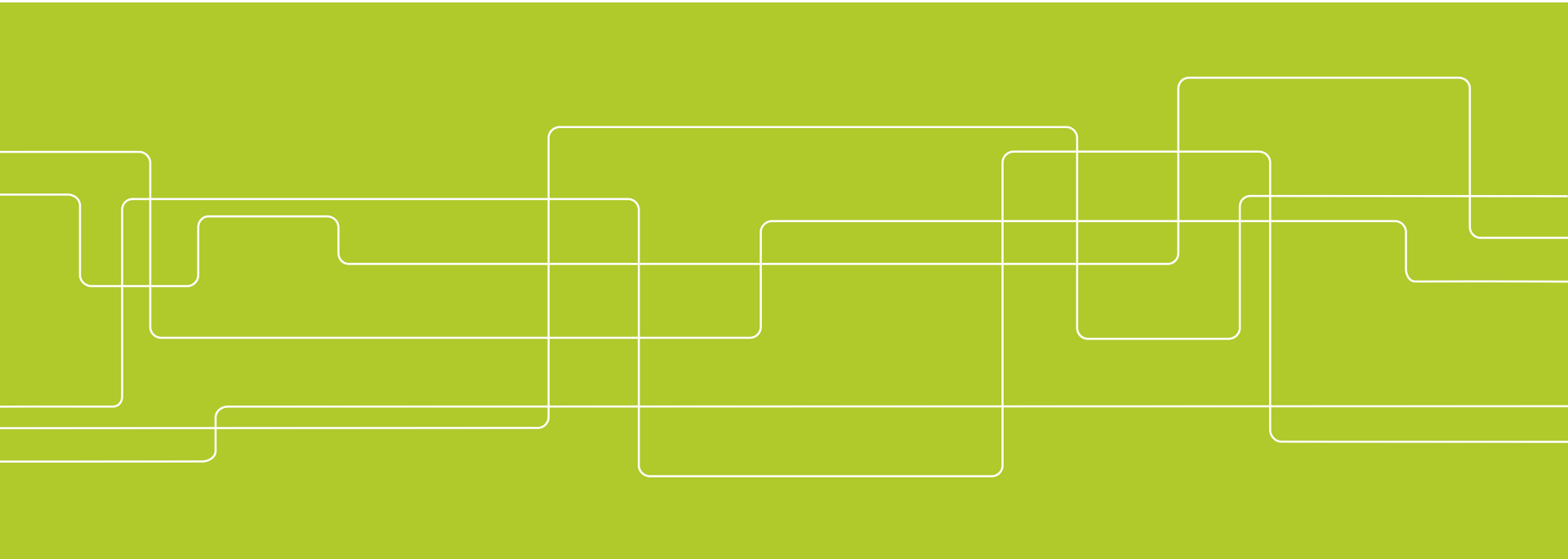




# Adaptation Patterns in Stockholm and Gothenburg

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# General Areas of Concern

Incidence of pricing can vary across population groups

- **Relevance**, relative to normal travel patterns
- **Cost**, relative to income
- **Geography**, relative to destinations and access to alternatives
- **Peak charging hours**, relative to schedule flexibility



## Some Theories

- Charges felt less by lower-incomes, due to car use
- Charges felt less by some higher-incomes, due to geography
- Burden of charges greater on lower-incomes
- Time-adjustment more difficult for lower-incomes
- Time-adjustment more difficult for families with children



# Research Questions

1. How great is mode-adjustment, compared to other adaptation strategies?
2. How much do seasonal effects blur the results?
3. Did Gothenburg see different adaptation strategies than Stockholm?
4. Do travelers reorganize trip chains to adapt?
5. Do household members rebalance activities?
6. What underlying circumstances are associated with different adaptation strategies for different groups?
7. Are these circumstances the *cause* of these differences?
8. What mitigation measures would give most effect?



# Approach

## Locations

- Stockholm, 2004-2006
- Gothenburg, 2012-2013

## Groups

- Men/Women
- 3 Quartiles of Income/Consumption
- 4 Age Groups
- Presence of Small Children and/or Youth

## Adjustments

- Mode Choice
- Car Occupancy
- # Trip-Chains
- # Trip-Links
- Length of Trip-Chains
- Dep. Time to Work/School
- Dep. Time back Home

## Trip Type

- Across Cordon
- Not Across Cordon



# Journey-to-Work/School Mode in Stockholm

## All Trips

		2006									
		Walk	Bike	MC	Car		Taxi	Para-transit	PT	Other	
					Driver	Pass.					
2004	Walk	65.3%	0.7%	0.0%	10.2%	2.4%	0.7%	0.0%	20.7%	0.0%	
	Bike	23.0%	15.1%	0.3%	16.0%	6.0%	0.3%	0.0%	38.7%	0.6%	
	MC	3.2%	0.0%	3.2%	48.4%	0.0%	0.0%	0.0%	45.2%	0.0%	
	Car	Driver	3.0%	0.5%	0.0%	81.0%	2.6%	0.1%	0.0%	12.8%	0.1%
		Pass.	5.8%	0.7%	0.0%	27.5%	41.3%	0.7%	0.0%	23.9%	0.0%
	Taxi	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	50.0%	0.0%	
	Paratransit	0.0%	0.0%	0.0%	0.0%	25.0%	0.0%	25.0%	50.0%	0.0%	
	PT	4.4%	0.3%	0.0%	11.7%	2.0%	0.3%	0.0%	80.9%	0.4%	
	Other	6.0%	4.0%	0.0%	12.0%	6.0%	0.0%	0.0%	62.0%	10.0%	



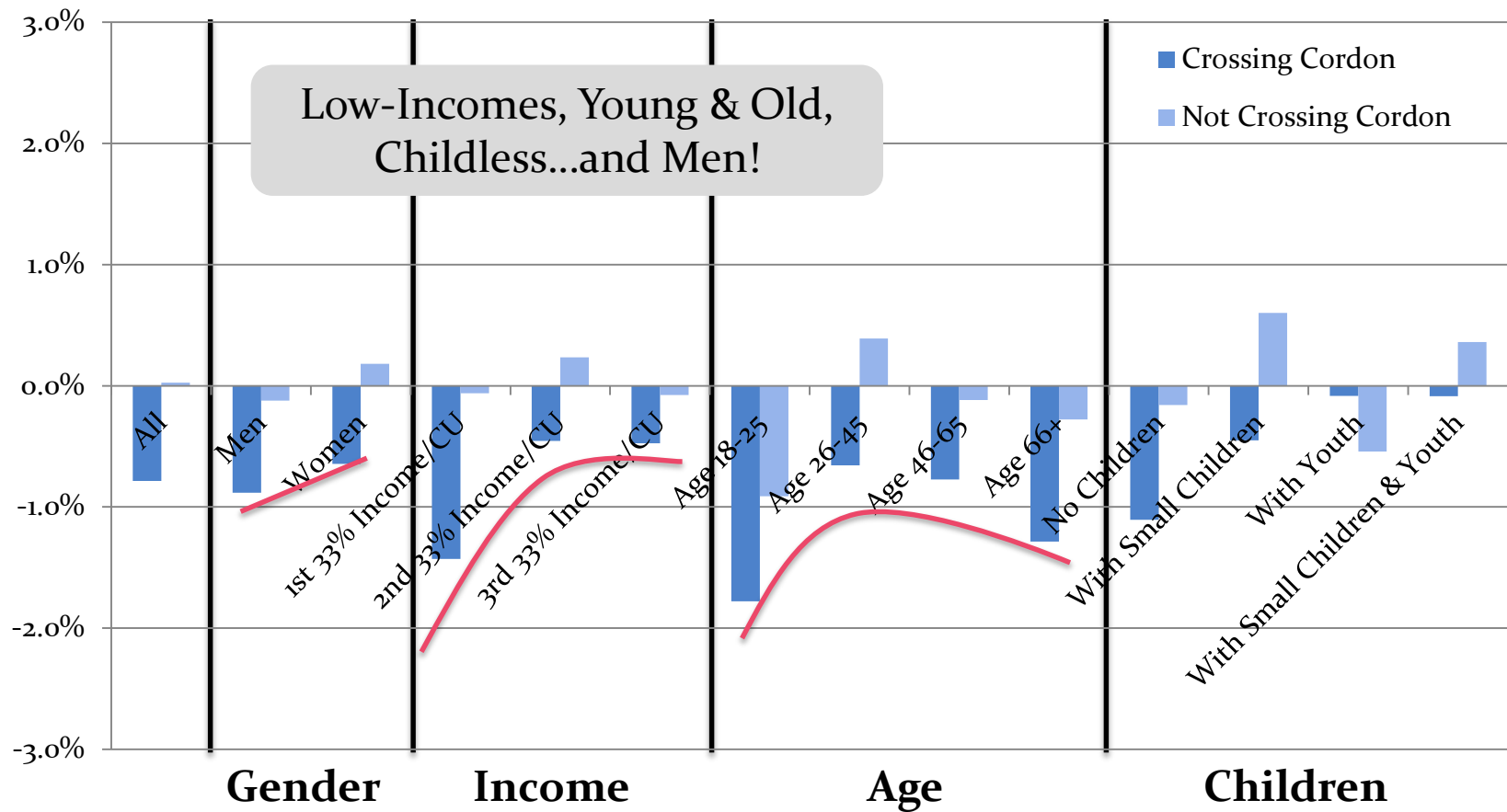
# Journey-to-Work/School Mode in Stockholm

## *Crossing Cordon Only*

		2006									
		Walk	Bike	MC	Car		Taxi	Para-transit	PT	Other	
					Driver	Pass.					
2004	Walk	<b>60.0%</b>	0.0%	0.0%	0.0%	0.0%	20.0%	0.0%	<b>20.0%</b>	0.0%	
	Bike	<b>14.3%</b>	<b>46.4%</b>	3.6%	7.1%	3.6%	0.0%	0.0%	14.3%	10.7%	
	MC	0.0%	0.0%	7.7%	38.5%	0.0%	0.0%	0.0%	<b>46.2%</b>	7.7%	
	Car	Driver	0.5%	0.5%	0.0%	<b>47.1%</b>	1.3%	0.0%	0.0%	<b>48.4%</b>	2.2%
		Pass.	0.0%	2.0%	0.0%	<b>16.3%</b>	<b>30.6%</b>	0.0%	0.0%	<b>46.9%</b>	4.1%
	Taxi	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	<b>100.0%</b>	0.0%	
	Paratransit	--	--	--	--	--	--	--	--	--	
	PT	3.2%	0.8%	0.0%	<b>30.2%</b>	5.6%	0.8%	0.0%	<b>36.5%</b>	<b>23.0%</b>	
	Other	0.0%	0.0%	0.0%	10.3%	3.8%	0.0%	0.0%	<b>14.1%</b>	<b>71.8%</b>	

