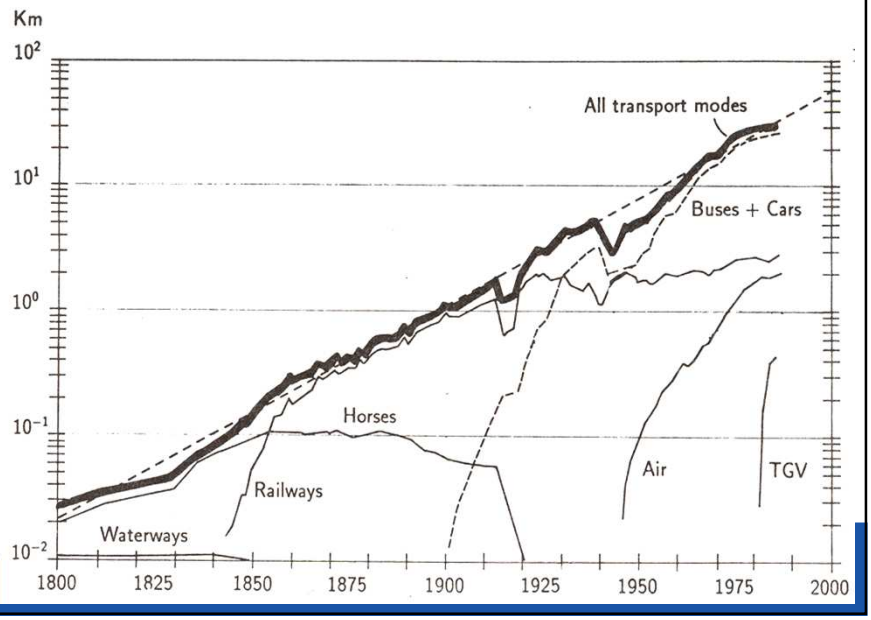
Trends in travel behaviour

Jonas Eliasson
Professor Transport Systems Analysis, KTH
Department for Transport Science & Centre for Transport Studies

Today's agenda

- Agglomeration benefits and our increasing demand for specialisation
- Some trends in travel behaviour
- The "peak car" hypothesis
- Do we capture agglomeration in CBA?
- Travel patterns over the lifecycle – some Swedish descriptives
- Urban transport policy and its challenges

Daily travel distance per person



Easier to transport people and goods
Technical development, infrastructure, economic development

Creates welfare
(money and quality of life)
- and problems

Increasing rewards of accessibility
Specialization of labour, production, lifestyles

Centre for Transport Studies STOCKHOLM

Increased demand for accessibility

Move to high-density location

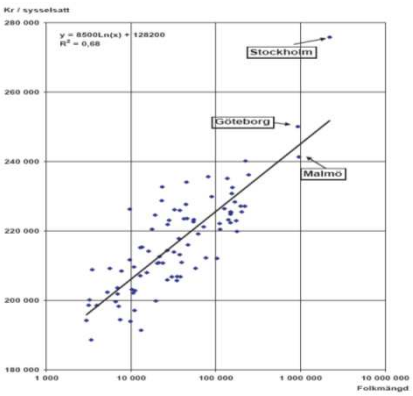
Urbanization

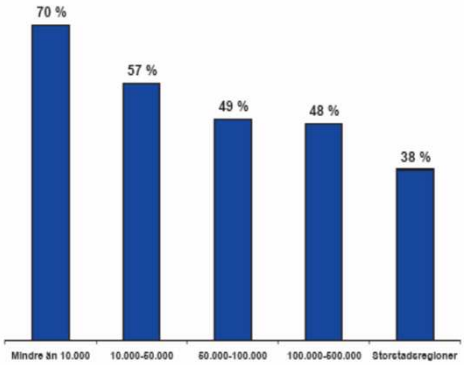
Travel longer distances

Centre for Transport Studies STOCKHOLM

(Strömquist, 2005)

