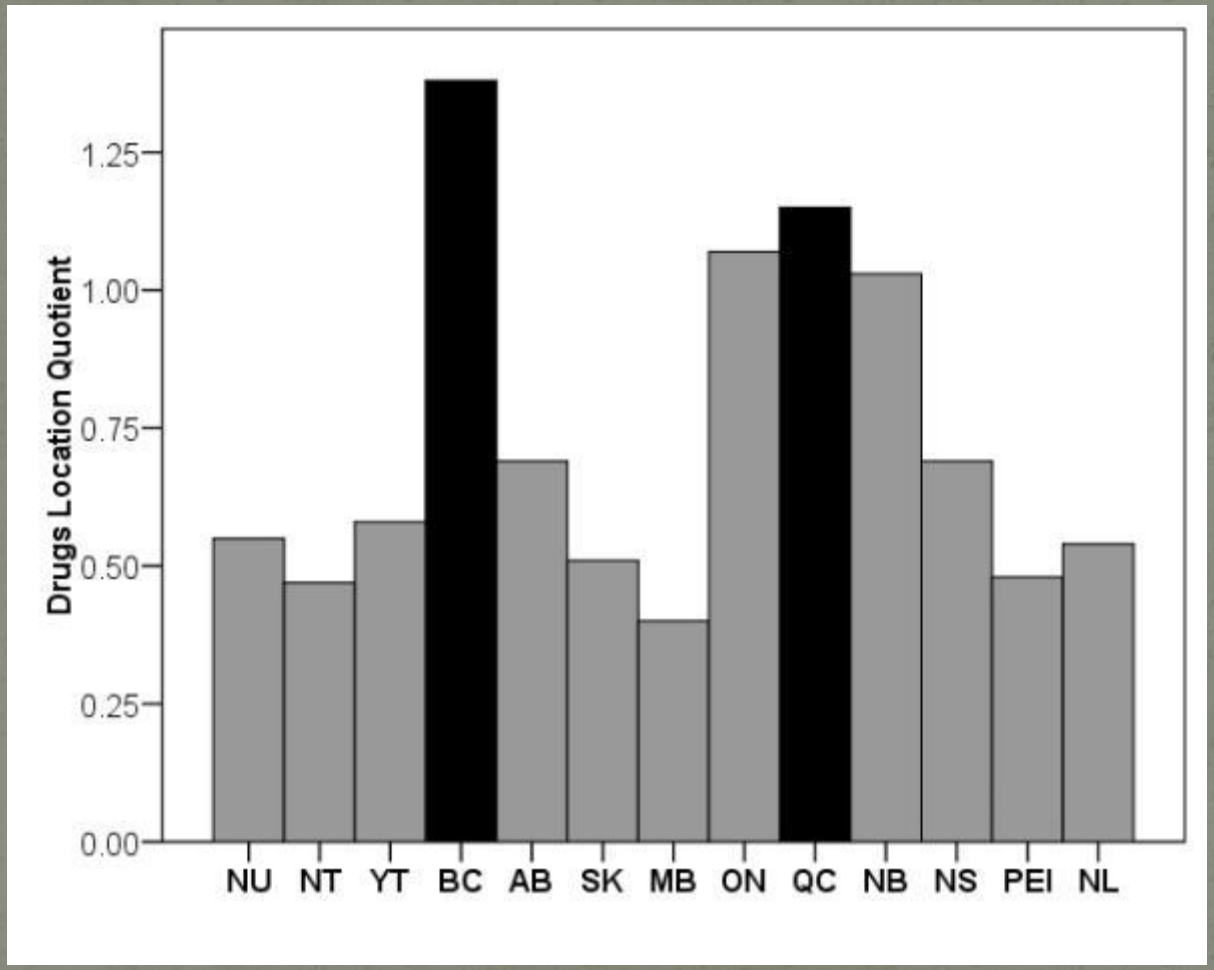
CA


Drugs Location Quotient
1.25
1.00
0.75
0.50
0.25
0.00
NU
NT
YT
BC
AB
SK
MB
ON
QC
NB
NS
PEI
NL

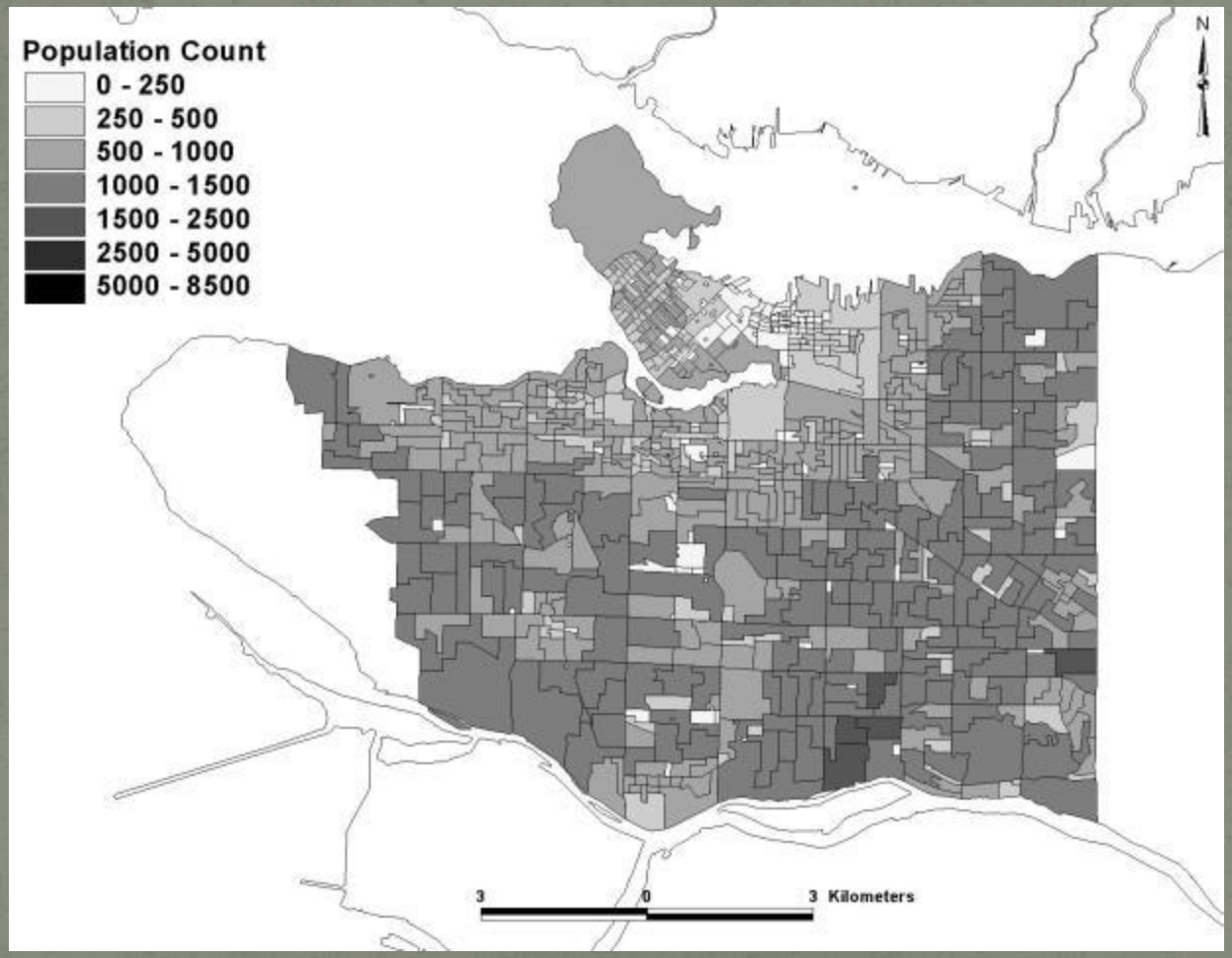
Populations at risk, a spatial approach

- Some research has shown that populations at risk can be unrelated to one another
  - This is, of course, expected: commercial versus residential burglary
- Sarah Boggs (1965)
  - Sometimes very high positive correlations with different populations at risk
  - Sometimes very high negative correlations
  - And sometimes no relationship at all
- This is problematic, a priori…

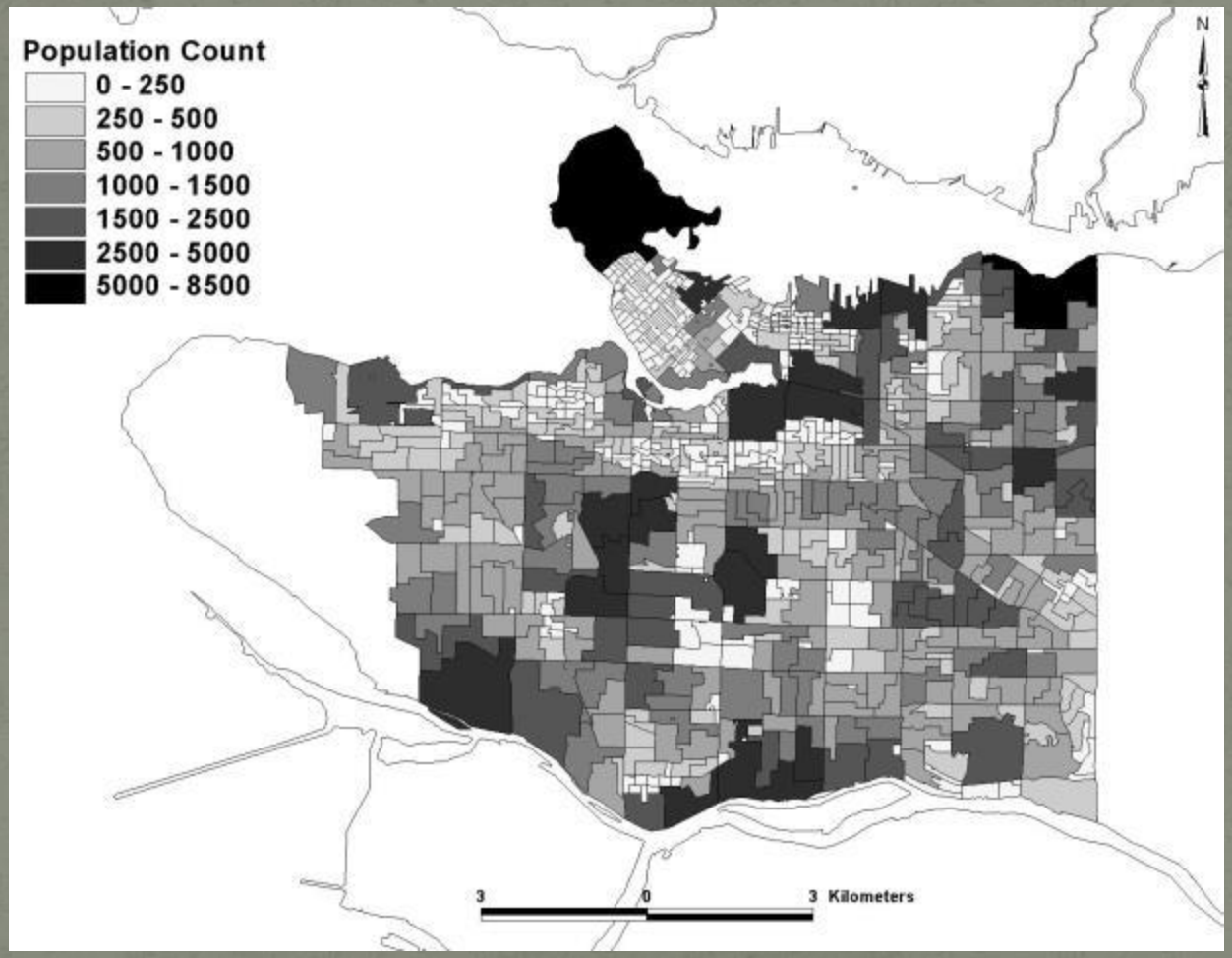
The ambient population and crime analysis