# Car Mode Share by Population Group

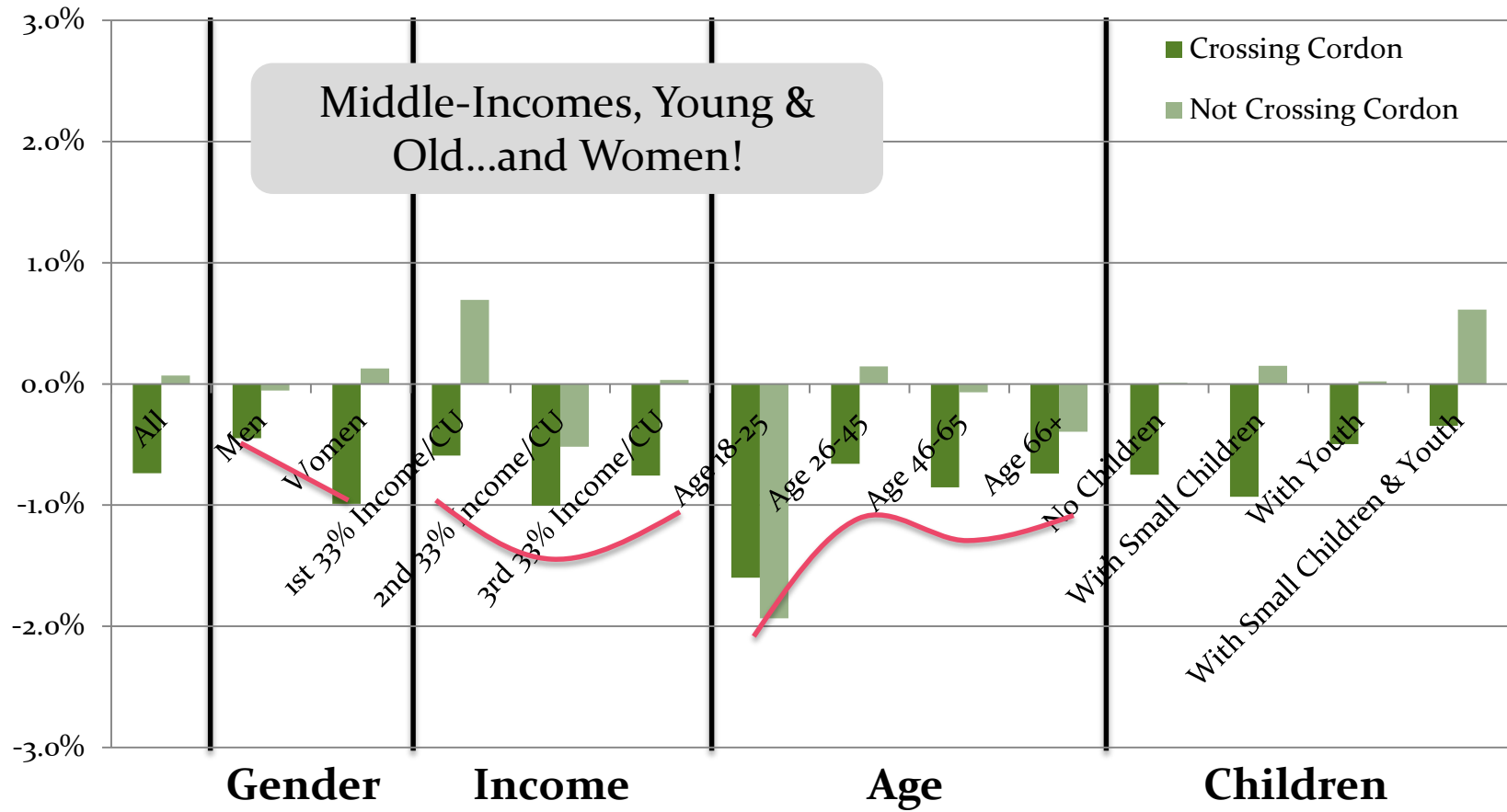
## Stockholm, % Change from 2004 to 2006