Better accessibility





Productivity **Welfare dependence**

Centre for Transport Studies STOCKHOLM

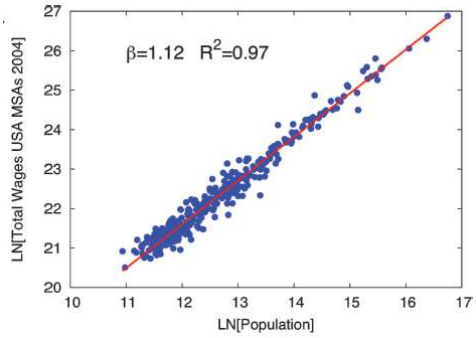
$Y \sim (\text{city size})^{\beta}$

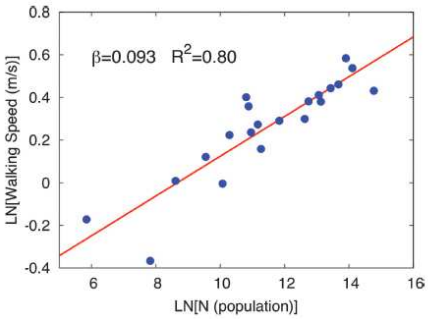
(Bettencourt et al, 2007)

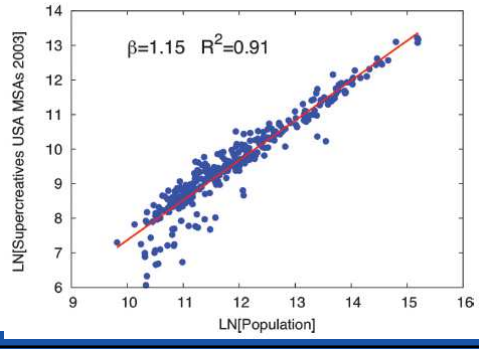
Y	β	95% CI	Adj-R^2	Observations	Country–year
New patents	1.27	[1.25,1.29]	0.72	331	U.S. 2001
Inventors	1.25	[1.22,1.27]	0.76	331	U.S. 2001
Private R&D employment	1.34	[1.29,1.39]	0.92	266	U.S. 2002
"Supercreative" employment	1.15	[1.11,1.18]	0.89	287	U.S. 2003
R&D establishments	1.19	[1.14,1.22]	0.77	287	U.S. 1997
R&D employment	1.26	[1.18,1.43]	0.93	295	China 2002
Total wages	1.12	[1.09,1.13]	0.96	361	U.S. 2002
Total bank deposits	1.08	[1.03,1.11]	0.91	267	U.S. 1996
GDP	1.15	[1.06,1.23]	0.96	295	China 2002
GDP	1.26	[1.09,1.46]	0.64	196	EU 1999–2003
GDP	1.13	[1.03,1.23]	0.94	37	Germany 2003
Total electrical consumption	1.07	[1.03,1.11]	0.88	392	Germany 2002
New AIDS cases	1.23	[1.18,1.29]	0.76	93	U.S. 2002–2003
Serious crimes	1.16	[1.11, 1.18]	0.89	287	U.S. 2003
Total housing	1.00	[0.99,1.01]	0.99	316	U.S. 1990
Total employment	1.01	[0.99,1.02]	0.98	331	U.S. 2001
Household electrical consumption	1.00	[0.94,1.06]	0.88	377	Germany 2002
Household electrical consumption	1.05	[0.89,1.22]	0.91	295	China 2002
Household water consumption	1.01	[0.89,1.11]	0.96	295	China 2002
Gasoline stations	0.77	[0.74,0.81]	0.93	318	U.S. 2001
Gasoline sales	0.79	[0.73,0.80]	0.94	318	U.S. 2001
Length of electrical cables	0.87	[0.82,0.92]	0.75	380	Germany 2002
Road surface	0.83	[0.74,0.92]	0.87	29	Germany 2002

Strong correlations

(Bettencourt et al, 2007)







Causality or sorting?

