



# The Impact of a Public Transit System on Crime: A Case Study on Los Angeles

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Konferenz Verkehrsökonomie und Verkehrspolitik  
TU Berlin

Berlin  
26. Juni 2014



Motivation

Literature

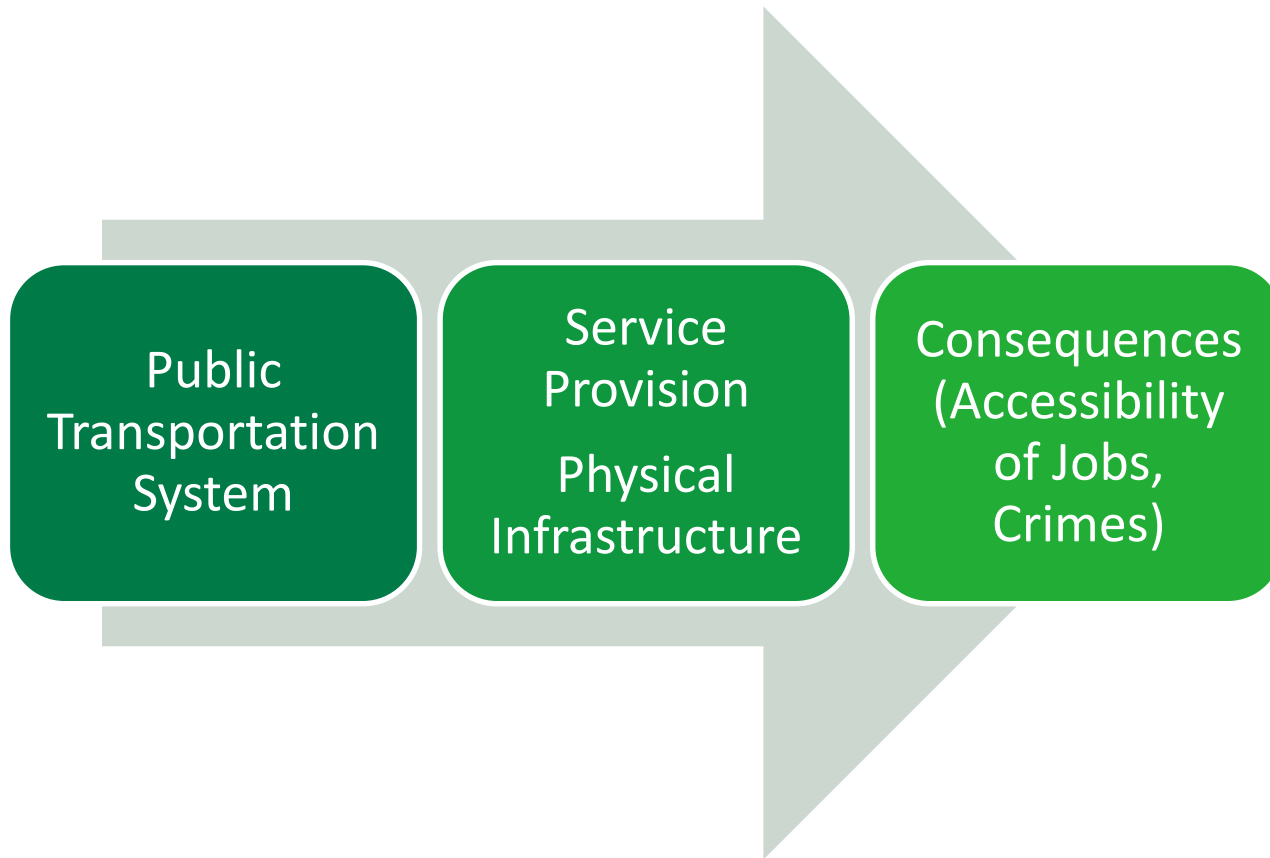
Modelling Approach & Hypotheses

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# MOTIVATION



## **What is the outcome of public transit systems?**

- Accessibility (i.e. less transportation cost) of certain areas for certain population groups
- Physical transportation infrastructure (i.e. people and personal interactions in and near stations)

## **How is social peace affected by a public transit system?**

- Broad job market → higher income (for low-income population?) → higher equality
- Easier access/location of potential crime scenes → attraction to criminals

# LITERATURE

### Social Aspects of Public Transportation

- *Lucas (2012)* - Social exclusion and accessibility planning
- *Bhatta/Drennan (2003)* - Benefits of public investments in transportation
- *Hine (2009)* - Impact of transport access on access of services, education, and jobs

### Income Inequality

- *Rodriguez-Pose/Tselios (2008)* – EU NUTS I/II, no transport features
- *Sanchez (1999)* – US MSA, inclusion of public transport service provision → higher public transit service level lowers income inequality
- *Nielsen/Alderson (1997)* – US Counties, no transport features
- *Bocarejo/Oviedo (2012)* – One city (Bogota), accessibility measures → no econometric analysis of Gini coefficient effects