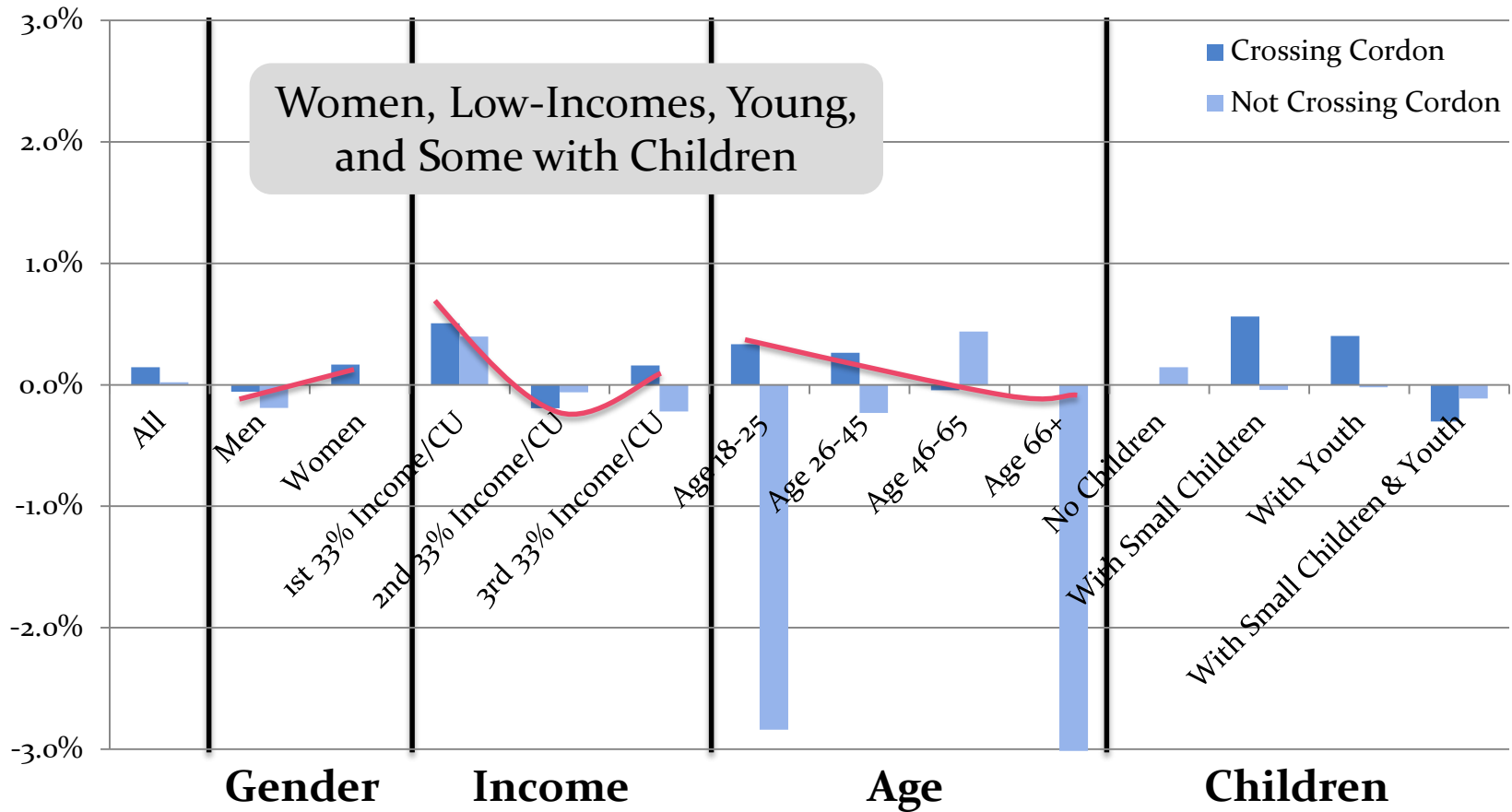
# Car Mode Share by Population Group

## Gothenburg, % Change from 2004 to 2006



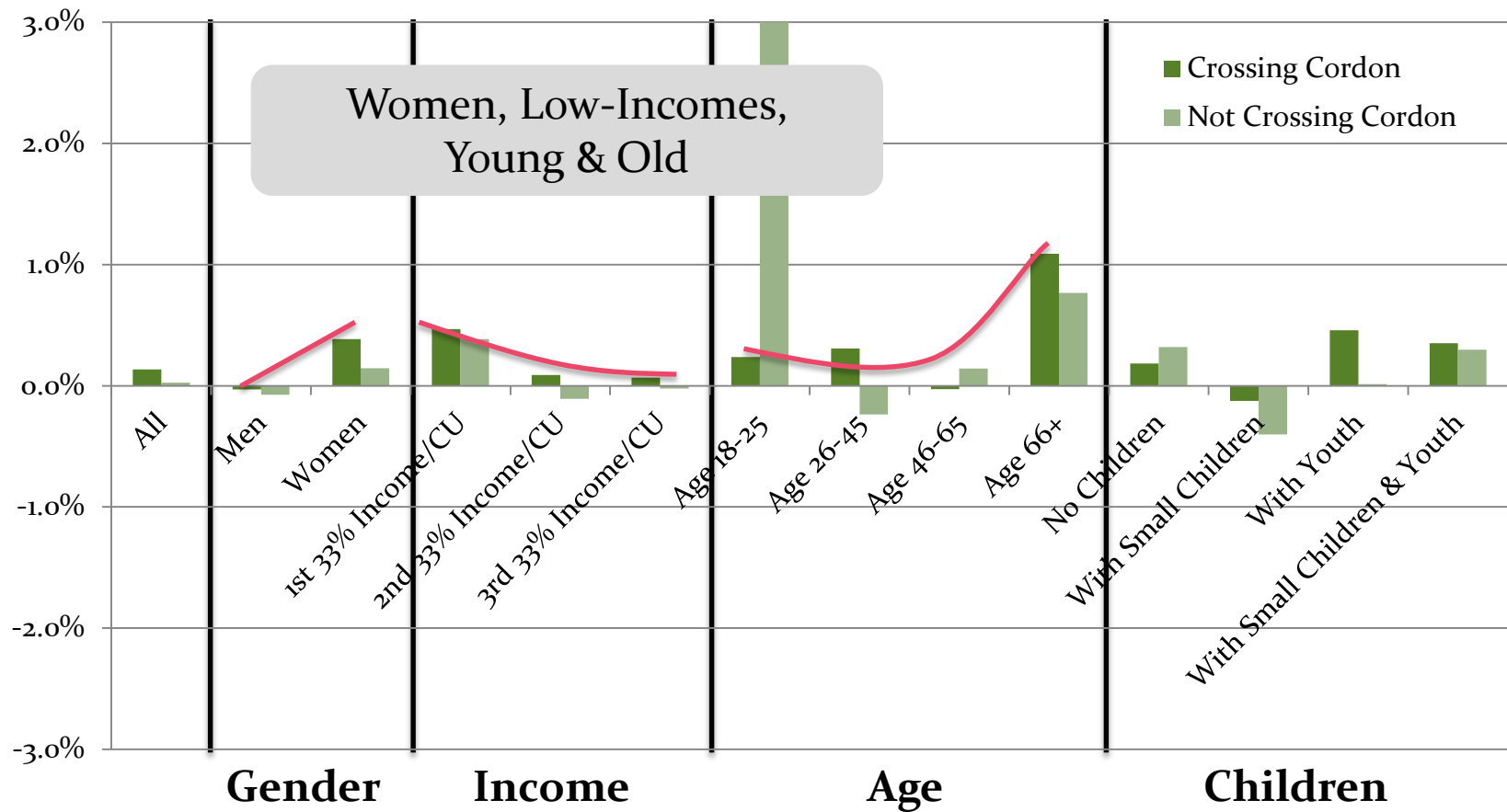
# Car Occupancy by Population Group

## Stockholm, % Change from 2004 to 2006



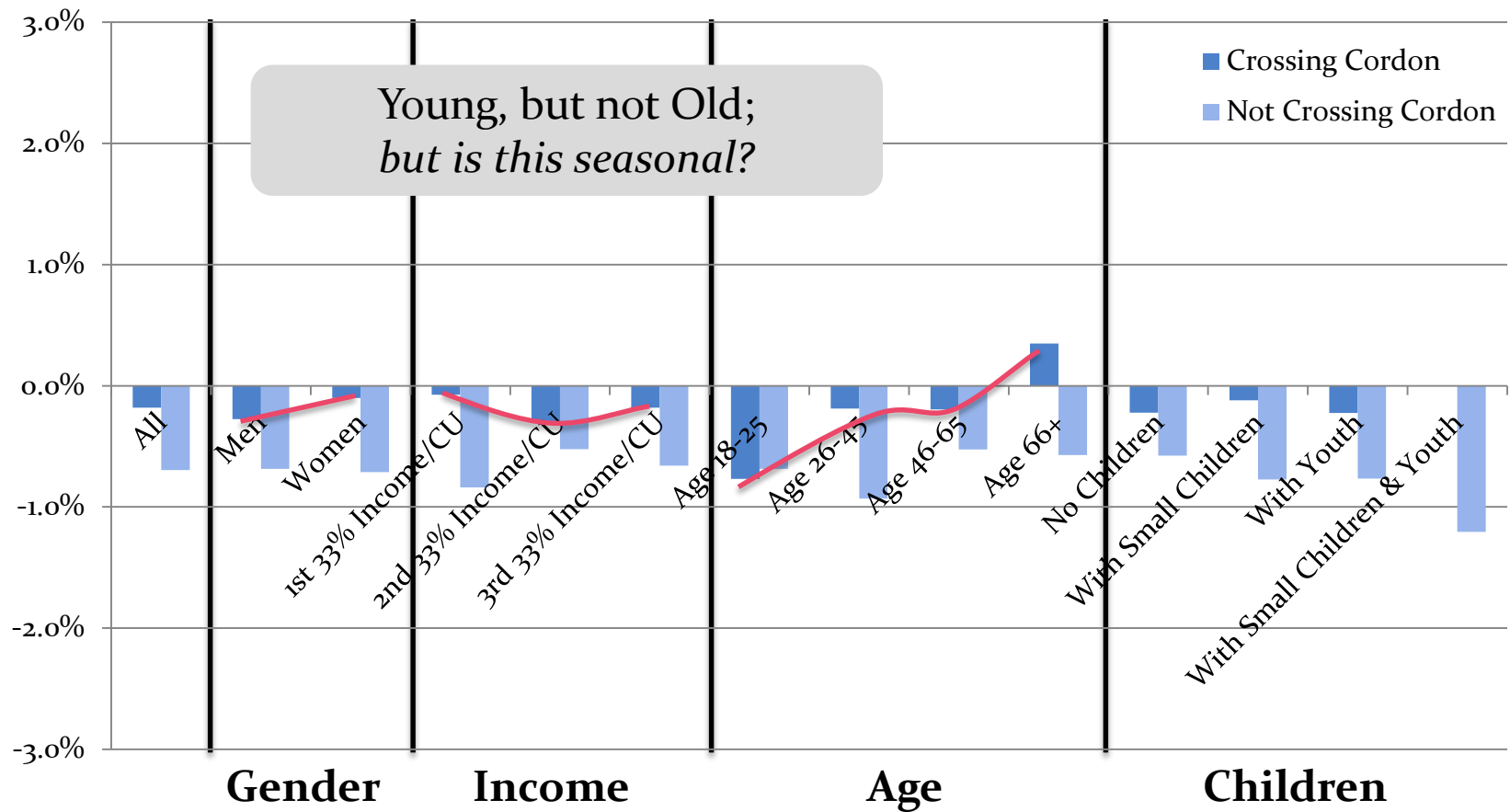
# Car Occupancy by Population Group

## Gothenburg, % Change from 2012 to 2013



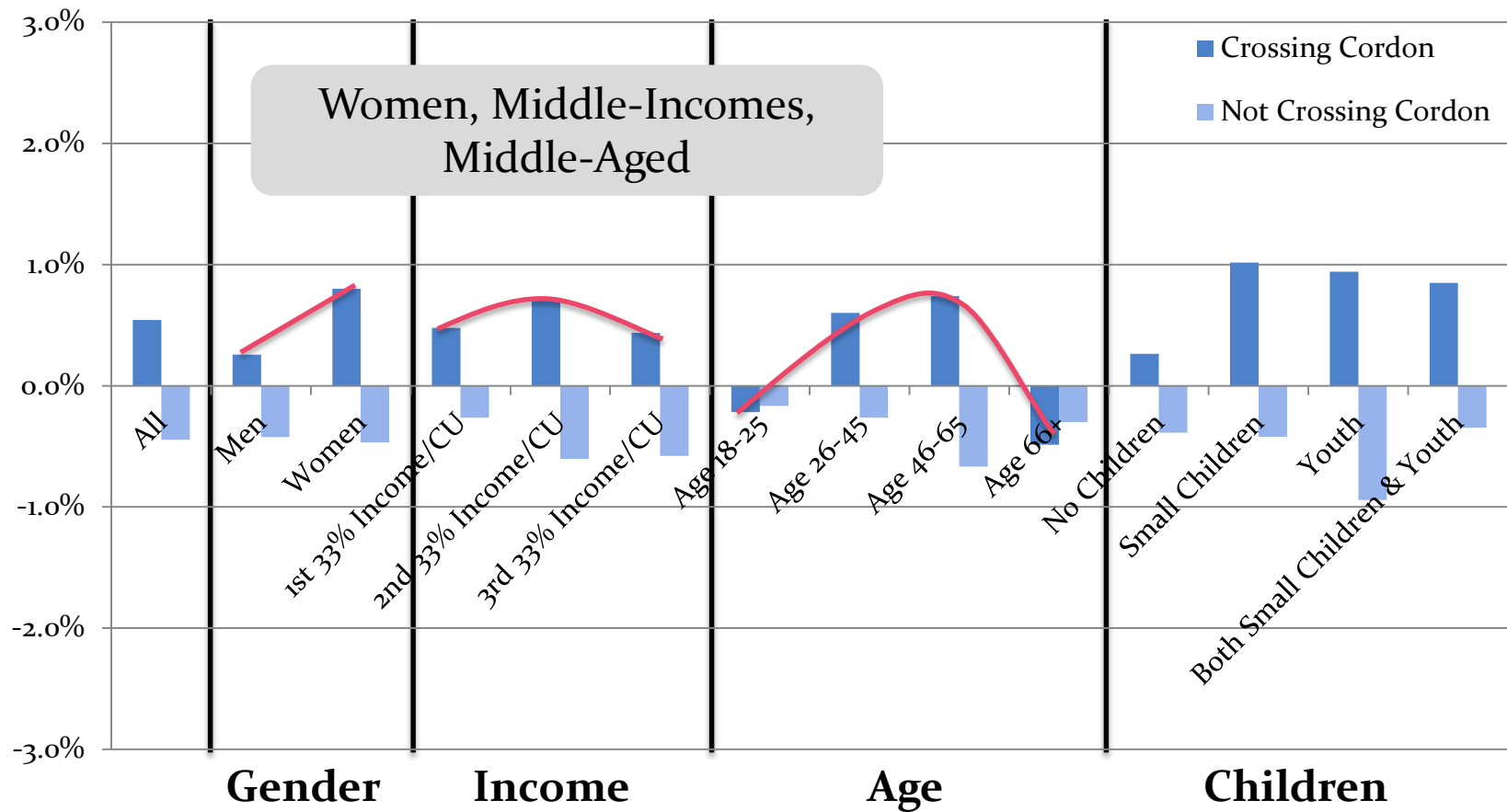