- Oak Ridge National Laboratory
  - 1 km x 1 km resolution
  - Proprietary algorithm…
- Very different than census counts, the most common population at risk in spatial crime analysis
- The implications could be huge

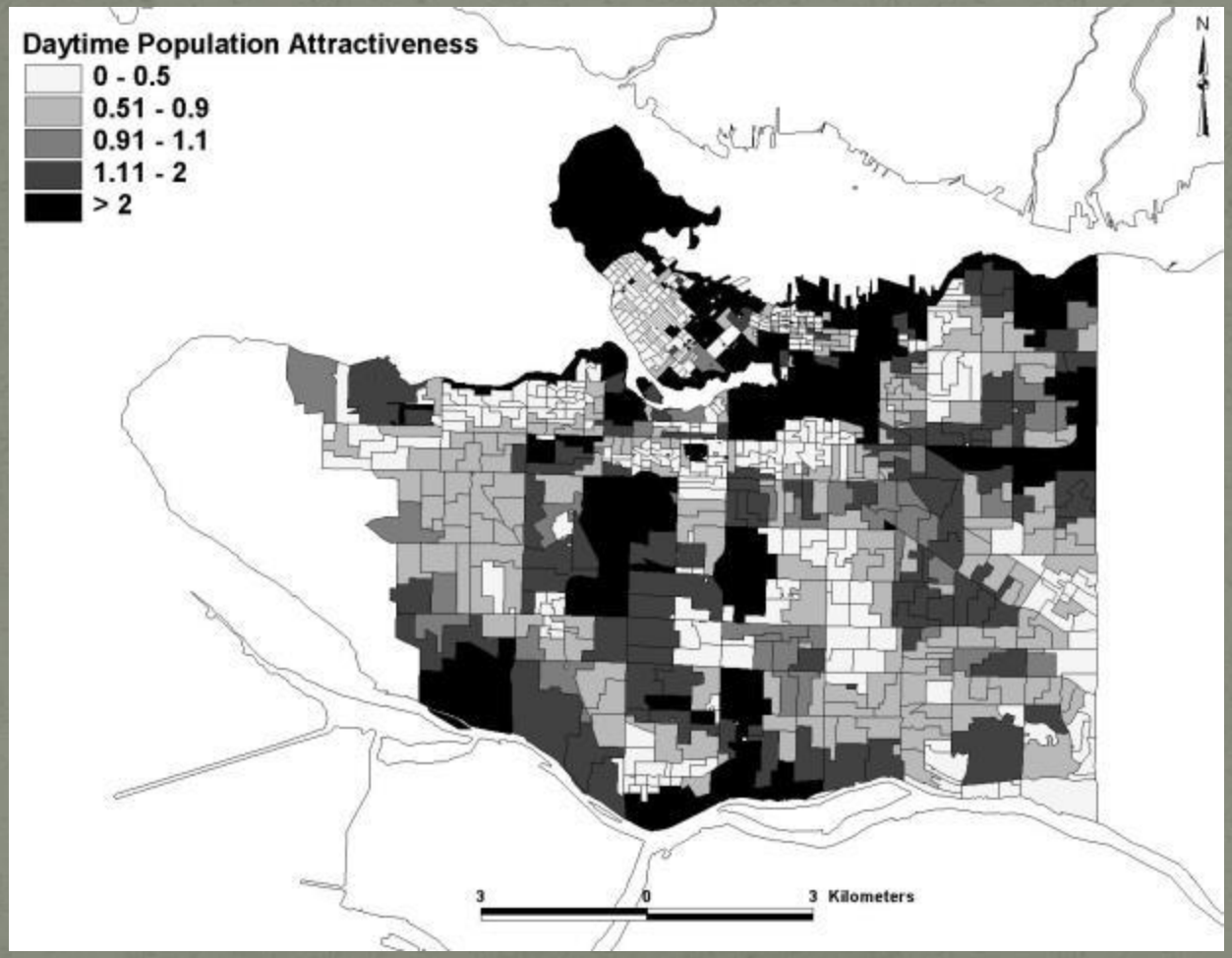
Resident population



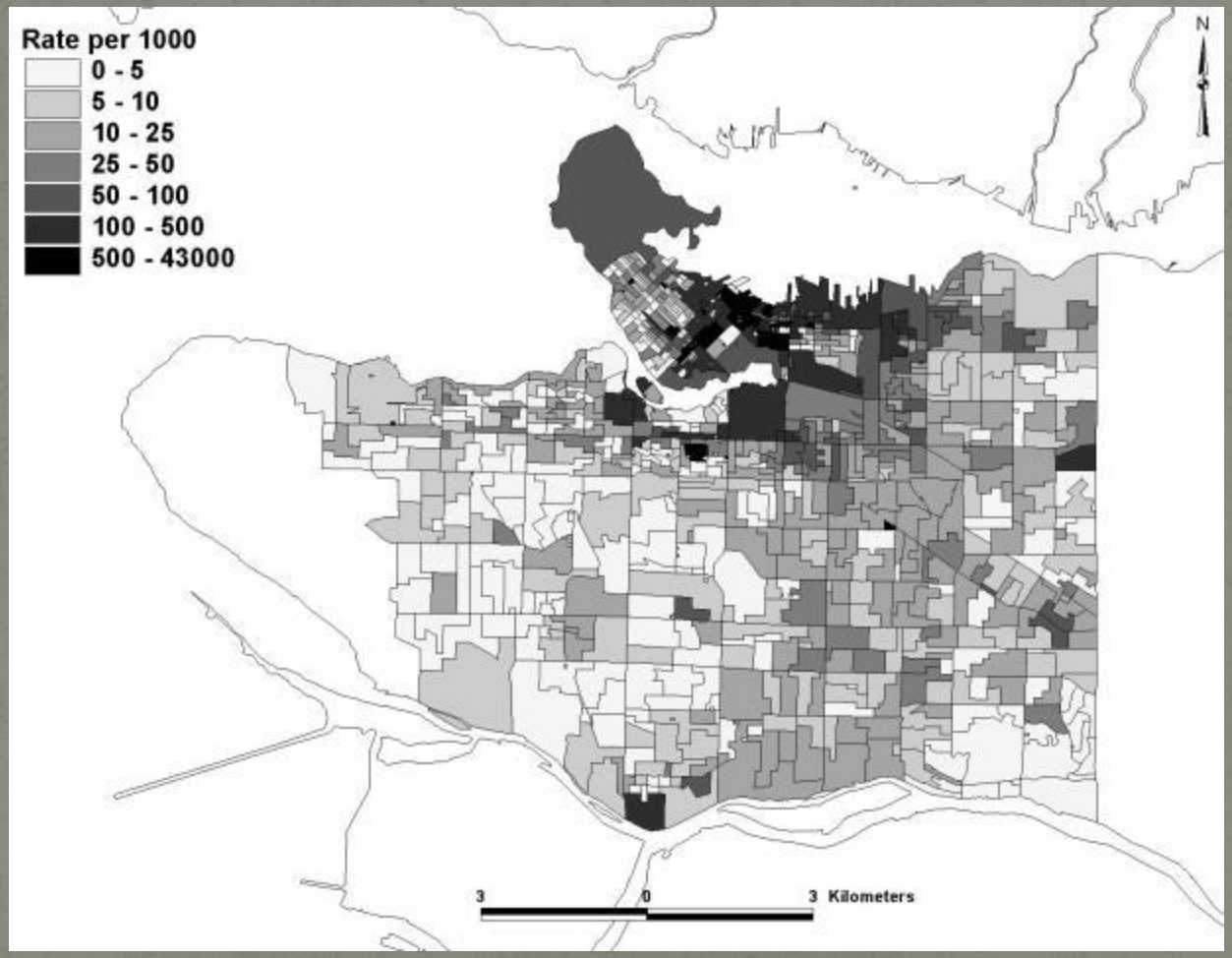
Ambient population



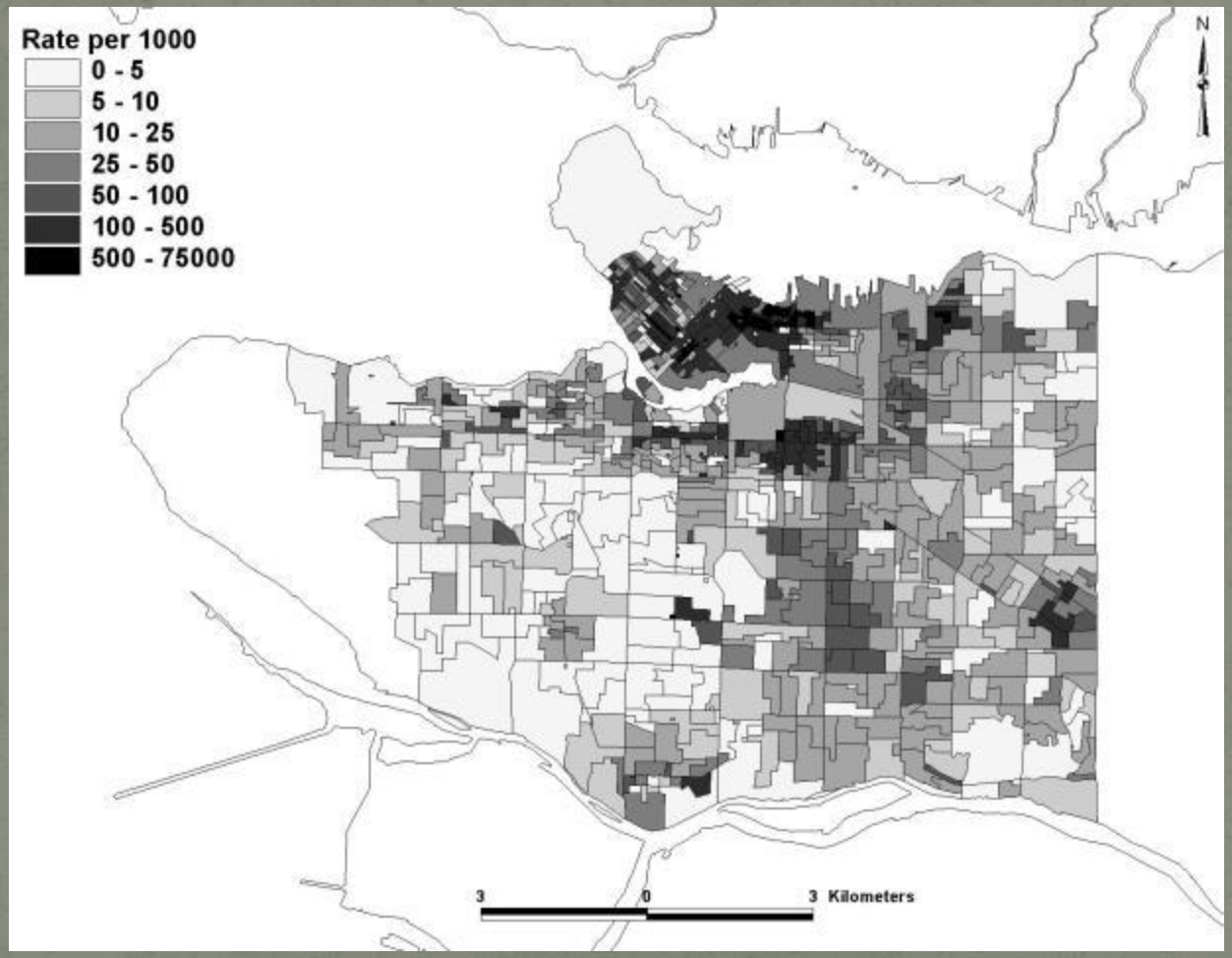
Daytime population attractiveness