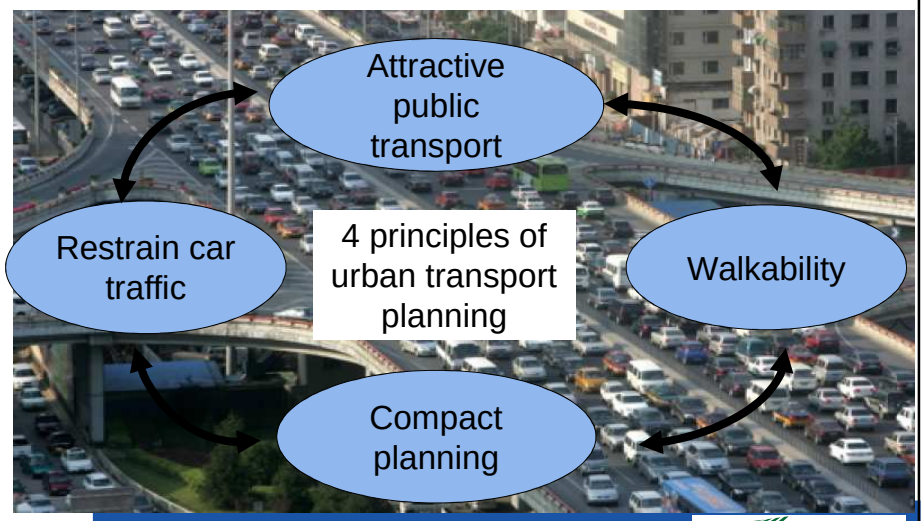
- Urban wage premium etc. empirical facts – but is it *caused by* the city?
- Answer determines whether we should strive to encourage city growth and increase accessibility!

Evidence of:

- Sorting (Combes, 2008)
- Learning (city as a university) (Gould, 2007)
- Matching (Melo and Graham, 2014)
- Scale benefits in markets, shared resources etc.

Centre for Transport Studies STOCKHOLM

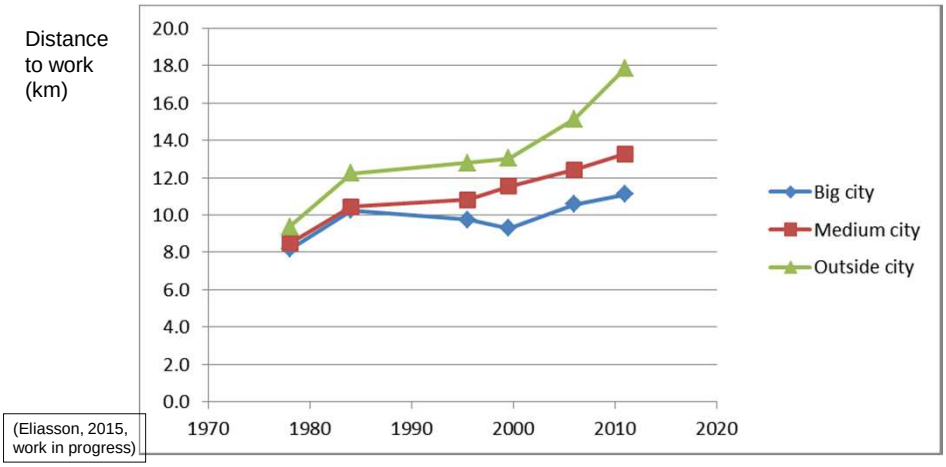
Congestion is unavoidable



Centre for Transport Studies STOCKHOLM

Work trip distances increase over time

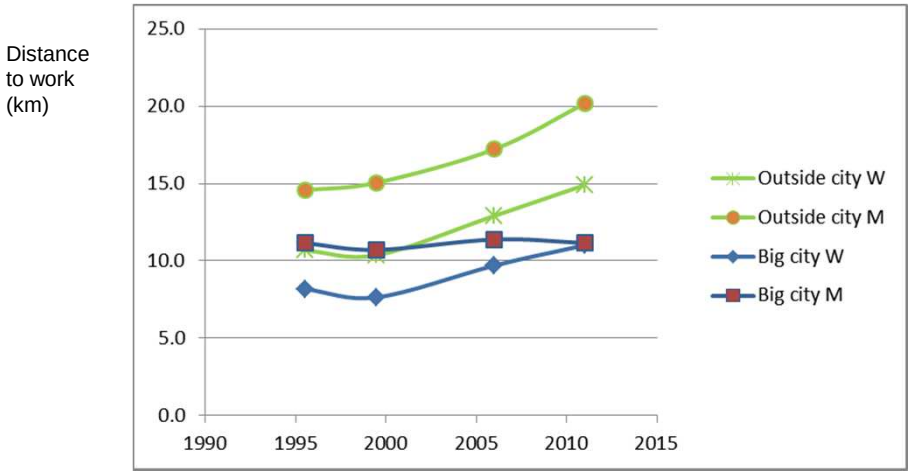
The more opportunities close by, the less need to increase travel distance