# Number of Trip Chains

## Stockholm, % Change from 2004 to 2006



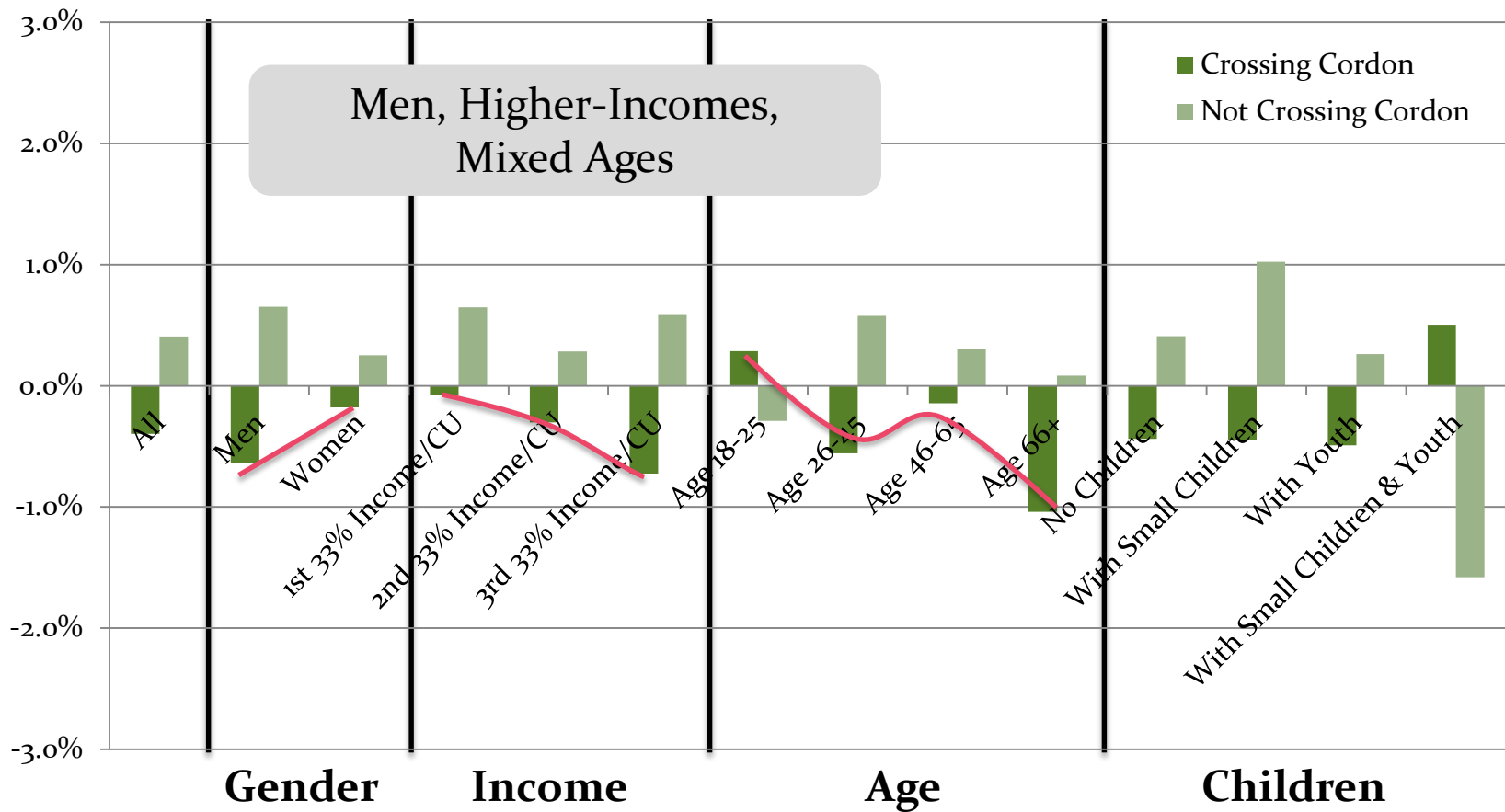
# Number of Links per Trip Chain

## Stockholm, % Change from 2004 to 2006



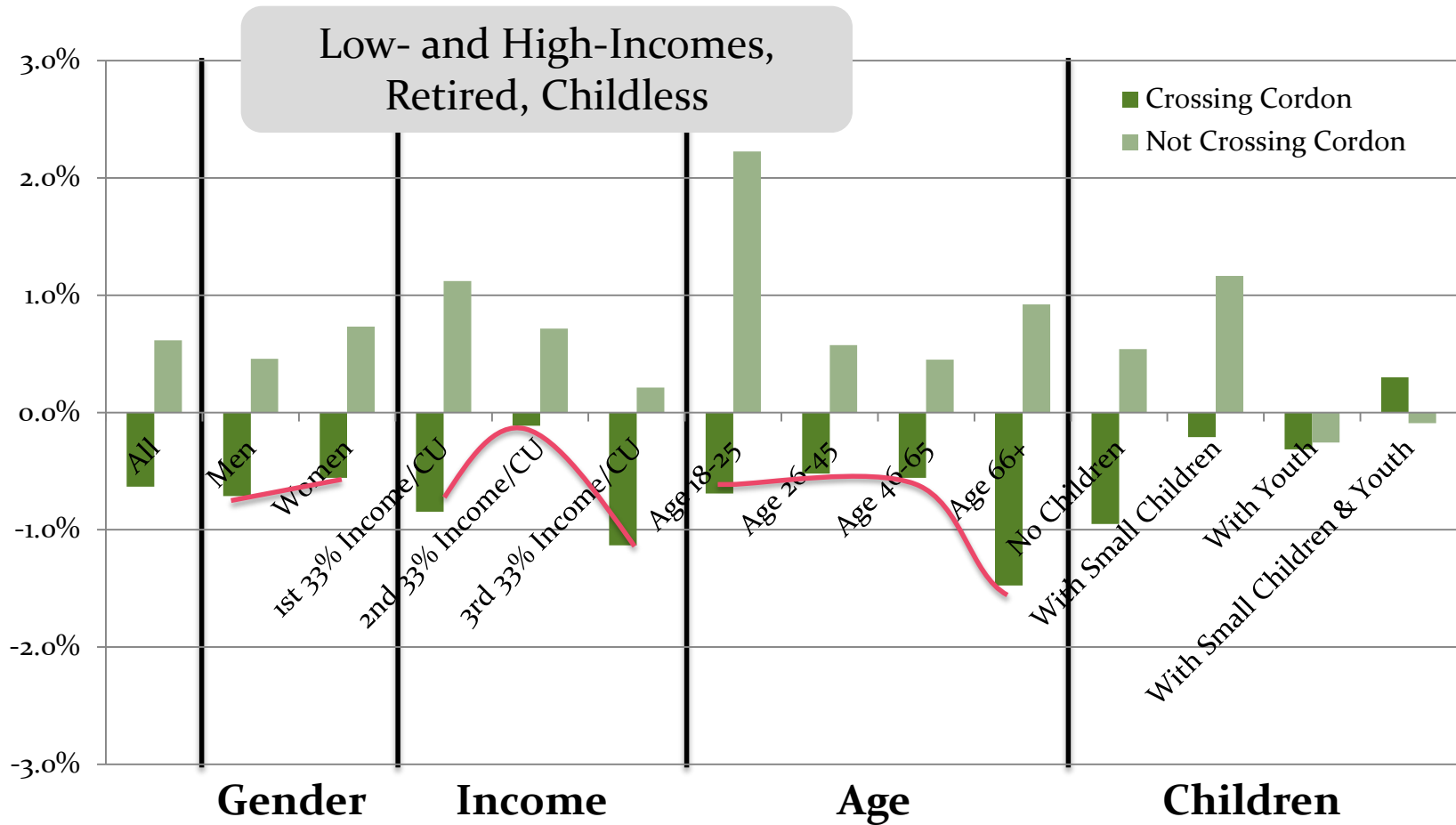
# Number of Trip Chains

## Gothenburg, % Change from 2012 to 2013



# Number of Links per Trip Chain

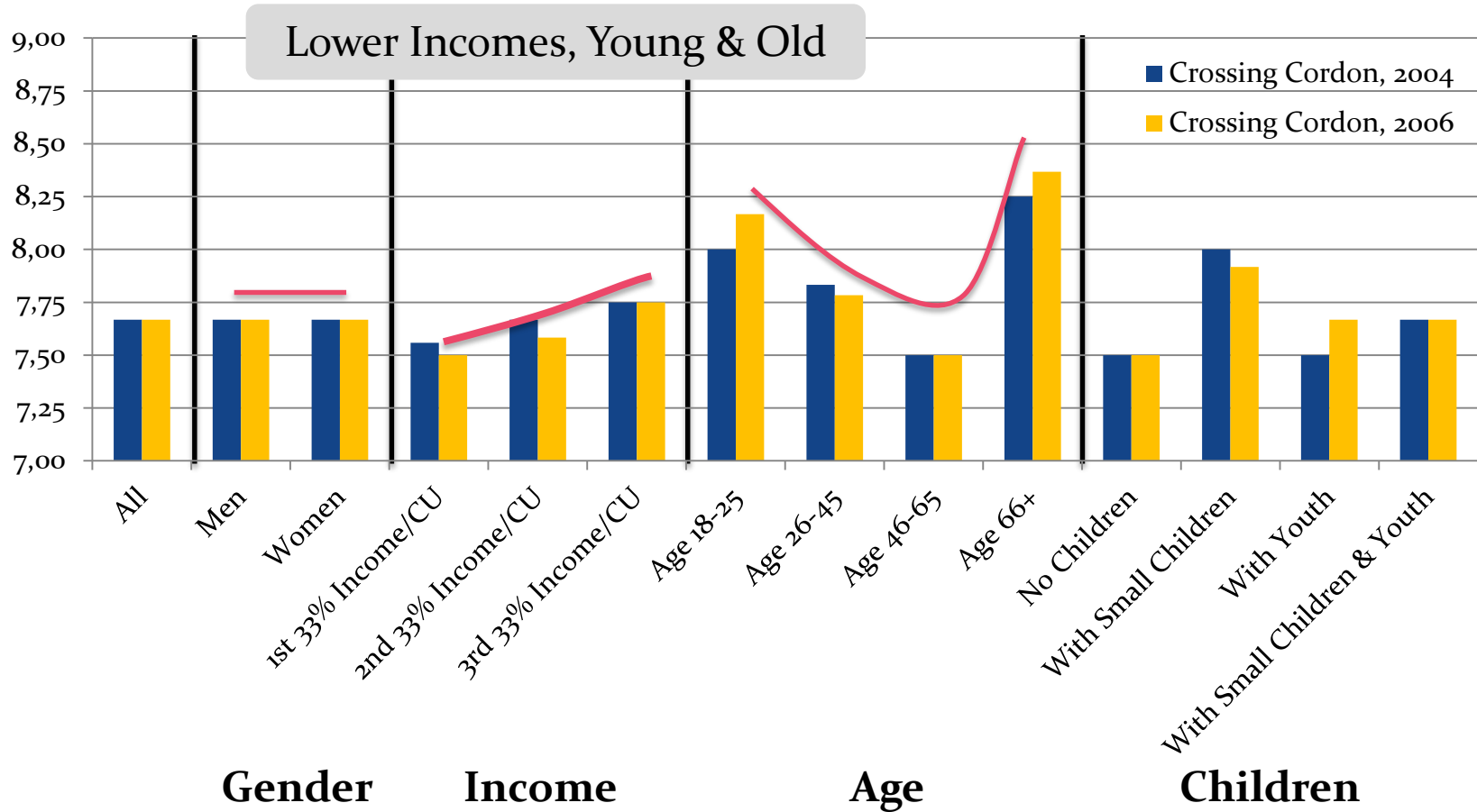
## Gothenburg, % Change from 2012 to 2013