Resident-based violent crime rate



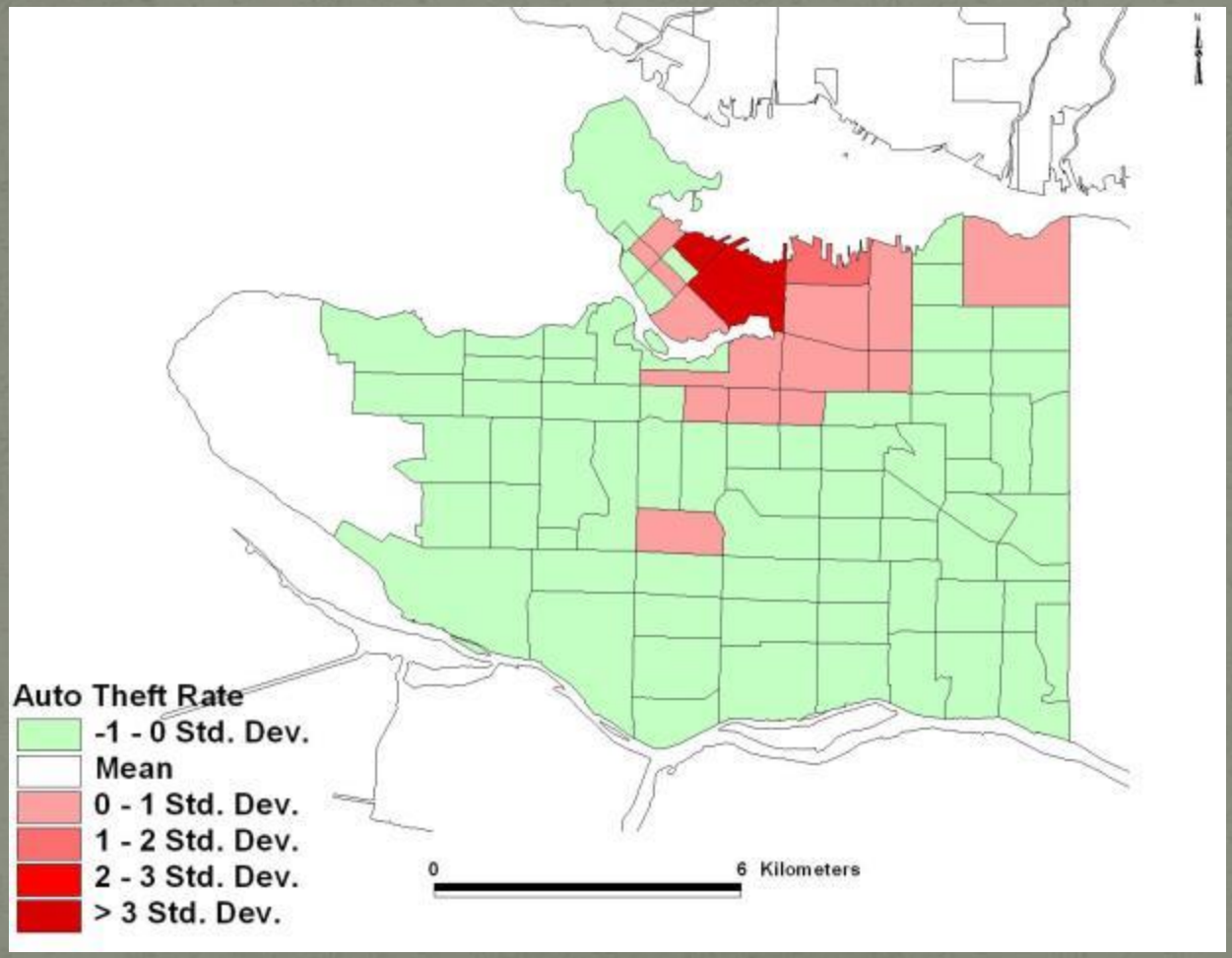
Ambient-based violent crime rate



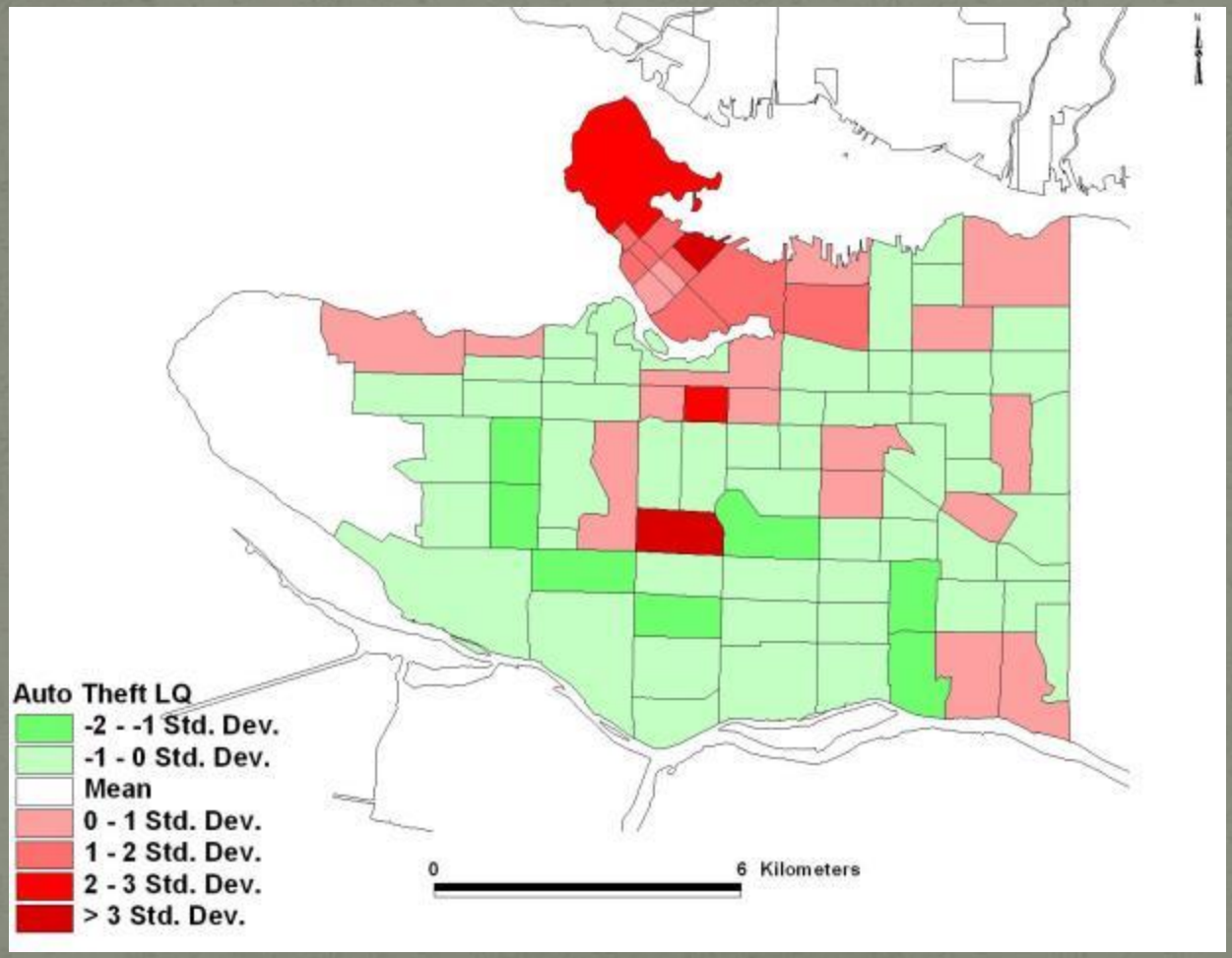
The location quotient for census tracts

- Above: provinces and their specialization relative to Canada
- Now: census tracts and the specialization relative to Vancouver
- With census data, we can understand criminal specialization!