(Eliasson, 2015, work in progress)

Centre for Transport Studies STOCKHOLM

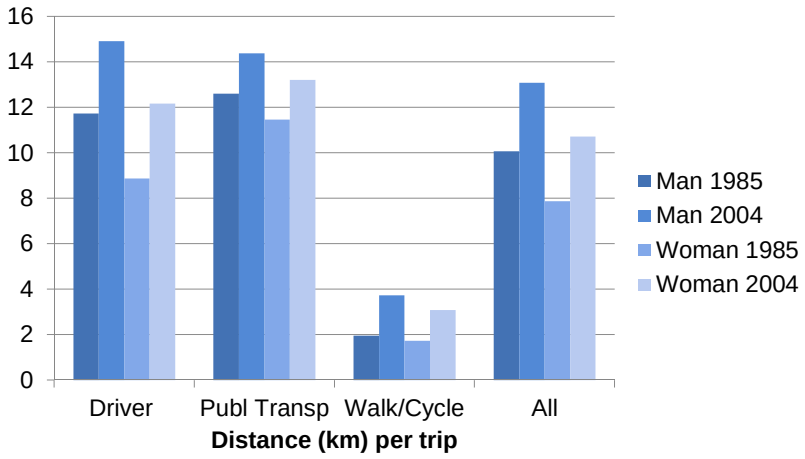
Men's and women's commuting distances are converging in cities