# Departure Time to Work/School

## Stockholm, 2004 vs. 2006

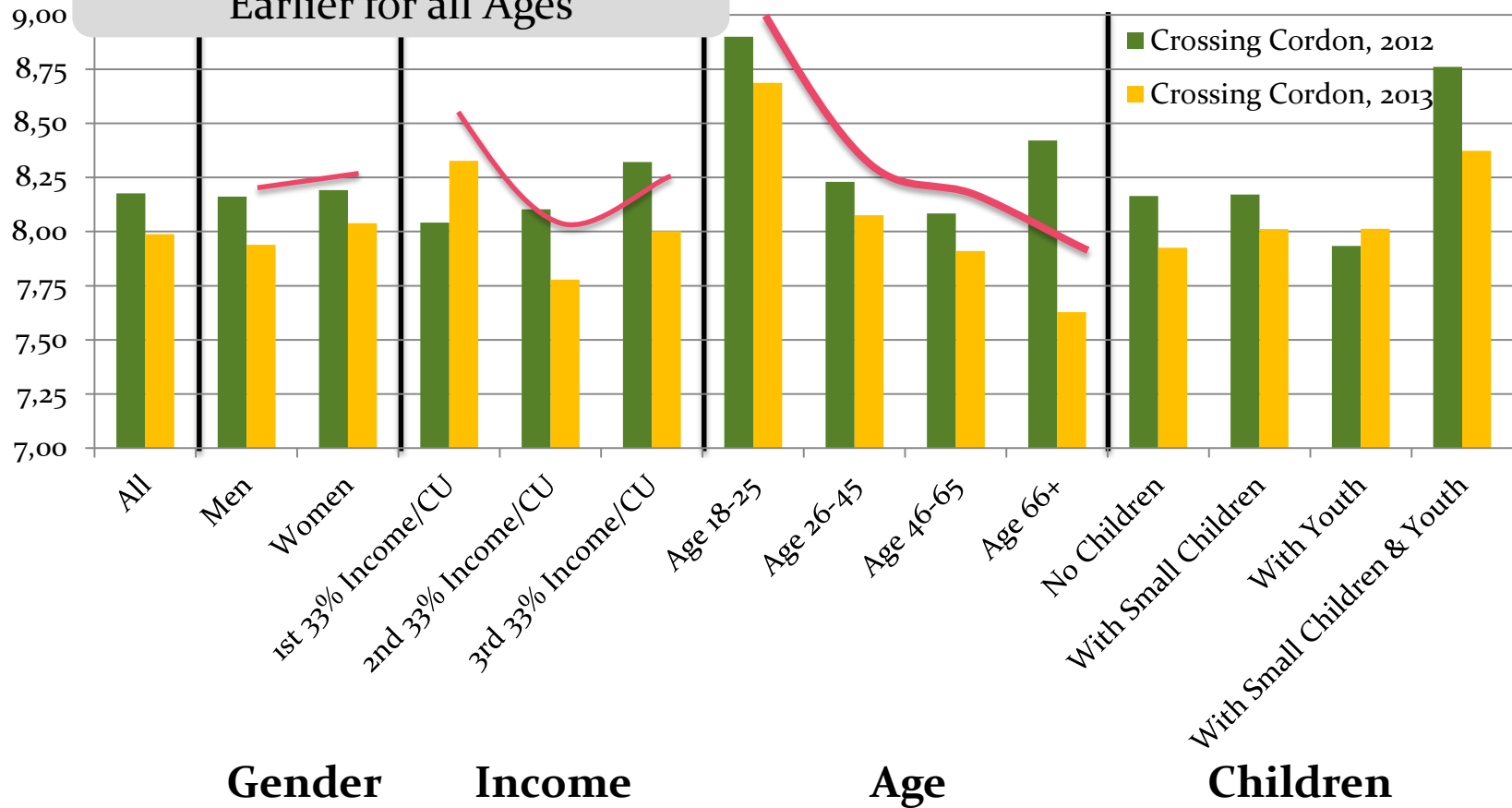




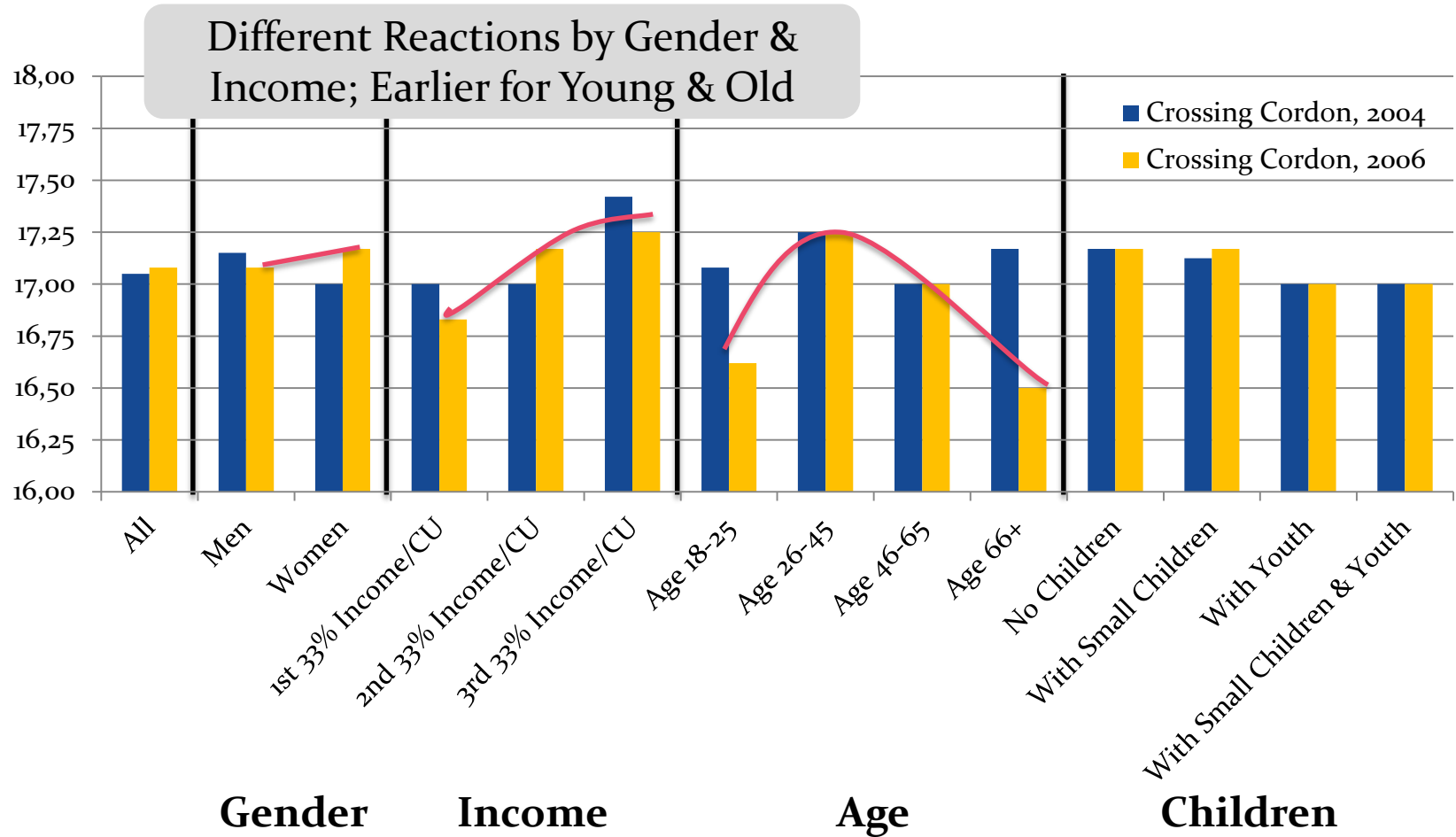


# Departure Time to Work/School Gothenburg, 2012 vs. 2013

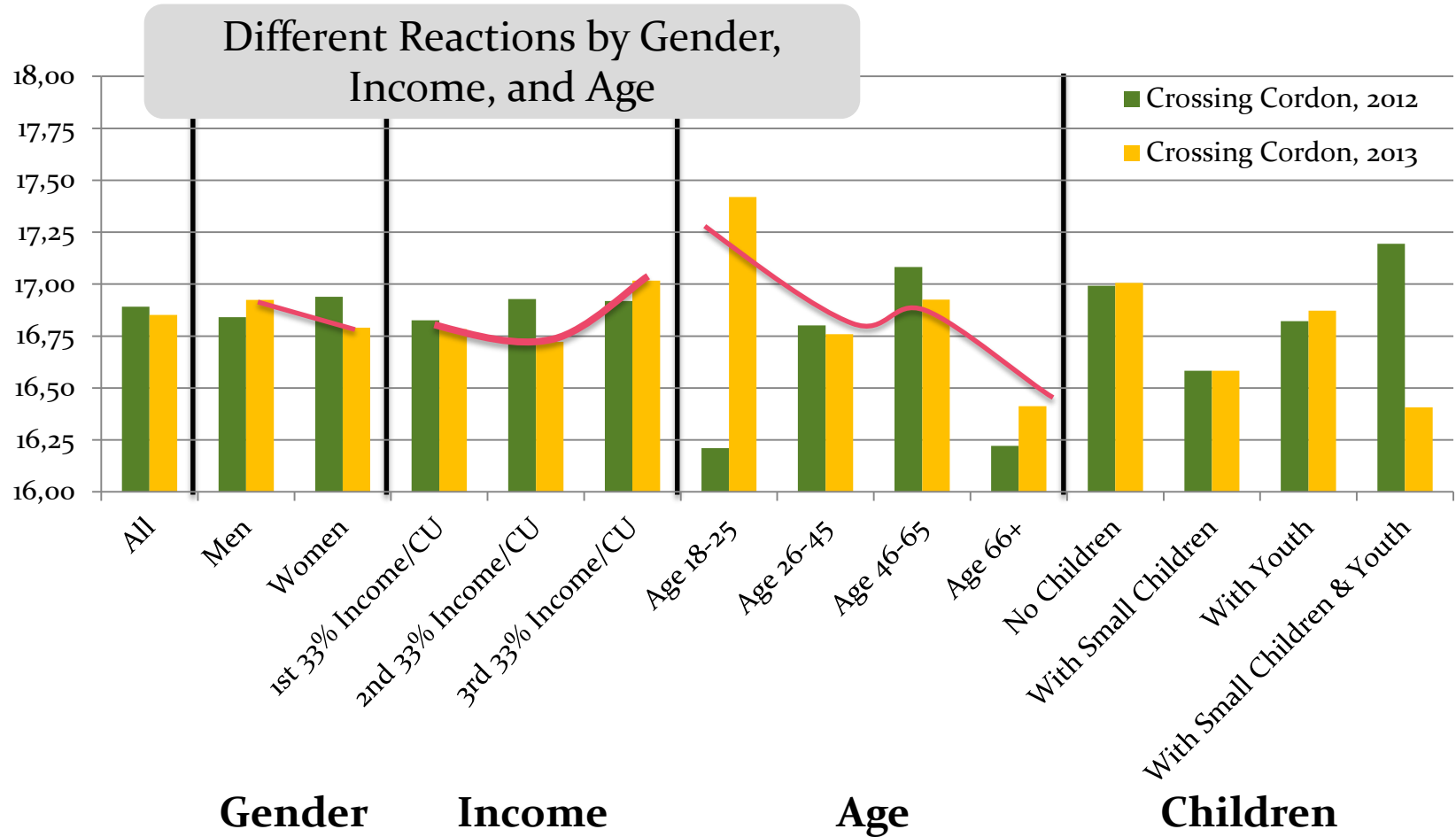
Different Reactions by Income;  
Earlier for all Ages



# Departure Time Back Home (Work Trip Chains) Stockholm, 2004 vs. 2006



# Departure Time Back Home (Work Trip Chains) Gothenburg, 2012 vs. 2013





# Focus on Gothenburg:

## *Contributions of Four Adaptation Patterns*

### **Total Effect:**

- 22 000 fewer veh/day

### **1. Carpooling:**

- 1,48 / veh → 1,49 / veh
- 6% of total reduction

### **2. Change of Mode:**

- 70% Car → 68% Car
- 31% of total reduction

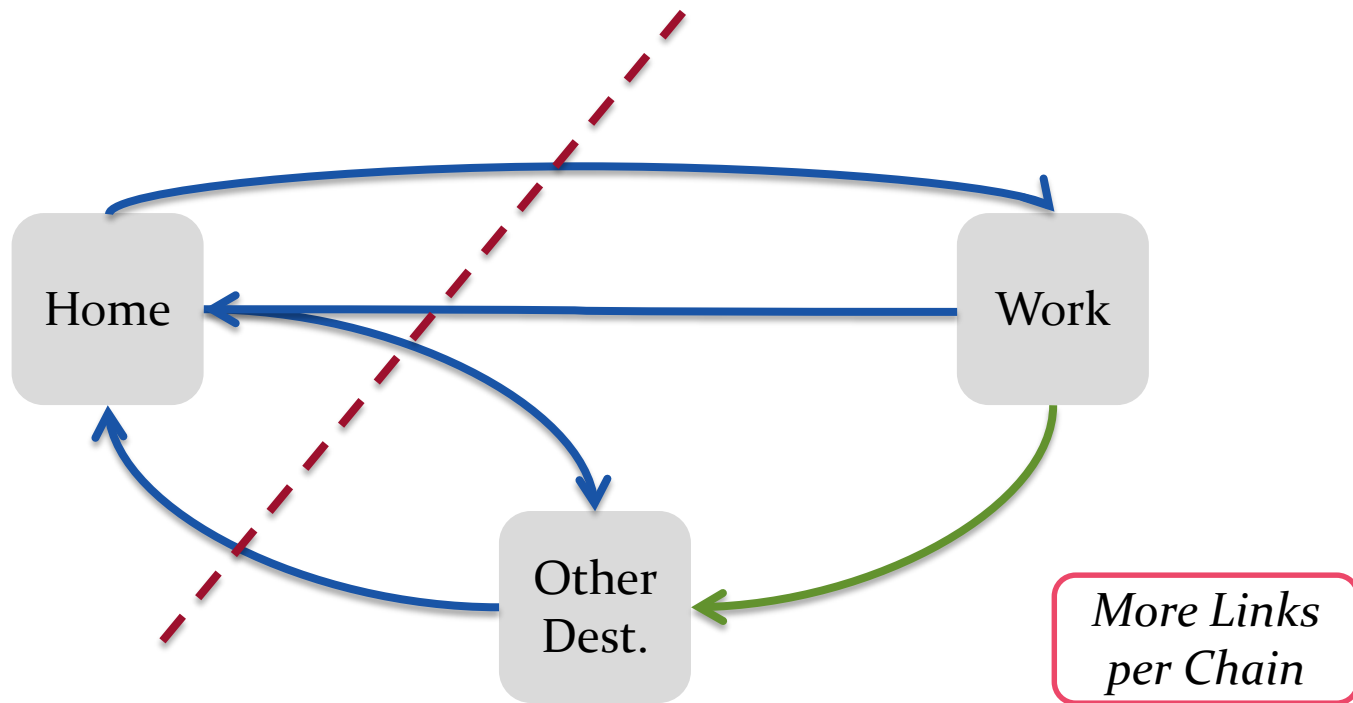
### **3. Destination Choice:**

- 64% → 62% of destinations across cordon
- But, not greater than for “unaffected” trips