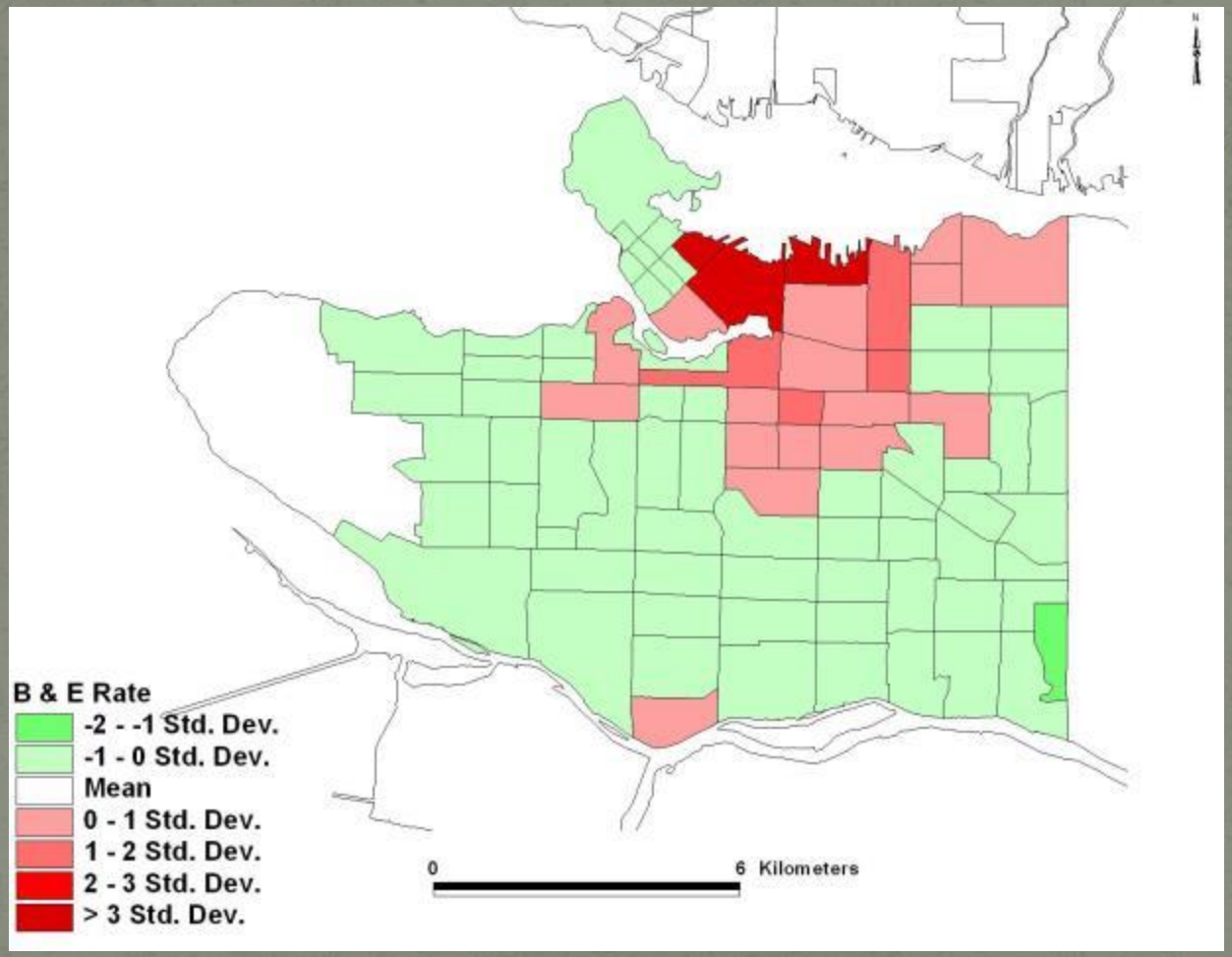
Automotive theft crime rate



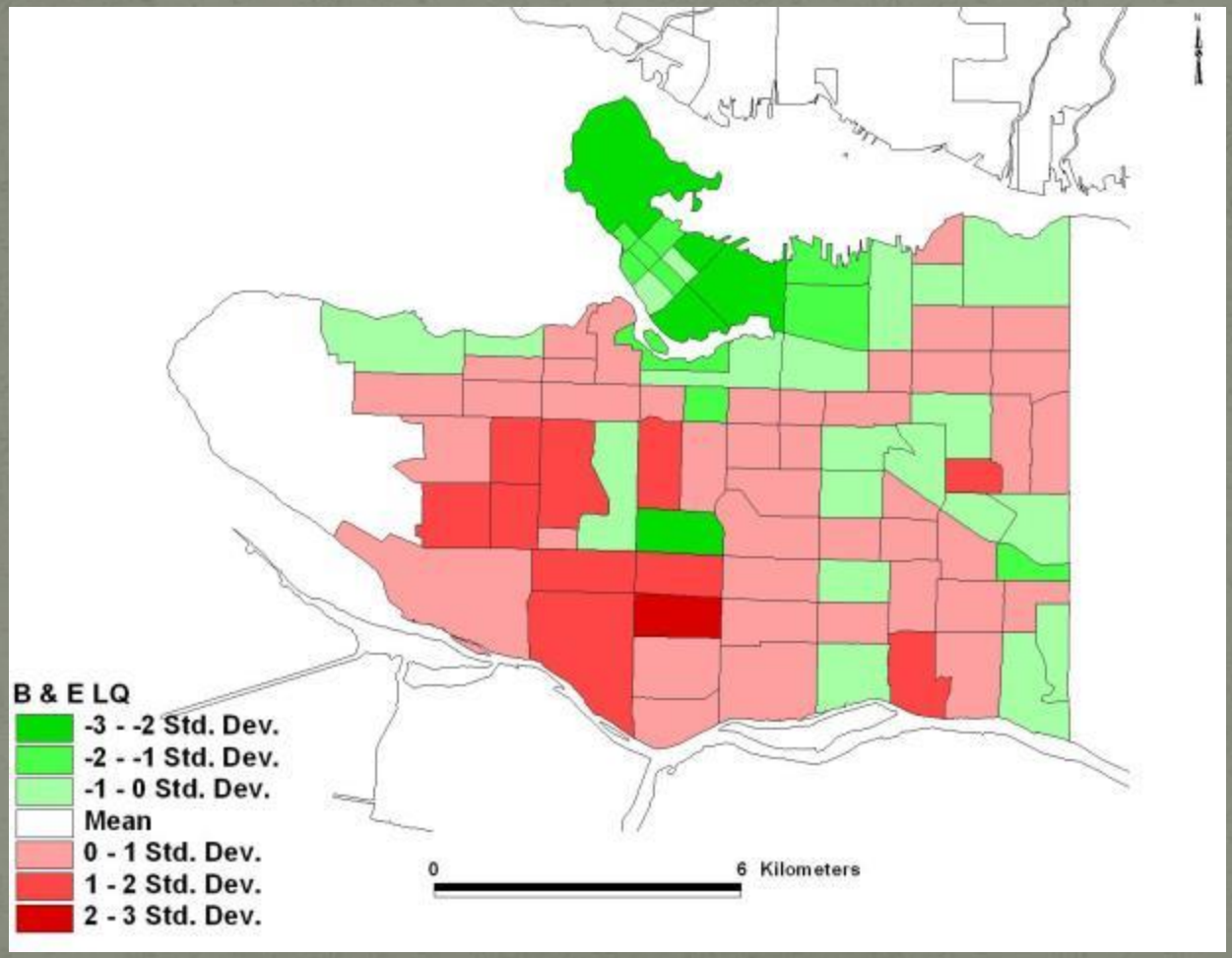
Automotive theft location quotient



Burglary crime rate



Burglary location quotient



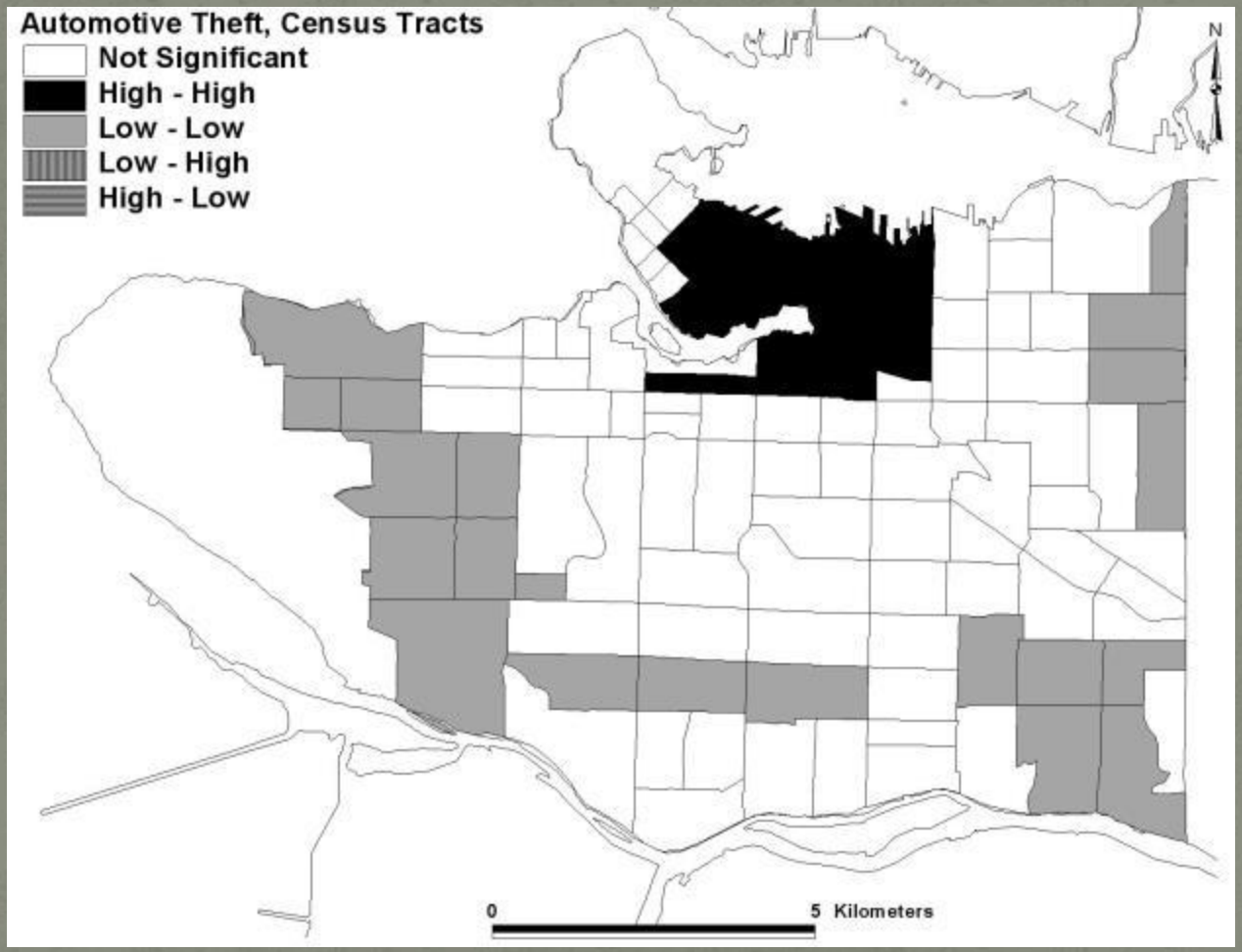
Local spatial crime analysis

- Positive spatial autocorrelation
  - Most common for social systems
- Negative spatial autocorrelation
- Global versus local spatial autocorrelation
- Local indicators of spatial association (LISA)