### Crime

- *Fajnsylber/Lederman/Loayza (1998)* – Country level, no transport features
- *Hartung/Pessoa (2007)* – State level (Brazil), no transport features
- *Carcach (2001)* – State level (Australia), accessibility index → less property crime in remote regions, more violent crime in highly accessible regions
- *Sampson/Raudenbush/Earls (1997)* – Neighborhood level (Chicago), no transport features
- *Plano (1993)* and *Poister (1996)* – Neighborhood level (Baltimore), distance to rail stations (very selective data) → no correlations
- *Block/Block (2000)* – Neighborhood level (Bronx, Chicago), distance to subway station, only robberies → positive relationship
- *Bowes/Ihlanfeldt (2001)*, *Ihlanfeldt (2003)* – Neighborhood level (Atlanta), transport features (distance to metro stations, no service feature), no separation of property/violent crime → more crime close to metro stations in city center
- *Ligett (2003)* – Neighborhood level (Los Angeles) → only one Metro line
- *Willoughby (2014)* – Neighborhood level (Durham) → no correlation

- Younger literature incorporates transport features on an appropriate geographical level
- Often: Limited economic modelling idea
- Almost no distinction between different crime types

# MODELLING APPROACH & HYPOTHESES



Becker, G. (1968): Crime and Punishment: An Economic Approach, Journal of Political Economy 76, p. 169-217.

„Economics of Crime“: Crime happens if **net benefit of crime to the criminal** exceeds a certain level (defined by his/her **moral barrier**)

$$D = \begin{cases} 1 & \text{if } nb \geq mb \\ 0 & \text{if } nb < mb \end{cases}$$

$$nb = (1 - r_{thwart}) * r - ac - tc - oc - r_{thwart} * p$$

D	Decision to commit crime	$pr_{thwart}$	risk of crime thwarting
nb	Net benefit of crime	r	Reward
mb	Moral barrier minimum	ac	Accounting cost
		tc	Transport cost
		oc	Opportunity cost
		p	Punishment

Determinants	Socio-demographic influence factors	Public Transit Service	Public Transit Infrastructure
<i>Reward</i>	Median income [+] Population density [+] Density retail/manufacturing employment [+] Population density [+]		
<i>Risk</i>	Proxies for policing/potential witnesses: Median income [-] Population density [-]	Accessibility (car) [-]	
<i>Cost</i>	Educational attainment [+] Median income [-]	Accessibility (car) [+] Accessibility (PT) [+] Freeway access [+]	Dist. metro station/bus stop [-] Rail surface [+]
<i>Punishment</i>	[Expected sentence] [-]		
<i>Moral Barrier</i>	Ethnicity [?] Origin [?] Potential gang activity [+] Inequality [+] Educational level [-] Residential instability [+] Family structure [?] Unemployment [+] Educational attainment [-]	<div style="border: 1px solid black; padding: 5px;"> <p><i>Criminals: Tendency of residents to engage in crime</i>  <i>Victims: Attractiveness of neighborhood to criminals</i>  <i>Transportation: Neighborhood access</i></p> </div>	

## Approach I

- Number of crime incidents: non-negative count data → *Poisson regression*
- Poisson assumption: mean = variance → violation due to omitted variables or over-dispersion → *Negative binomial regression*
- Coefficient output as *incident rate ratio*: growth factor of endogenous variable for every unit increase of exogenous variable
- Exposure variable: Area of Census tract

## **Further issues/robustness checks**

- Control variables: Major malls, major campuses, stadiums, correctional facilities, Metro line
- No punishment variable (→ constant)
- Variation of inequality measure: Poverty Density vs. Gini Coefficient vs. Rich-Poor Ratio
- Mono- vs. polycentric city: Distance to CBD vs. Accessibility (car, public transit)
- Distance bands to Metro station/bus stop
- Interaction effects with income and centrality (distance to CBD resp. accessibility)

## Approach II

- Take severity of crime incidents into account → *Ordered Logit Model*
- Parallel lines assumption violated → *Generalized Ordered Logit Model*
- Coefficients: Increase of probability of a certain crime
- Assumptions on ordering:
  - Theft < Burglary < Motor Vehicle Theft < Arson
  - Assault < Robbery < Rape < Homicide

# DATA

## Area

- Los Angeles County
- Spatial units: Census Tracts (2152)
- Highly urbanized to rural zones
- Radial Metro network, extensive bus services (local to BRT) → strong variation in public transit service provision
- Relatively high crime rates

## Data Sources

- CrimeMapping, CompStat 2013/14
- US Census 2011/12
- Google Maps Routing data 2013, metro.org

## **Crime Data (Part I crimes)**

- Property Crime (theft, burglary, MV theft, arson)
- Violent Crime (assault, robbery, rape, homicide)
  