# Focus on Gothenburg: *Contributions of Four Adaptation Patterns*

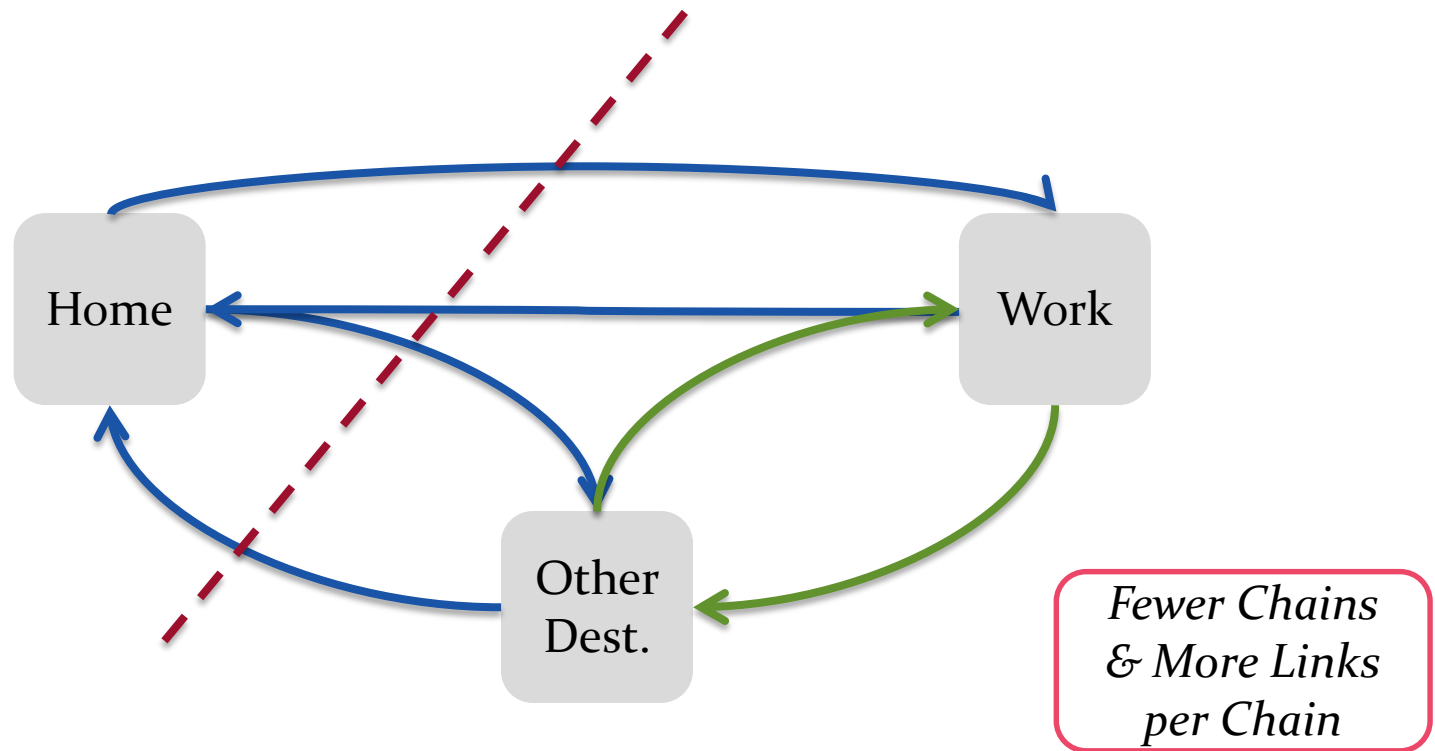
## 4. *Reorganization of Trip Chains*





# Focus on Gothenburg: *Contributions of Four Adaptation Patterns*

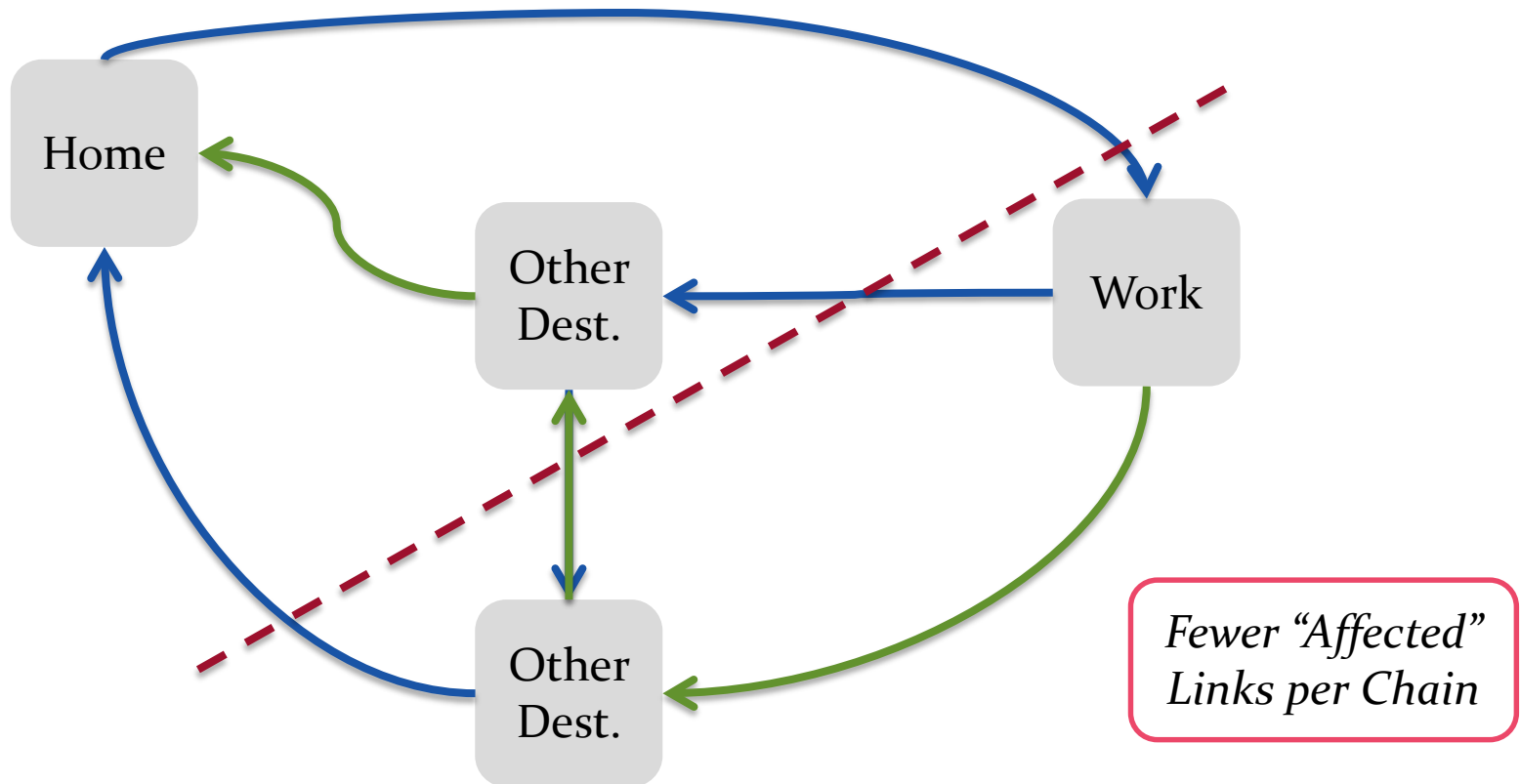
## 4. *Reorganization of Trip Chains*





# Focus on Gothenburg: *Contributions of Four Adaptation Patterns*

## 4. *Reorganization of Trip Chains*





# Focus on Gothenburg:

## *Contributions of Four Adaptation Patterns*

### *4. Reorganization of Trip Chains*

Indicator	2012	2013	Delta
Trip Links per Trip Chain	3,17	3,22	1,8%
Trip Links per "Affected" Trip Chain	3,69	3,87	4,8%
"Affected" Trip Links per Trip Chain	1,25	1,17	-7,0%
"Affected" Trip Links per "Affected" Trip Chain	2,04	1,98	-2,9%



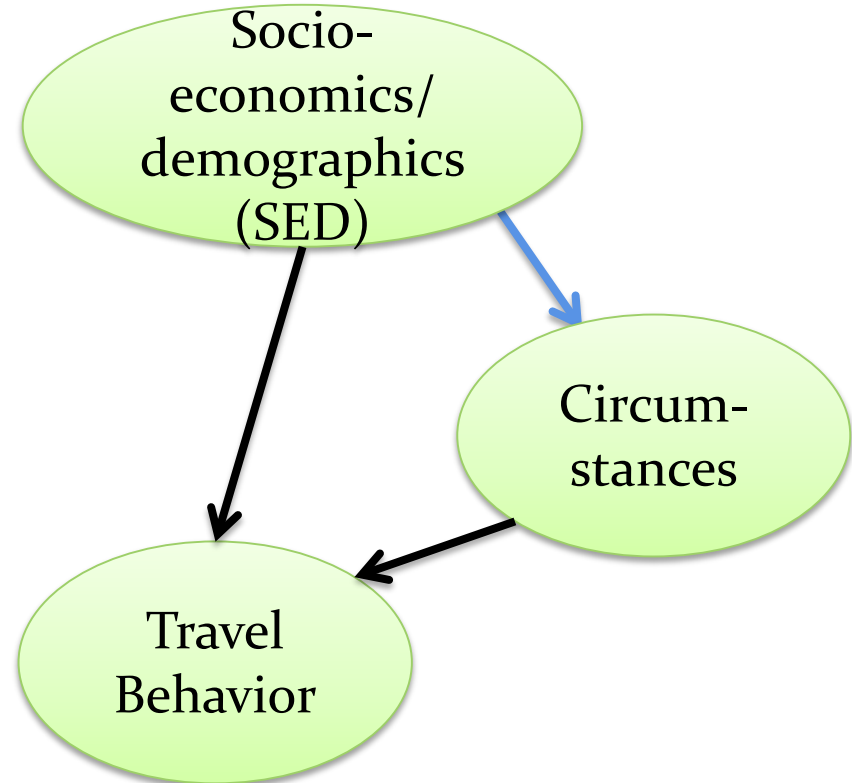
# Focus on Stockholm:

## *The Role of Underlying Conditions*

Where equity effects are present, can their mechanisms be explained?

- *Commute over the cordon*
- *Flexible work hours*
- *Access to car*
- *Public transport pass*

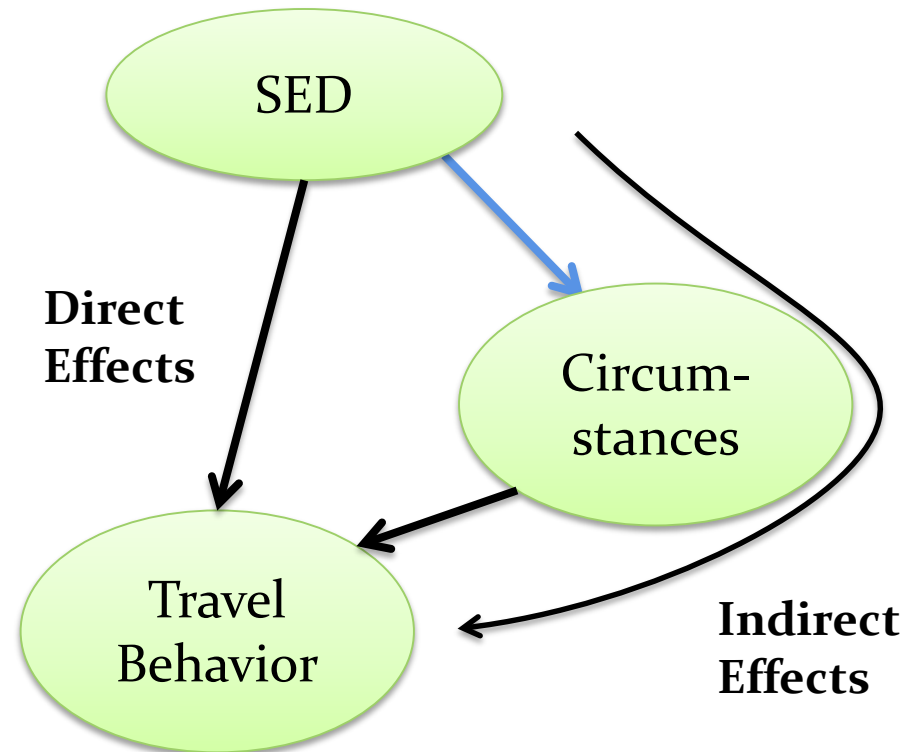
Where equity effects *aren't* present, do circumstances still matter?