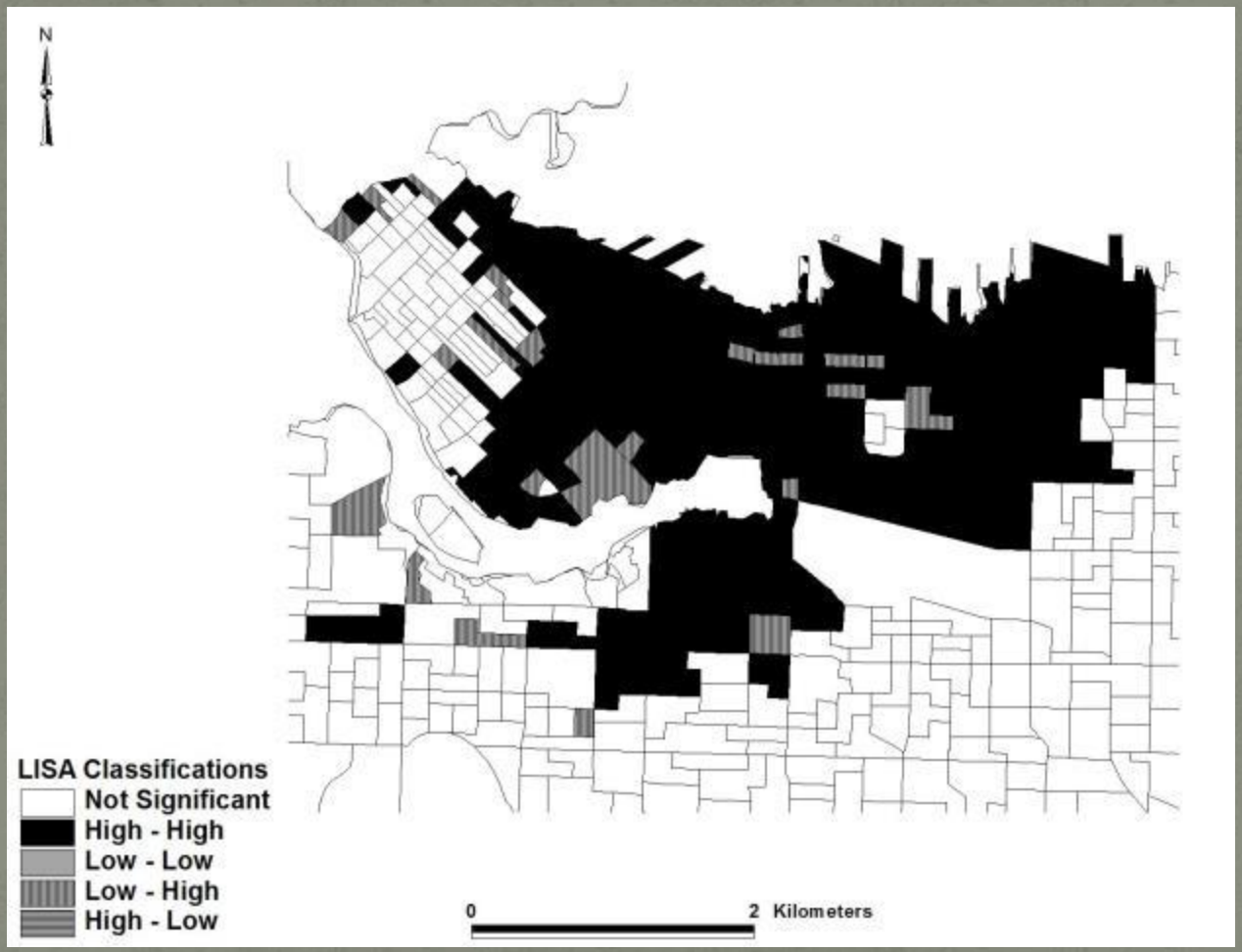
Local Moran's I

- High-High
- High-Low
- Low-High
- Low-Low

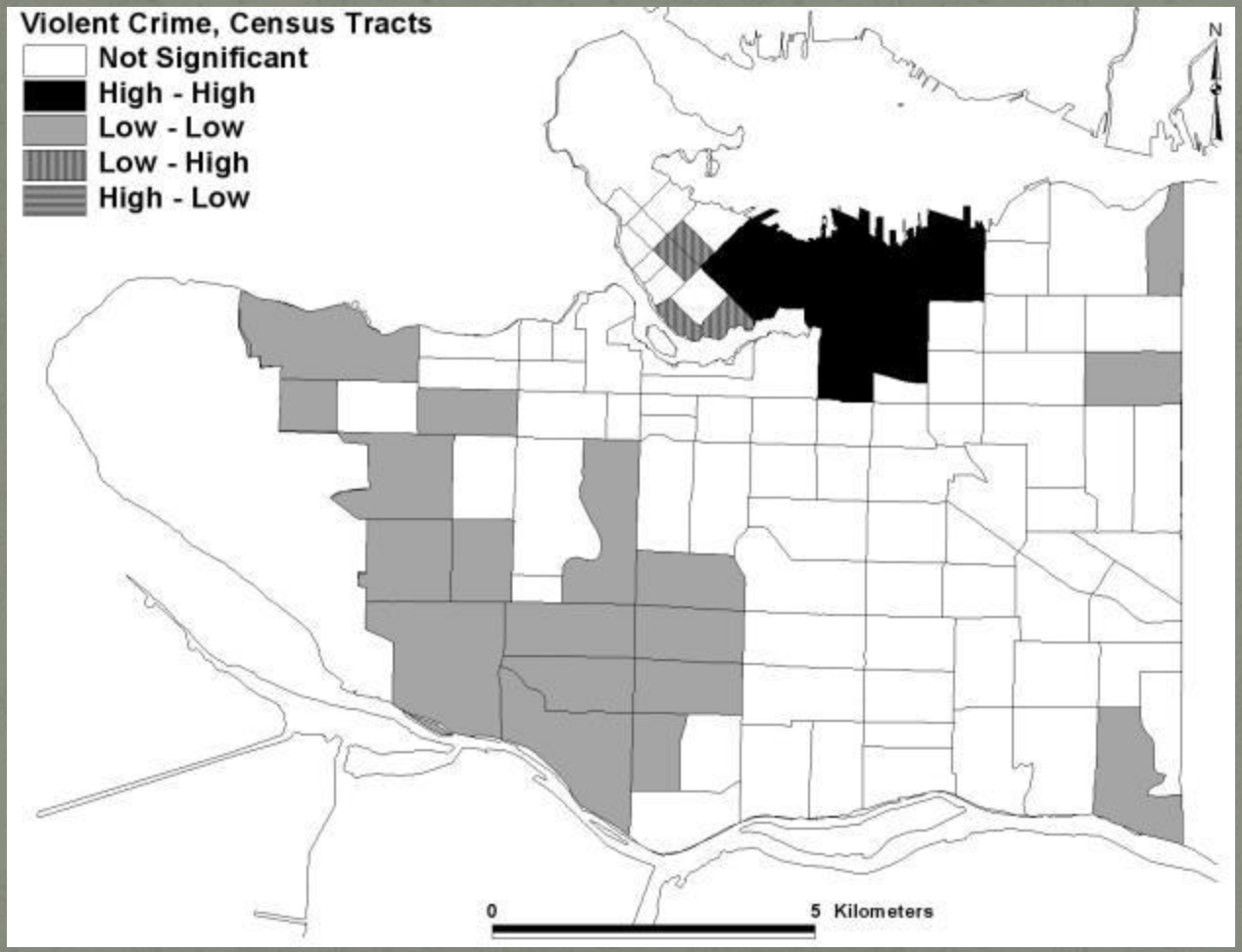
Automotive theft, LISA



The importance of scale (auto theft)



Violent crime, LISA



The importance of scale…again

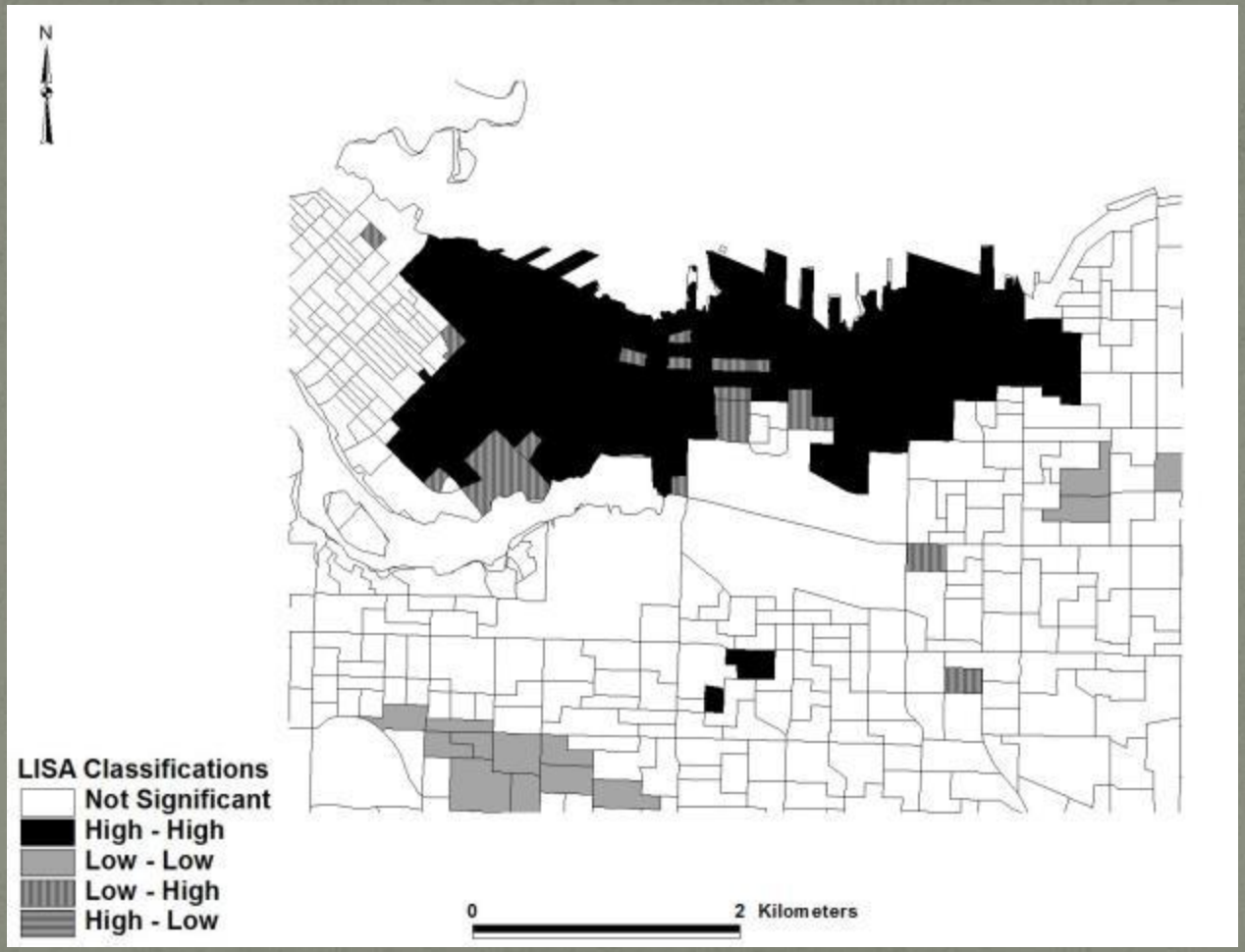


Table 5
Multinomial logistic regression results, dissemination areas, automotive theft