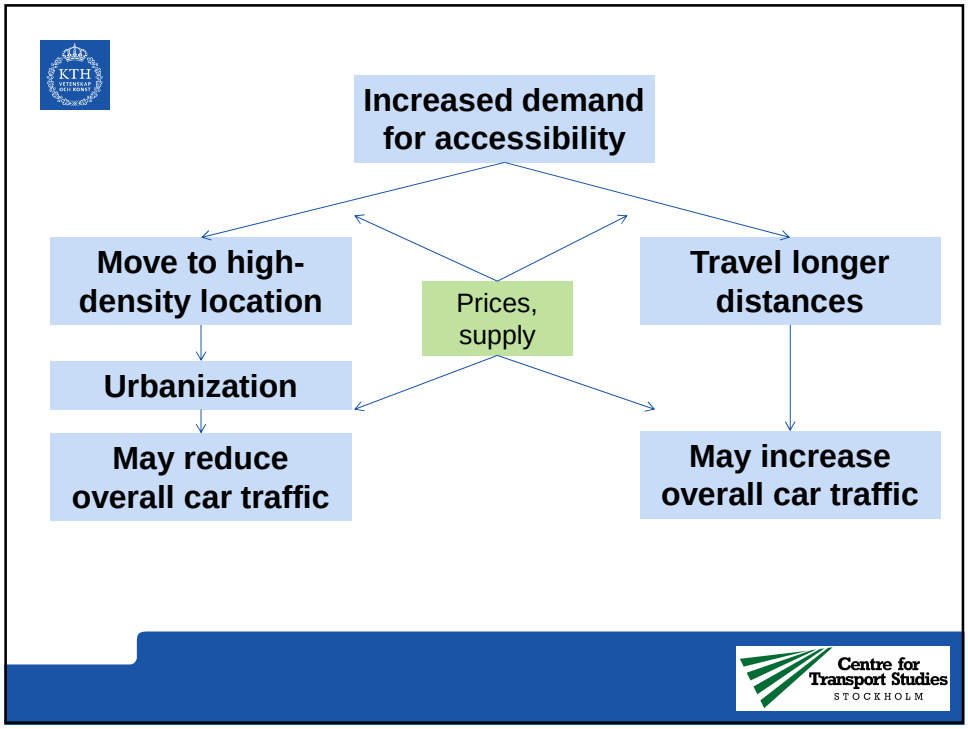
Centre for Transport Studies STOCKHOLM

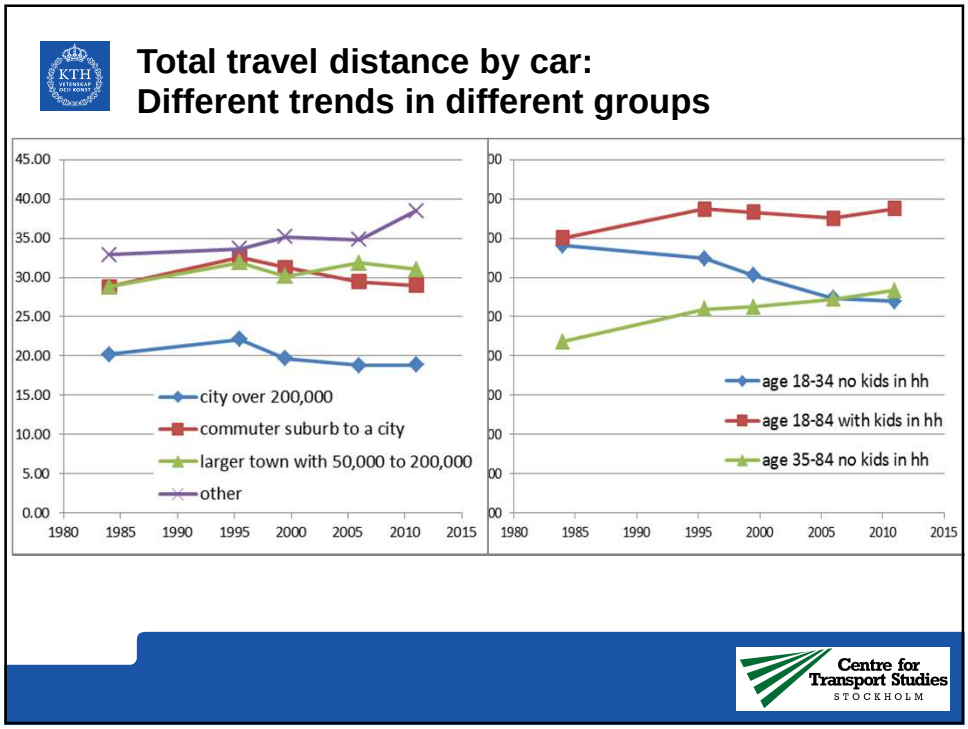
Trip lengths increase for all modes (Stockholm 1985-2004)

(Maria Börjesson, 2010)

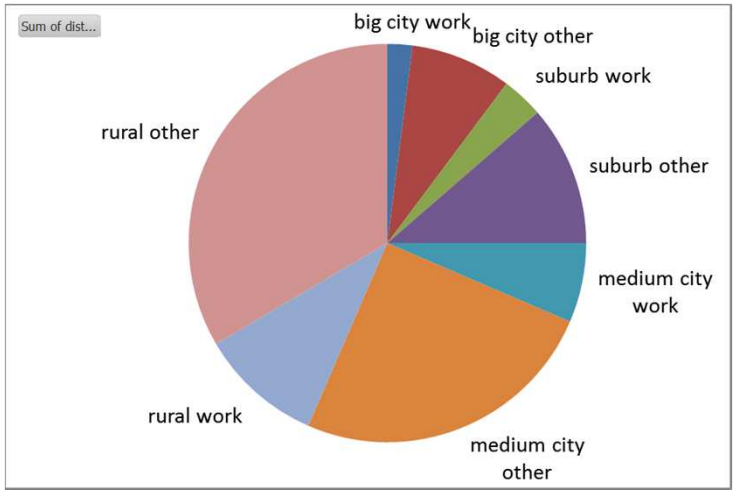


Centre for Transport Studies STOCKHOLM


Increased demand for accessibility
Move to high-density location
Prices, supply
Travel longer distances
Urbanization
May reduce overall car traffic
May increase overall car traffic
Centre for Transport Studies
STOCKHOLM