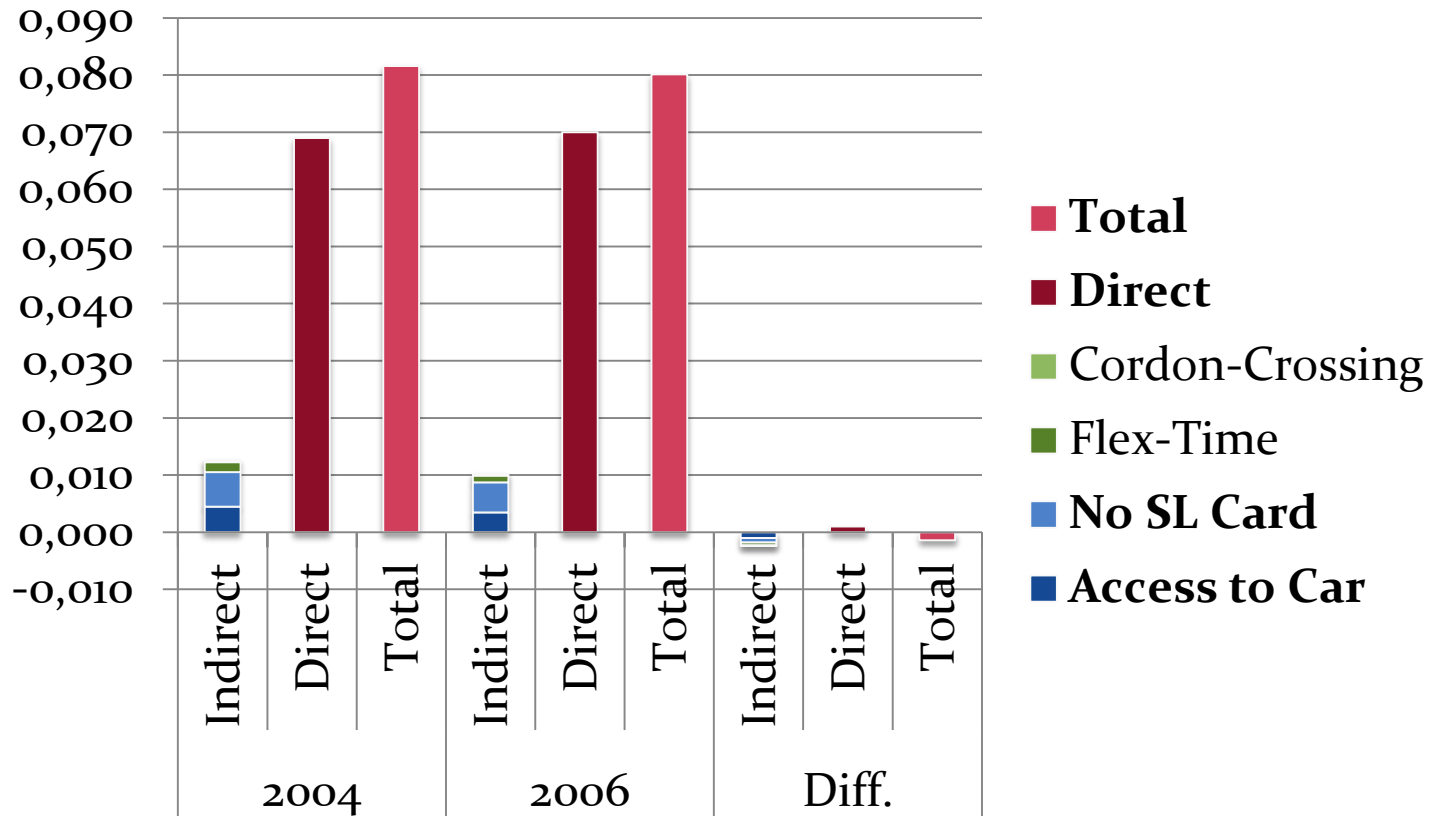
# Focus on Stockholm: *The Role of Underlying Conditions*

**Travel Behavior =**  
 $f(\text{SED} \ \& \ \text{Circumstances})$

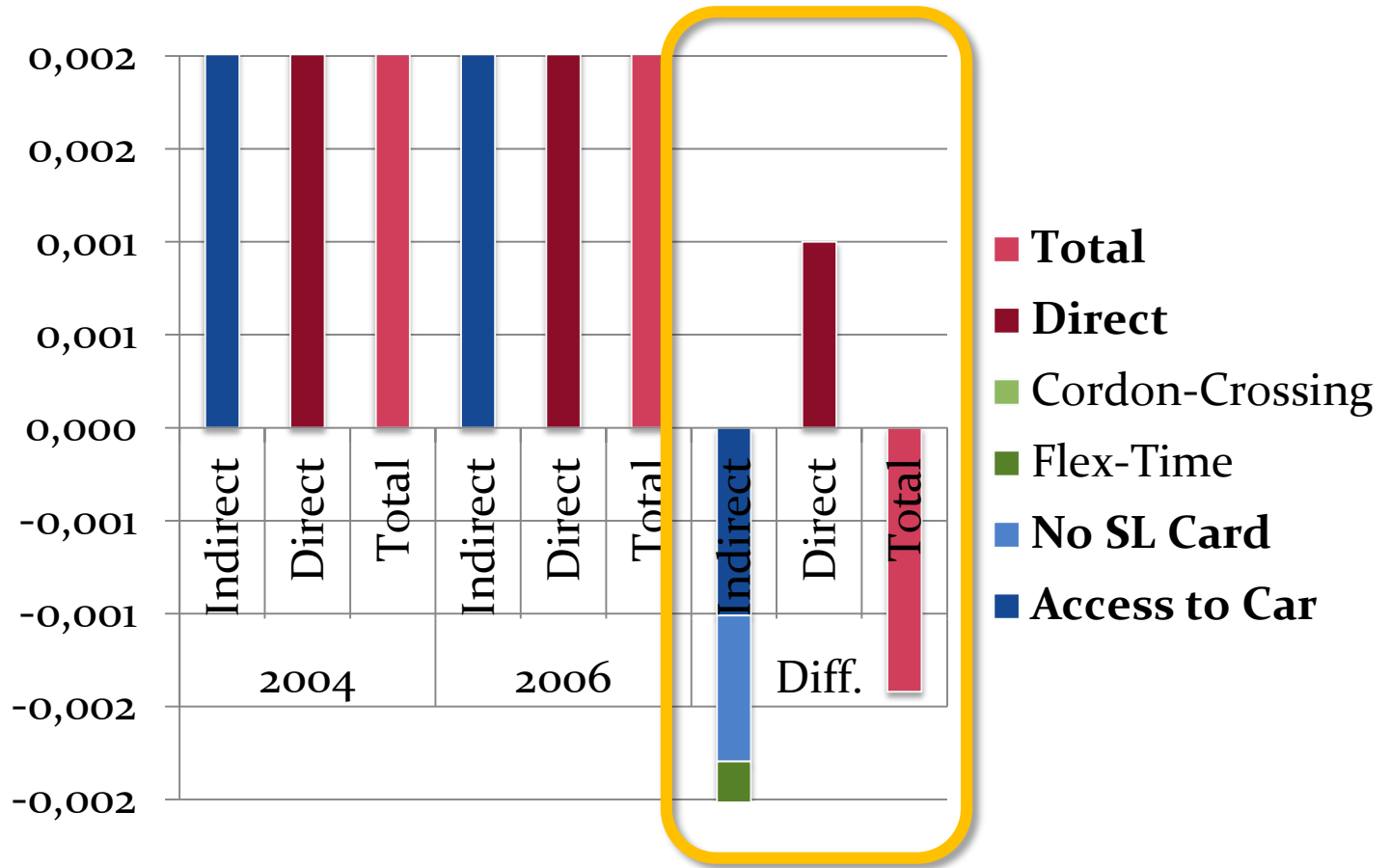
$\text{Circumstances} = f(\text{SED})$



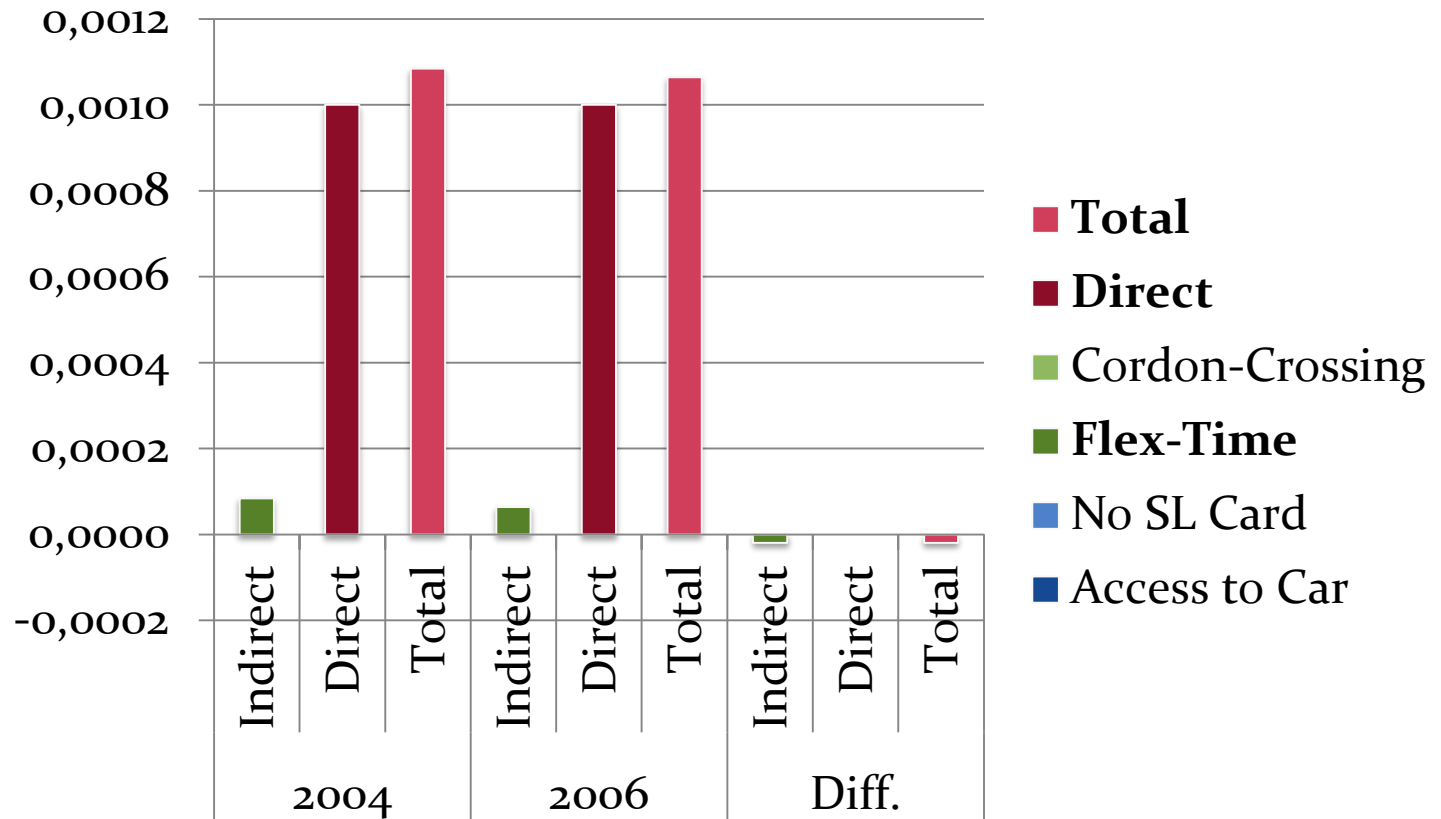
# Males Take More Auto Trips Across Cordon during the Peak Period