- Lagged by approx. 1 year



## Transport Services: Accessibility

- Combined measure of attractivity of destinations (jobs) and spatial friction (real world distances) → Spatial centrality with respect to jobs

*Demand weighted potential indicator*

$$DPI_i = \sum_{j=1}^n \frac{WP_j * e^{-\alpha TT_{ij}}}{D_j} \quad \text{with} \quad D_j = \sum_{k=1}^n W_k * e^{-\alpha TT_{kj}}$$

i, k	Origin ZCTA	$TT_{ij}$	Travel time from ZCTA i to j
j	Destination ZCTA	$WP_j$	Number of workplaces in ZCTA j
$\alpha$	Distance decay parameter	$W_k$	Working-age population in ZCTA k

# Descriptive Statistics

Variable	Mean	St. Dev.	Min	Max	Variable	Mean	St. Dev.	Min	Max
Property Crime Incidents	19.25	22.73	0.00	276.00	Violent Crime Incidents	7.43	20.40	0.00	823.00
Share African American Population	8.45	13.50	0.00	92.70	Median Income	28653.92	13735.69	-2500	99595
Share Asian Population	13.67	15.68	0.00	88.5	Population Density	7.76	1.11	1.35	9.86
Share Latino Population	47.31	29.45	0.00	100.00	Retail Employment Density	256.39	263.57	0.00	3789.31
Share Foreign-Born Population	35.50	14.60	0.00	81.80	Manufacturing Employment Density	266.90	366.42	0.00	5732.74
Share Young Males (15-25)	7.71	4.02	0.00	68.27	Distance CBD (km)	22.29	14.27	0.24	84.70
Share Young African American Males	0.65	1.20	0.00	11.93	Accessibility (Car)	70.62	16.92	0.00	103.16
Share Young Asian Males	0.89	1.45	0.00	13.68	Accessibility (PT)	71.01	27.56	0.00	169.39
Share Young Latino Males	4.38	3.62	0.00	56.44	Freeway Access (D)	0.35	0.48	0.00	1.00
Poverty Density	1158.64	1699.27	0.00	21823.85	Share Rail Surface	1.58	3.85	0.00	33.81
Gini Coefficient	41.84	6.40	6.00	71.97	Distance nearest Metro Station (km)	9.60	11.83	0.06	68.42
Rich-Poor Ratio	12.04	2.62	1.00	18.00	Distance nearest Bus Stop (km)	2.66	8.34	0.00	64.03
Educational Attainment (Years)	12.74	1.53	9.55	16.27	Mall (D)	0.01	0.11	0.00	1.00
Share Renters	52.12	26.81	0.00	100.00	Stadium (D)	0.00	0.09	0.00	1.00
Vacant Housing Density	128.37	190.34	0.00	2786.74	Campus (D)	0.00	0.09	0.00	1.00
Share Female-headed Households	16.57	8.78	0.00	56.50	Correctional Facility (D)	0.00	0.03	0.00	1.00
Unemployment Rate	7.18	3.16	0.00	57.90					

# ESTIMATION RESULTS

## Property Crime - General

- Share African American Population (+)
- Share Asian Population (-)
- Share Foreign-born Population (+)
- Share Young African American Males (gangs) (-)
- Poverty Density (-)
- Residential Instability (+)
  - Share of Renters (+)
  - Vacant Housing Density (+))
- Unemployment Rate (+)
- Population Density (+) → reward effect dominant
- Mall (+)
- Stadium\* (+)

## **Transportation Features**

### Centrality

- Flat crime gradient (w.r.t. Distance to CBD and Accessibility (Car))
- PT accessibility: Negative PC gradient
- Relatively more property crime close to Metro stations and bus stops (<1500m)
- More property crime near Expo, Red (Gold and Purple)\* line

### Interaction effects

- Especially more property crime close to Purple line Metro stations
- Less property crime close to Metro stations with increasing remoteness of location

### Freeway Access (+11 to 14%)

## Violent Crime - General

- Share African American Population (+)
- Share Asian Population (-)
- Share Young African American Males (gangs) (-)
- Poverty Density (-)
- Educational Attainment (-) → Moral Barrier effect dominant
- Residential Instability (+)
  - Share of Renters (+)
  - Vacant Housing Density (+)
- Population Density (+) → reward effect dominant
- Mall (+)
- Campus (-)
- Correctional Facility (+)

## **Transportation Features**

### Centrality

- Negative crime gradient (w.r.t. Distance to CBD and Accessibility (PT))\*
- Relatively more violent crime close to Metro stations and bus stops (<1000m)
- More violent crime near Green, Red (Gold and Purple)\* line

### Interaction effects

- Especially more property crime close to Green, Gold and Purple line Metro stations
- Less property crime close to Metro stations with increasing remoteness of location