	High-High	Low-Low	Low-High	High-Low
Constant	-3.848*	-3.954*	-6.191*	
Population Change, %		-0.040 [−0.240]*	0.052 [0.051]	-0.189 [−0.000]*
Males 15–24, %	-0.180 [−0.119]	0.252 [1.533]*		
Single Parents, %	-0.198 [−0.130]*	0.098 [0.597]*		
Ethnic Diversity	0.029 [0.019]	-0.028 [−0.171]*		
Unemployment Rate	0.159 [0.105]*		0.116 [0.114]*	
Post-secondary, %	0.031 [0.021]*			
Average Income, 000s	0.027 [0.018]*	0.017 [0.105]*	0.022 [0.021]*	
Population Density	-0.006 [−0.004]*	0.001 [0.001]*		-0.127 [−0.000]*
Dwelling Value, 000s	-0.011 [−0.007]*		-0.005 [−0.005]	
Rentals, %		-0.018 [−0.106]*		
Major Repairs, %	-0.091 [−0.060]*	-0.057 [−0.349]*		
Probability of cluster	0.66	6.08	0.99	0.00
Pseudo – R^2	0.337			
Percent Correct	82.32			

Notes. Marginal effects are shown in brackets, calculated using average values; *t*-statistics are shown in parentheses; all retained variables are statistically significant at least at the 10 percent level; * indicates $p<0.05$.

Table 6
Multinomial logistic regression results, dissemination areas, burglary

	High-High	Low-Low	Low-High	High-Low
Constant	-5.26*		-2.386*	
Population Change, %	0.026 [0.158]*			
Males 15–24, %				0.291 [0.379]*
Recent Immigrants, %		-0.031 [−0.180]*		-0.060 [−0.079]*
Ethnic Diversity	0.025 [0.152]*	-0.019 [−0.110]		-0.031 [−0.040]
Unemployment Rate	0.072 [0.435]*		0.067 [0.153]*	
Dwelling Value, 000s	0.003 [0.016]*	0.001 [0.007]	-0.004 [−0.009]	-0.007 [−0.009]*
Major Repairs, %		-0.042 [−0.244]*		
Probability of cluster	6.06	5.83	2.31	1.30
Pseudo – R^2	0.074			
Percent Correct	76.67			

Notes. Marginal effects are shown in brackets, calculated using average values; *t*-statistics are shown in parentheses; all retained variables are statistically significant at least at the 10 percent level; * indicates $p<0.05$.

Table 7
Multinomial logistic regression results, dissemination areas, violent crime

	High-High	Low-Low	Low-High	High-Low
Constant		-1.869*	-6.597*	
Males 15–24, %		0.116 [0.719]*		
Single Parents, %	-0.195 [−0.046]*			0.376 [0.000]*
Ethnic Diversity	0.032 [0.008]	-0.026 [−0.158]*		
Unemployment Rate	0.161 [0.038]*	-0.048 [−0.299]*	0.117 [0.066]*	
Average Income, 000s	0.022 [0.005]*			
Population Density	-0.006 [−0.001]*	0.001 [0.002]*		-0.052 [−0.000]*
Dwelling Value, 000s	-0.018 [−0.004]*	0.002 [0.009]		
Rentals, %		-0.020 [−0.125]*	0.031 [0.017]*	-0.054 [−0.000]
Major Repairs, %	-0.078 [−0.018]*			
Probability of cluster	0.24	6.20	0.56	0.00
Pseudo – R^2	0.255			
Percent Correct	83.43			

Notes. Marginal effects are shown in brackets, calculated using average values; *t*-statistics are shown in parentheses; all retained variables are statistically significant at least at the 10 percent level; * indicates $p<0.05$.

The journey to crime

- Theoretically and empirically shown to be short
- Why travel further than necessary?
- All human behaviour
- Journey to violent crime is most often shorter than the journey to property crime
  - Commercial burglary, for example

Journey to crime in BC

Table 1. Distance to crime by crime type, kilometers, all ages.

Crime type	First quartile	Median	Third quartile	Interquartile range	Count
Homicide	0.00	0.66	4.61	4.61	374
Sexual assault	0.00	0.92	5.13	5.13	5971
Aggravated assault	0.00	0.30	2.52	2.52	8622
Assault	0.00	0.00	1.70	1.70	49,414
Robbery	0.89	2.09	6.49	5.60	856
Armed robbery	0.86	2.51	7.89	7.03	974
Residential burglary	0.35	1.50	4.67	4.32	4872
Commercial burglary	0.71	1.97	5.81	5.10	340
Other burglary	0.62	2.03	4.82	4.19	396
Theft of motor vehicle	0.23	2.21	7.26	7.03	2930
Theft from motor vehicle	0.64	1.78	4.45	3.82	1540
Theft	0.14	1.28	4.71	4.57	4968
All crimes	0.00	0.65	3.51	3.51	81,257

Source: RCMP Police Information Reporting System (PIRS).

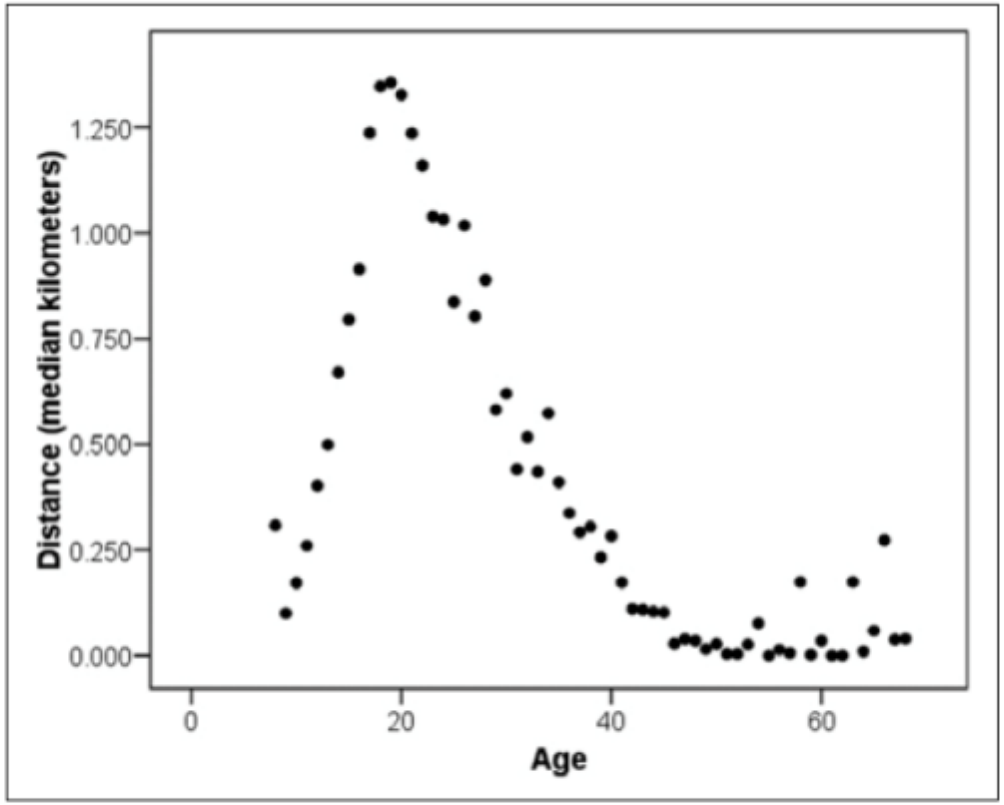


Figure 1. The age–distance to crime curve, by single year of age, all crime types aggregated.
Source: RCMP Police Information Reporting System (PIRS).

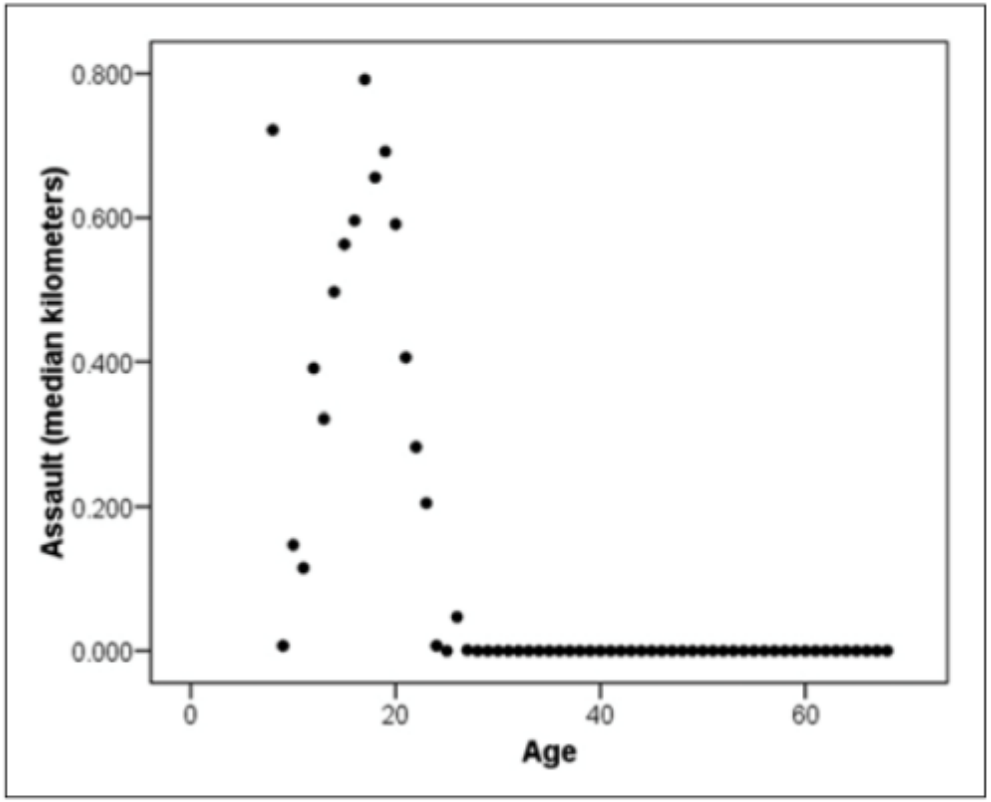


Figure 2d. The age–distance to crime curve, by single year of age, assault.
Source: RCMP Police Information Reporting System (PIRS).