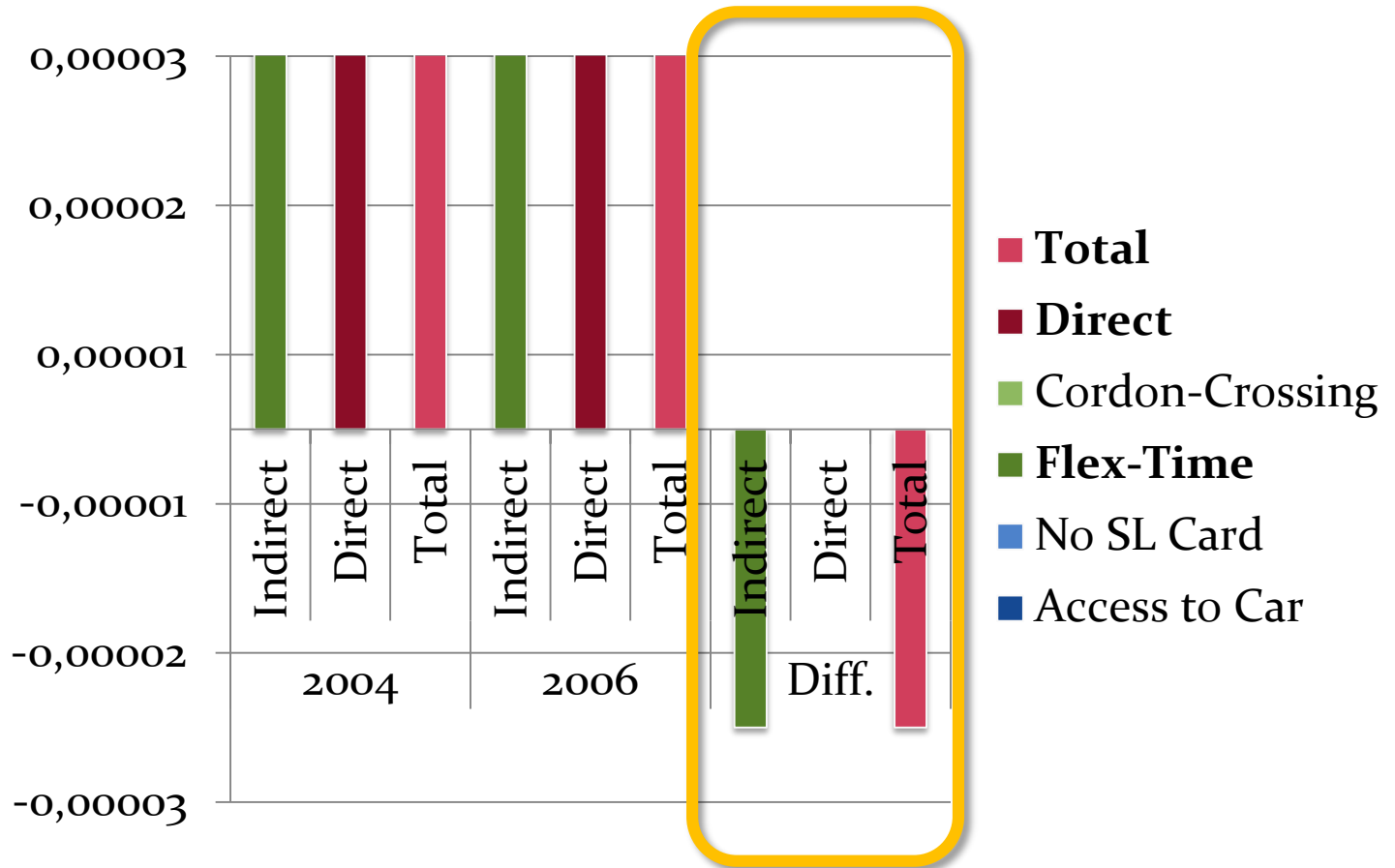
# Gender Effect decreased after the Toll



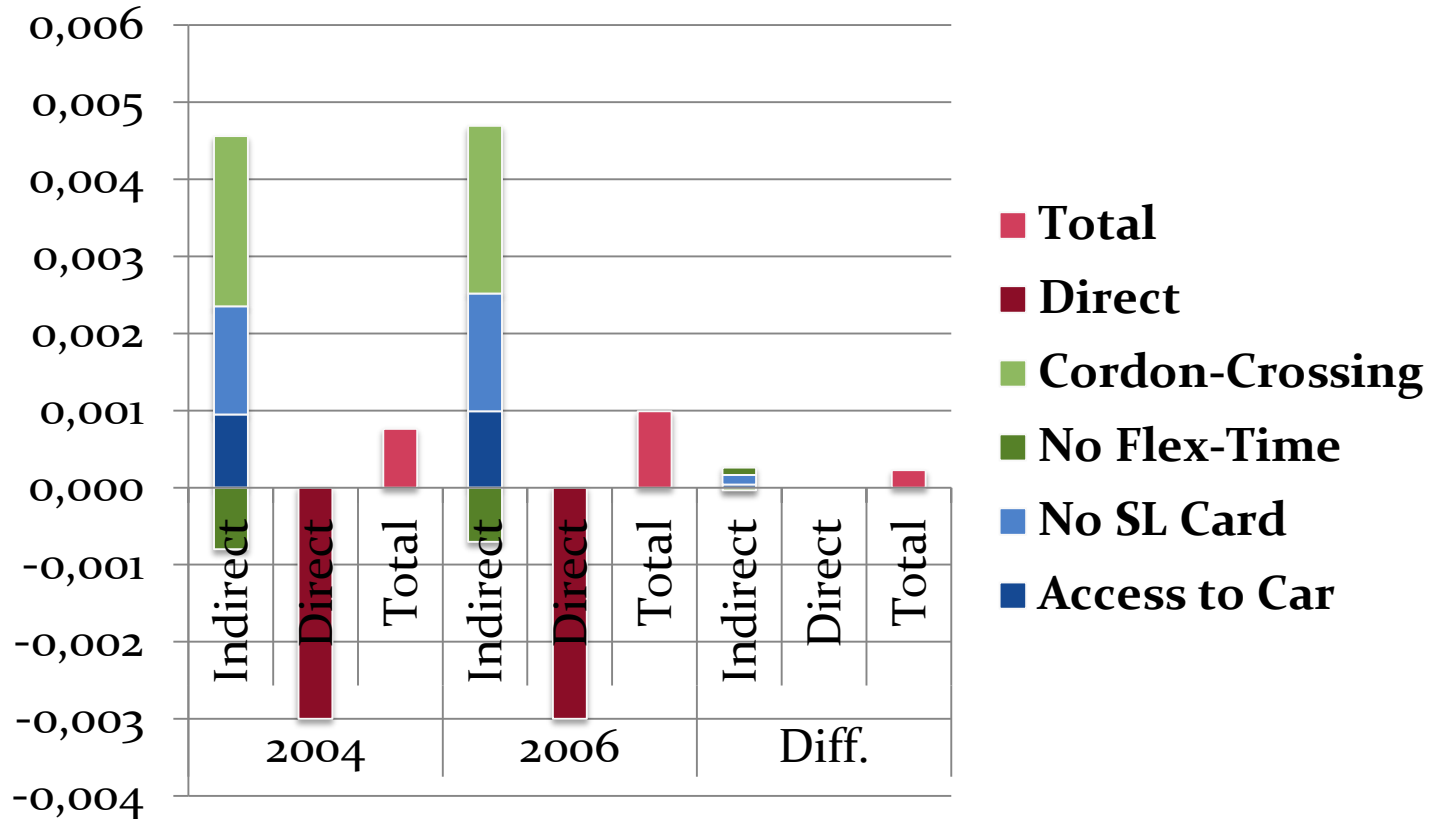
# Wealthier Take More Auto Trips Across Cordon during the Peak Period



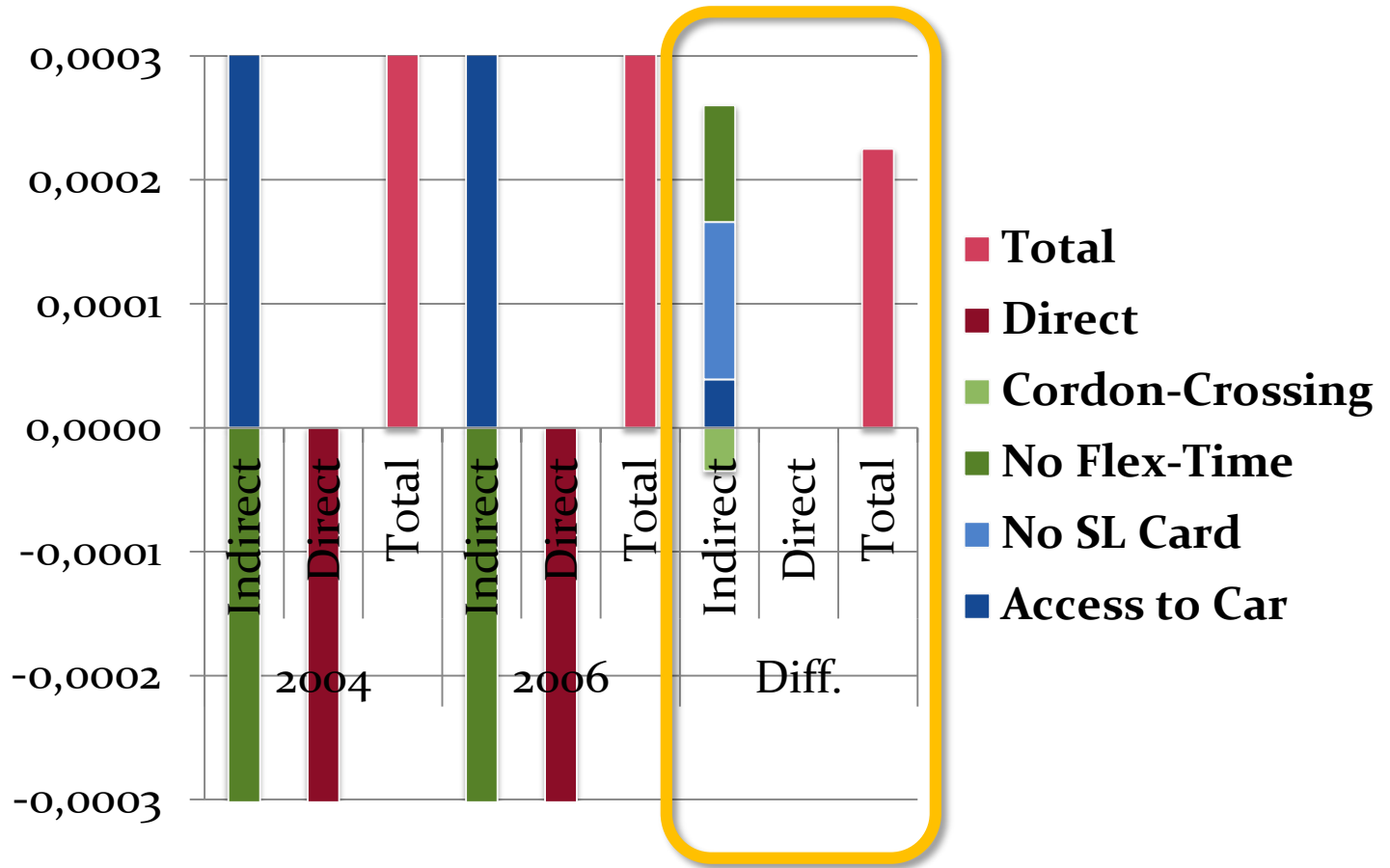
# Income Effect decreased *slightly* after the Toll



# Older Take More Auto Trips Across Cordon during the Peak Period



# Age Effect *increased* after the Toll







# Comparison between Stockholm and Gothenburg

- **Gender Effect**
  - In **Gothenburg**, this difference increased (but not in Stockholm)
- **Age Effect**
  - In **Gothenburg**, this difference disappeared with congestion charges
  - In **Stockholm**, this difference increased
- **Income Effect**
  - Barely any effect of congestion charges in either city
- *Equity effects are generally more pronounced in Gothenburg than in Stockholm*



## Conclusions (1/3)

1. **How great is mode-adjustment, compared to other adaptation strategies?**
  - *The largest share: about 31% in Gothenburg*
2. **How much do seasonal effects blur the results?**
  - *Significantly – “unaffected” trips show many of the same effects as “affected” trips, and many results are different from Gothenburg*
3. **Did Gothenburg see different adaptation strategies than Stockholm?**
  - *Yes: reductions and reorganizations in trip chains is evident*
  - *Could be in Stockholm too, but not observable*
4. **Do travelers reorganize trip chains to adapt?**
  - *(see above)*



## Conclusions (2/3)

5. **Do household members rebalance activities?**
  - *Impossible to be sure given lack of household surveys*
  - *Increased Car Occupancy in Gothenburg suggests consolidation of trip tours*
6. **What underlying circumstances are associated with different adaptation strategies for different groups?**
  - *Access to a car matters more for females*
  - *Work schedule matters more to low-incomes*
  - *Older people more often commute across the cordon*
7. **Are these circumstances the cause of these differences?**
  - *For the main effects before charging, no.*
  - *For the change in effects after charging, largely yes.*



## Conclusions (3/3)

### 8. What mitigation measures would give most effect?

#### Key Principle:

- *Mitigation of Congestion Charges should improve the 2<sup>nd</sup>-best alternative*

#### 2<sup>nd</sup>-Best Alternatives:

- *Public transport – improve capacity and level of service?*
- *Increased car occupancy – discounts for HOVs?*
- *Altered trip-chaining – but how to improve with policy? Traveler info?*

#### Not Effective Mitigation:

- *Changing the start- and end-times of the charges – charging times seem to be having an effect on sorting trips (as intended)*