Total travel distance by car:
Different trends in different groups
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1980
1985
1990
1995
2000
2005
2010
2015
city over 200,000
commuter suburb to a city
larger town with 50,000 to 200,000
other
age 18-34 no kids in hh
age 18-84 with kids in hh
age 35-84 no kids in hh
Centre for Transport Studies
STOCKHOLM

Where do carbon emissions from car traffic come from?



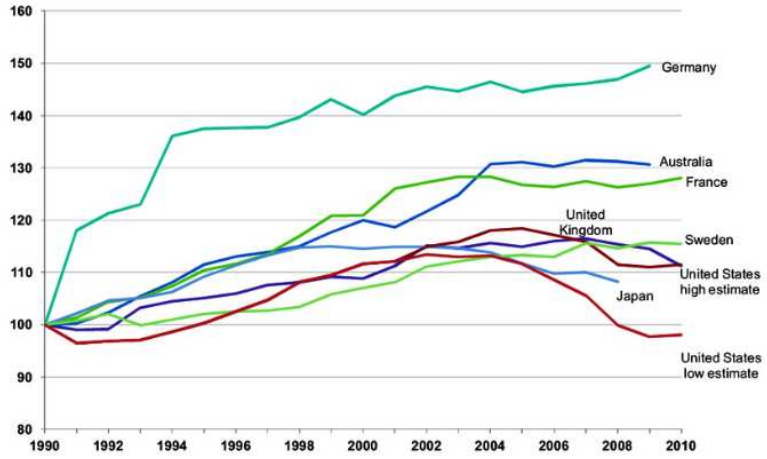
Centre for Transport Studies STOCKHOLM

The peak car hypotheses

1. *Weakest version*: Total car traffic has not grown (or even declined) in recent years in ”western countries”
2. *Weak version*: This is not explained by GDP or fuel price (but possibly by other policies and urbanisation)
3. *Strong version*: This is (primarily) *because of* a lasting change in attitudes and lifestyles (not the other way around).
   - => Standard explanatory variables – prices, GDP, ”hard” policies, urbanisation, demographics – are not enough to explain data
   - => Standard forecasting models won’t work (”parameters have changed”)
4. *Strongest version*: The declining/non-growing trend will continue even if gas prices fall and GDP grows

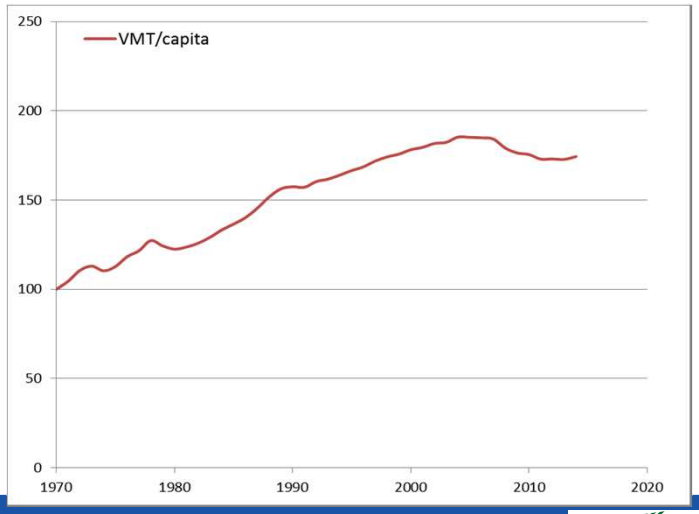
Centre for Transport Studies STOCKHOLM

Person car traffic in some western countries
(Goodwin/ITF, 2010)