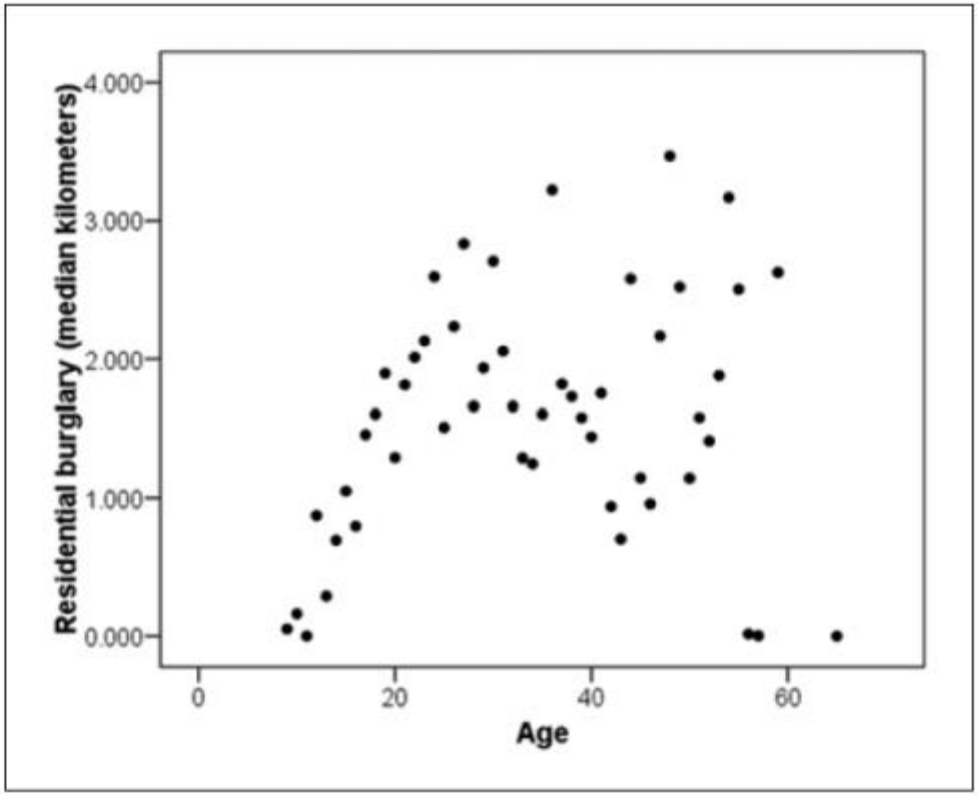


Figure 3a. The age–distance to crime curve, by single year of age, residential burglary.
Source: RCMP Police Information Reporting System (PIRS).

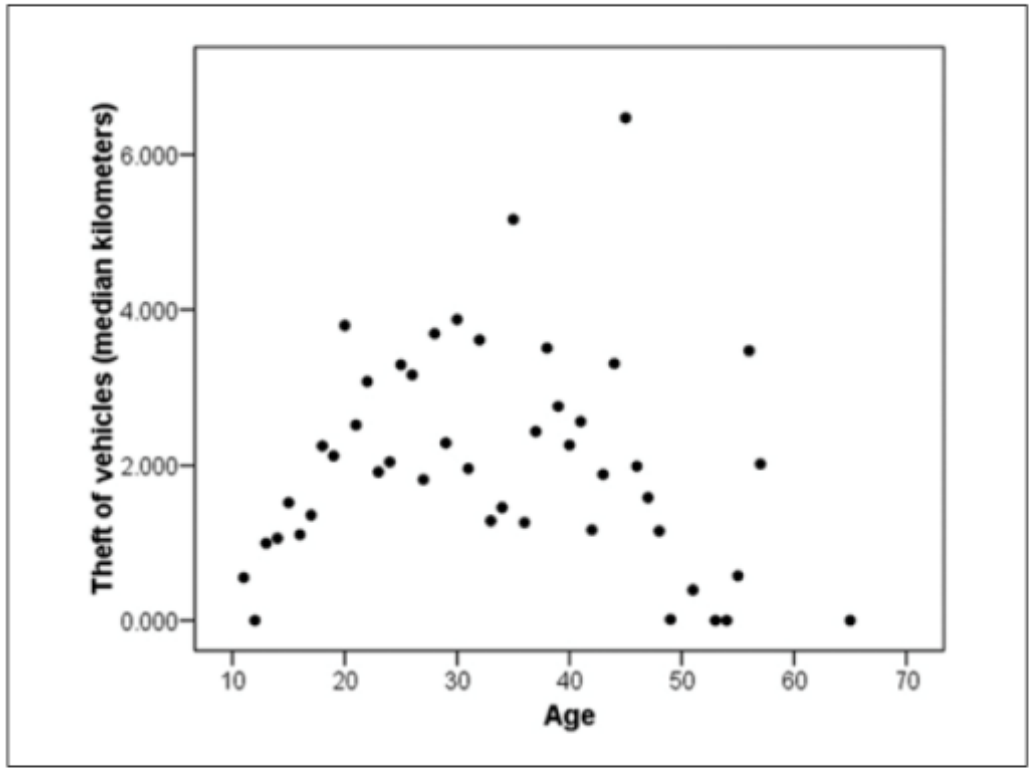


Figure 3d. The age–distance to crime curve, by single year of age, theft of motor vehicle.
Source: RCMP Police Information Reporting System (PIRS).

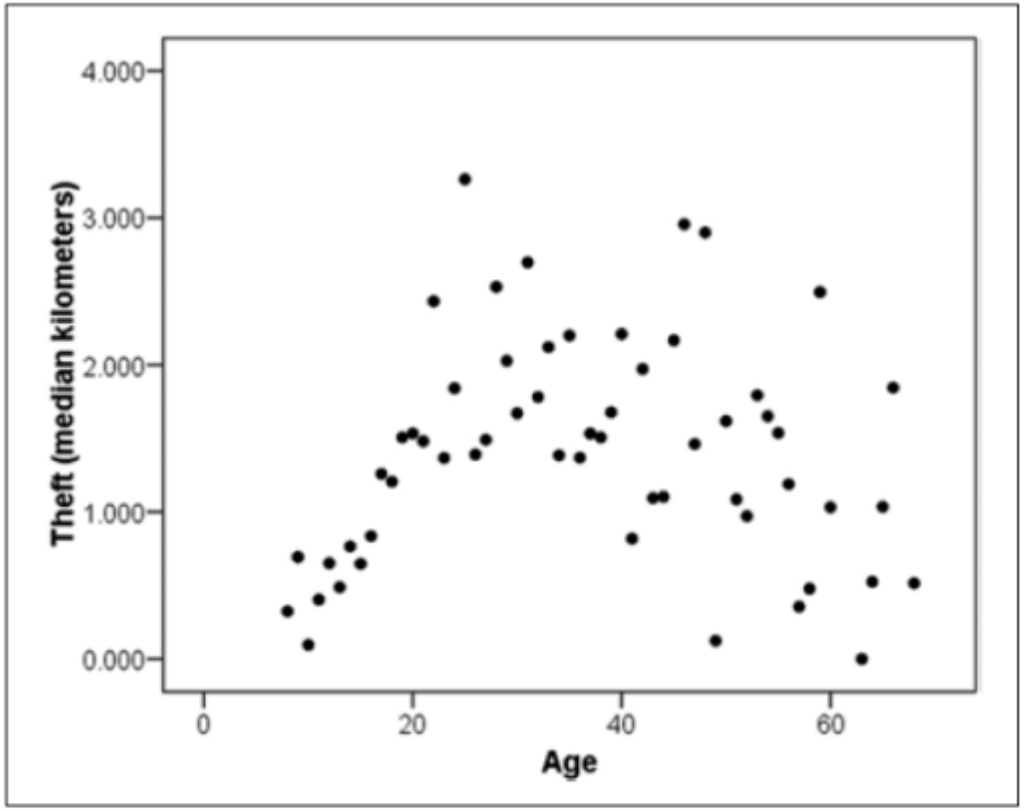


Figure 3f. The age–distance to crime curve, by single year of age, theft.
Source: RCMP Police Information Reporting System (PIRS).

What do we need to advance this literature?

- Census data
- Road network data
- High performance computing

Crime and place

- History of spatial criminology: spatial heterogeneity → cartographically larger units of analysis (smaller areas)
- Though countries/provinces/states/neighbourhoods are still common
- The micro-spatial unit of analysis seems most appropriate: street segments, street intersections, discrete locations

Crime concentrations

Table 1
Counts and percentages for crime types (aggregate and disaggregate).

	Count	Percentage	Percentage of street segments accounting of 50 percent of Crime	Percent of street segments that have any Crime	Percent of street segments with crime that account for 50 percent of crime
Ottawa, 2006					
Commercial Break and Enter	1460	19.5	0.55	2.31	23.78
Residential Break and Enter	2517	33.6	1.36	4.86	27.95
Total Break and Enter (Aggregate)	3977	53.1	1.67	6.61	25.30
Commercial Robbery	145	1.9	0.01[a]	0.30	27.84
Individual Robbery	241	3.2	0.31	0.65	47.66
Other Robbery	362	4.8	0.30	0.82	35.93
Total Robbery (Aggregate)	748	10.0	0.38	1.46	26.10
Theft of Vehicle	2765	36.9	0.99	4.50	22.02
Total (without double counting)	7490	100.0	1.70	9.52	17.87
Vancouver, 2001					
Assault	7643	13.4	1.62	18.75	8.64
Burglary	13,025	22.9	7.61	39.43	19.31
Robbery	1251	2.2	0.84	5.32	15.87
Sexual Assault	440	0.8	1.12	2.99	37.32
Theft	11,255	19.8	2.58	26.79	9.64
Theft of Vehicle	6273	11.0	5.97	27.11	22.01
Theft from Vehicle	16,991	29.9	2.64	18.75	8.64
Total (without double counting)	56,878	100.0	5.02	61.42	8.18

[a] actual value: 0.000823.