### Freeway Access\* (+10%)

## **Violent Crime (Homicides)**

- Share Young Males (-)
- Share Young African American Males (gangs) (+)
- Gini Coefficient (-)
- Educational Attainment (-)
- Population Density (+)
- Campus (-)
- Correctional Facility (-)



## **Transportation Features**

### Centrality

- Flat homicide gradients
- Relatively more homicides in 500-1000 meter distance to Metro stations and very near to bus stops (<250 meters)\*
- No general effect of proximity to Metro lines

Interaction effects – significantly more homicides close to particular stations:

- Blue, Gold and Red line (<500m distance)
- Purple line (<1000m distance)
- Expo line (<3000m distance)

Share of Rail Surface (+) → cover-up

## **Severity Levels of Property and Violent Crimes**

- Small or statistically insignificant coefficients for variables characterizing **offender** and victim
- Centrality, freeway access and share of rail surface with small or statistically insignificant coefficients

# Property Crimes

	Distance CBD				Accessibility			
	Theft	Burglary	MVT	Arson	Theft	Burglary	MVT	Arson
<b>Distance Band: Metro</b>								
500m	5.3%	-3.8%		-0.2%				
1000m	-8.9%	3.0%	6.0%	-0.1%	-13.0%	5.7%	7.3%	
1500m	-8.1%		6.8%		-11.9%	3.7%	8.0%	
3000m	-11.4%		9.9%		-15.0%	3.8%	11.1%	
5000m	-7.0%		6.5%		-10.5%	2.7%	7.7%	
<b>Distance Band: Bus</b>								
250m	11.3%	-13.3%		-0.3%	8.7%	-11.3%	2.8%	-0.1%
500m		-4.1%	7.3%	-0.1%	-5.7%		8.0%	
1000m			5.1%		-5.1%		6.1%	
1500m	-5.2%		5.3%		-7.9%		6.6%	
3000m			5.8%		-5.2%		6.9%	
<b>Red Line</b>	7.9%		-6.9%	-0.1%	7.4%		-6.9%	-0.1%
<b>Purple Line</b>	10.2%	-3.5%	-6.6%	-0.1%	11.7%	-4.5%	-7.1%	-0.2%
<b>Blue Line</b>	4.7%		-5.1%		6.2%		-5.3%	
<b>Expo Line</b>	6.7%		-6.4%	-0.2%	8.0%		-7.0%	-0.2%
<b>Green Line</b>			-3.8%		5.3%		-4.4%	
<b>Gold Line</b>	6.3%		-6.4%		8.5%	-2.3%	-6.3%	
<b>Observations</b>		44164				44164		
<b>Pseudo R<sup>2</sup></b>		0.0634				0.0634		

- Theft probability high close to Metro stations and bus stops
- Burglary less likely very close to Metro stations and bus stops
- MVT likely a bit away from Metro stations/bus stops
- High theft probability near Purple, Red, Expo and Gold Line

# Violent Crimes

		Distance CBD				Accessibility			
		Assault	Robbery	Rape	Homicide	Assault	Robbery	Rape	Homicide
<b>Distance Band: Metro</b>									
	500m	-9.7%	10.2%			-4.7%	5.1%		
	1000m	-8.3%	8.7%			-3.4%	3.7%		
	1500m	-9.1%	9.4%			-4.6%	5.0%		
	3000m	-7.5%	7.3%			-3.2%	3.0%		
	5000m	-7.4%	7.5%			-3.9%	4.0%		
<b>Distance Band: Bus</b>									
	250m	-21.3%	18.9%	1.8%	0.6%	-11.9%	10.6%	0.9%	0.4%
	500m	-11.0%	7.3%						0.7%
	1000m	-12.9%	10.2%						
	1500m	-13.7%	8.6%	5.7%	-0.6%			3.1%	-0.7%
	3000m	-11.8%	10.1%						
<b>Red Line</b>									
<b>Purple Line</b>									
<b>Blue Line</b>									
<b>Expo Line</b>									
<b>Green Line</b>									
<b>Gold Line</b>									
<b>Observations</b>				16804				16804	
<b>Pseudo R<sup>2</sup></b>				0.0606				0.0604	

- Risk of robbery increases closer to Metro stations and bus stops (latter with heterogeneous pattern for CBD model)
- Some hints that rape and homicides may be affected by public transportation infrastructure

# SUMMARY

## Transportation significantly affects crimes in Los Angeles County

### *Property crime:*

- Freeway access
- More property crime close to Metro stations/bus stops (esp. Purple line respectively theft/larceny)
- Farther out Metro stations generate less property crime

### *Violent crime:*

- More violent crime close to Metro stations/bus stops (esp. Green, Gold and Purple line respectively robbery)
- Farther out Metro stations/bus stops generate less violent crime

→ Relatively similar and robust effects