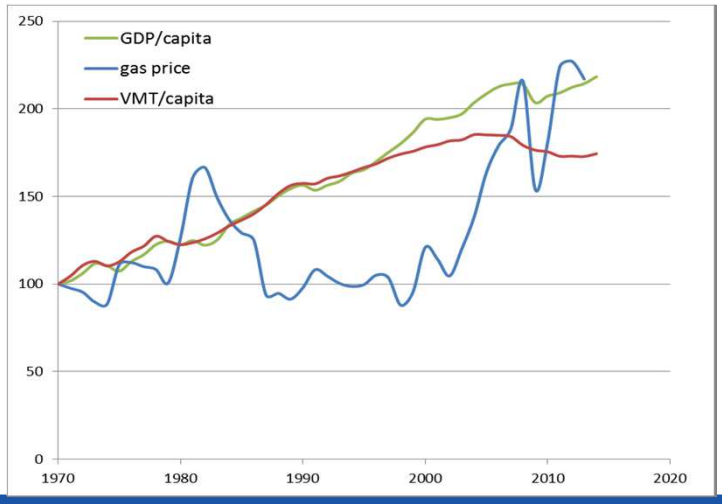
Centre for Transport Studies STOCKHOLM

US VMT/capita



Centre for Transport Studies STOCKHOLM

US VMT/capita, GDP/capita, gas price



Centre for Transport Studies STOCKHOLM

Can US "peak car" be explained by GDP and gas price?

(Eliasson, 2015, work in progress)

Naïve model:

log(VMT/cap) = *const* + *a**log(GDP/cap) + *b**gasprice

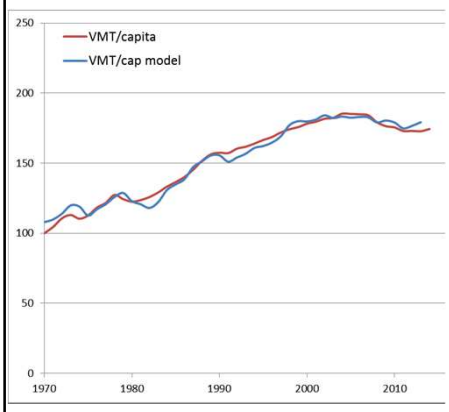
Results:

	a (GDP elast.)	*b* (gas price elast.)
data 1970-2014	0.81	-0.14
data 1970-2004	0.83	-0.06

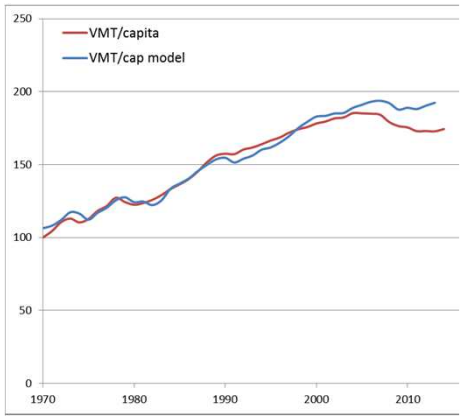
Would expect *b* to be -0.1 to -0.3 in the US [*short run*]