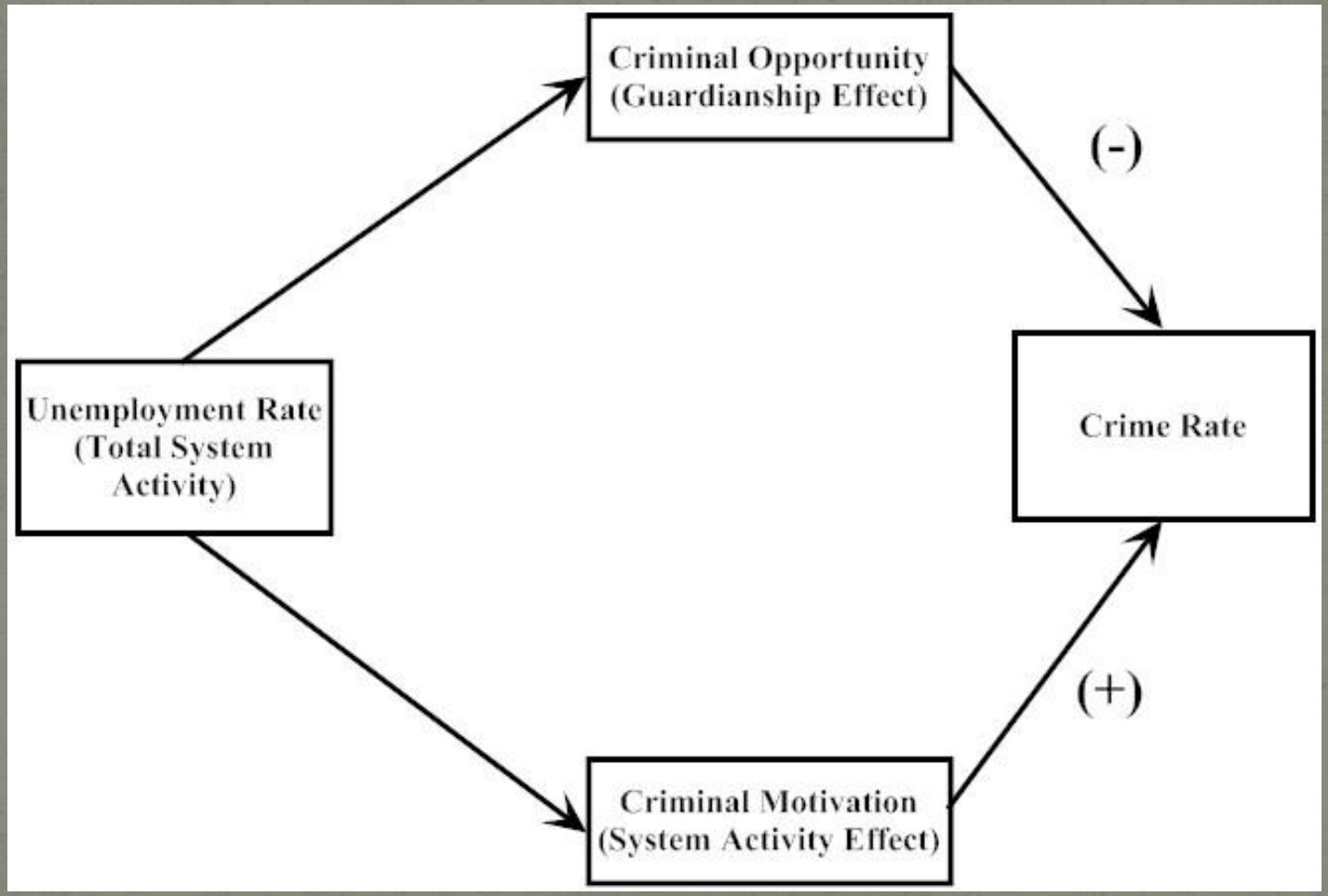
Crime trajectories

The economy and crime

- Does an increase in unemployment increase or decrease crime?

The economy and crime

- Theoretically it can do both!
- More unemployed persons: increased numbers of motivated offenders
- More unemployed persons: more people at home protecting person and property
- Which one dominates?


Criminal Opportunity
(Guardianship Effect)
(-)
Unemployment Rate
(Total System
Activity)
Crime Rate
(+)
Criminal Motivation
(System Activity Effect)

But is it just unemployment?

- Unemployment is an imperfect measure
- More direct measure of the economy? GDP, GPP?
- Low income?
- Activity-based data?

Canadian provincial level data

- Excellent data quality
- Many years of data
- More variables than available in most countries
- Including the United States

Table 2
Regression results, natural logarithm of property crime rate, Canadian Provinces, 1981–2009, All

	Property Crime		Violent Crime	
	Long Run Effects	Short Run Effects	Long Run Effects	Short Run Effects
GPP, millions 1992 dollars	2.01*	0.127	-7.69***	-2.99***
GPP per capita, 1992 dollars	-0.429	-0.021	3.28**	2.49***
Unemployment, percent	-0.048**	-0.014***	0.127***	-0.037***
Low income, percent	0.863***	0.007	-2.28***	-0.159**
Young males, percent	-6.27***	-0.561***	18.26***	0.73***
Gini coefficient	0.012	0.016***	-0.119*	0.026***
Alcohol spending, percent of GDP	0.878***	-0.156**	-1.54***	0.312***
Number of police officers	2.27***	0.706***	-5.97***	1.01***
Police officers per 100 000	-1.97*		10.03***	
Criminal incidents per officer	0.060	0.966***	3.59***	0.592***
Corrections spending, percent of GDP		-0.059		-0.161**
Immigrants, percent		-1.94***		-1.28
Immigrants, young male, percent		15.38***		14.88**
Net immigrants, percent		1.95***		1.01
Net immigrants, young male, percent		-15.09***		-13.56**
Interprovincial immigrants, percent		-0.072		-0.556***
Interprovincial immigrants, young male, percent		-0.222		1.28***
Interprovincial net immigrants, percent		-0.052		0.137*
Interprovincial net immigrants, young male, percent		0.296**		-0.072
Adjusted-R^2	0.96		0.95	

Notes. Estimated parameters are elasticities. * 10 percent significance; ** 5 percent significance; *** 1 percent significance. All inference based on heteroskedasticity and autocorrelation consistent errors.

Longitudinal research

- Very little in criminology that considers geography
- Literally a handful…some of which here at SFU
- Important for understanding theoretical relationships
  - Within- and between-group effects
- A 5-year census cycle and measurement error

Table 1
Crime counts by classification and year.

	1991	1996	2001
Property crime	63,588	80,019	47,556
Burglary	18,054	23,317	13,022
Automotive theft	28,678	36,867	23,261
Theft	16,856	19,835	11,273
Violent crime	14,618	14,098	10,321
Assault	10,281	9752	7458
Robbery	3359	3522	2230
Total crimes	155,434	187,410	115,121
Success rate	94%	93%	93%

Table 2
Descriptive statistics for dependent and independent variables.

	Minimum	Maximum	Mean	Std. deviation
Property crime rate	15.68	2467.90	140.88	237.63
Violent crime rate	1.96	508.65	27.35	54.74
Burglary rate	6.61	353.33	38.39	37.26
Auto theft rate	7.84	1487.31	66.45	136.74
Theft rate	1.23	627.26	36.05	66.73
Assault rate	0.99	346.02	19.21	39.49
Robbery rate	0.15	133.22	6.46	12.92
Unemployment, %	1.90	38.21	8.52	4.40
Population change, %	8.76	108.22	22.22	10.80
Males 15–24, %	1.39	15.76	8.36	3.13
Single parent families, %	6.31	31.65	15.98	5.04
Recent immigrants, %	3.71	38.71	18.21	7.86
Ethnic diversity	16.67	78.03	51.47	14.53
Post-secondary, %	10.61	91.48	33.79	14.70
Income, 000s	20.78	195.53	66.86	27.84
Population density	10.47	277.11	61.20	48.14
Dwelling value, 000s	115.99	1196.70	374.90	181.05
Rentals, %	14.36	98.17	50.95	20.86
Major repairs, %	1.09	21.13	8.06	3.18

Note. All crime rates are per 1000 residents.

Table 4
Regression results of logged property crime rate on full model, Vancouver census tracts (1991, 1996, 2001).

	Long run (between-group) effects		Short run (within-group) effects	
	Coefficient	Percent change	Coefficient	Percent change
Unemployment, %	0.11***	11.05	−0.04***	−4.23
Population change, %	0.04***	3.51	0.02**	1.54
Males 15–24, %	−0.04	−3.99	0.05***	5.32
Post-secondary, %	0.01	0.77	−0.02***	−2.04
Single parent families, %	−0.04***	−3.43	−0.02	−1.98
Recent immigrants, %	0.01**	1.40	0.01	0.48
Ethnic diversity	0.26	30.15	0.06	6.45
Income, 000s	0.00	0.37	0.00	−0.22
Population density	−0.00***	−0.27	−0.01*	−0.83
Dwelling Value, 000s	0.00	−0.07	0.00**	0.11
Rentals, %	0.00	0.08	0.01	0.76
Major repairs, %	0.06***	6.52	0.00	0.11
Adjusted R^2 = 0.74				

Notes. $N = 261$; all coefficients rounded to two decimal places.
* 10% Statistical significance.
** 5% Statistical significance.
*** 1% Statistical significance; statistical significance based on White's heteroskedastic consistent standard errors.

Table 8
Regression results of logged violent crime rate on full model, Vancouver census tracts (1991, 1996, 2001).

	Long run (between-group) effects		Short run (within-group) effects	
	Coefficient	Percent change	Coefficient	Percent change
Unemployment, %	0.18***	19.12	−0.01	−1.43
Population change, %	0.03*	2.53	0.01	0.94
Males 15–24, %	−0.01	−0.93	0.05**	4.80
Post-Secondary, %	0.01	1.27	−0.02**	−1.59
Single parent families, %	−0.01	−1.26	0.00	−0.18
Recent immigrants, %	0.01	1.41	0.00	−0.25
Ethnic diversity	0.61	83.43	0.31	36.27
Income, 000s	0.00	0.36	0.00	0.02
Population density	−0.00**	−0.18	−0.01*	−1.02
Dwelling value, 000s	−0.00*	−0.12	0.00	0.09
Rentals, %	0.01	0.63	0.01	0.68
Major repairs, %	0.05**	4.61	−0.01	−1.19
Adjusted $R^2 = 0.75$				

Notes. $N = 261$; all coefficients rounded to two decimal places.
* 10% Statistical significance.
** 5% Statistical significance.
*** 1% Statistical significance; statistical significance based on White's heteroskedastic consistent standard errors.

This is the only census/neighbourhood level study of its kind

- It was made possible because of the Canadian census
- And the Data Liberation Initiative
- Almost everything I do is dependent on the DLI
- It helps advance social science in Canada
  - Hopefully aiding public policy

DLI and Crime Science

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