Centre for Transport Studies STOCKHOLM

Predictions vs. actual



Based on 1970-2014



Based on 1970-2004

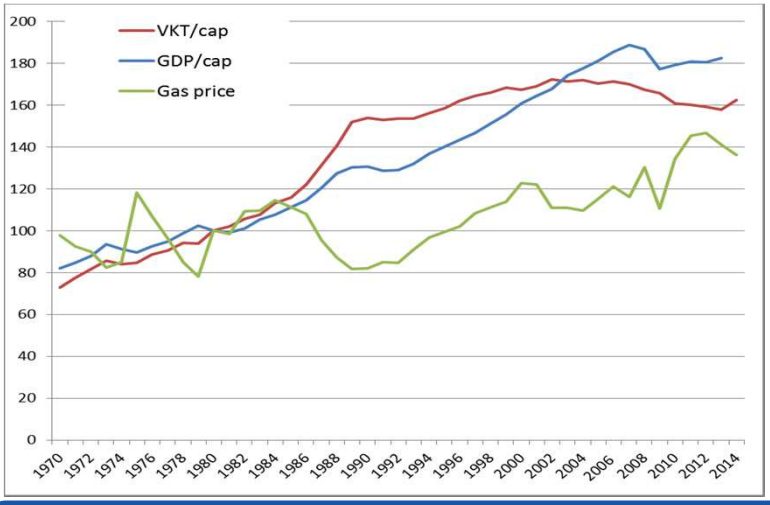
Centre for Transport Studies STOCKHOLM

Comments

- Model based on 1970-2014 explains data well and gives expected elasticities
- Model based on 1970-2004 gives slight overestimation of 2004-2014 data, but has suspiciously low price elasticity
- Lagged variables would give better fit
- Lower GDP elasticity, higher price elasticity in recent years (?)
- GDP & gas price seem to explain most of the VMT trend

Centre for Transport Studies STOCKHOLM

Same experiment for the UK



Centre for Transport Studies STOCKHOLM

Can the decline be explained by GDP and gas price?

Naïve model:

log(VMT/cap) = *const* + *a**log(GDP/cap) + *b**gasprice

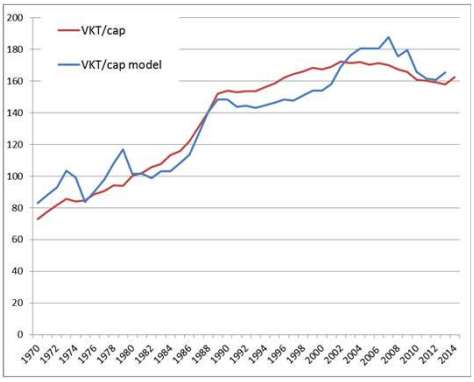
Results:

	a (GDP elast.)	*b* (gas price elast.)
data 1970-2014	1.08	-0.47
data 1980-2014	0.87	-0.45
data 1970-2002, smoothed gas price	1.33	-0.45

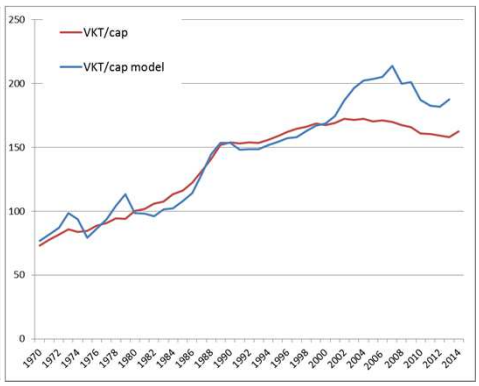
Would expect *b* to be -0.3 to -0.5 in the UK [*short run*]

Centre for Transport Studies STOCKHOLM

Predictions vs. actual (UK)



Based on 1980-2014



Based on 1970-2002

Centre for Transport Studies STOCKHOLM

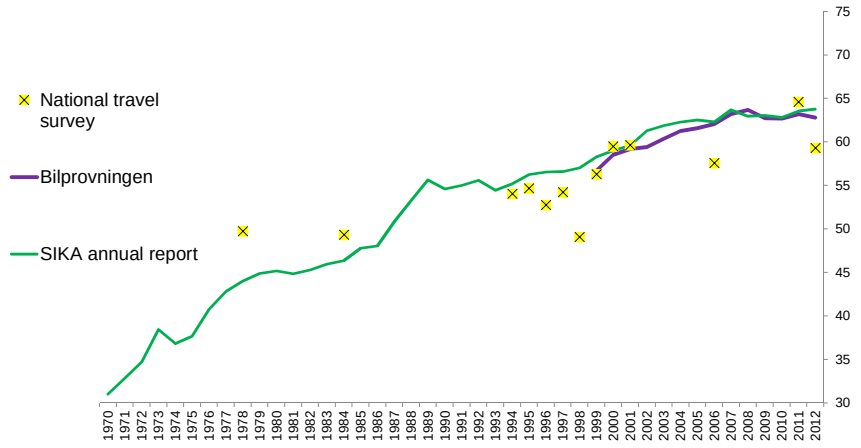
Comments

- Models explain trend reasonably well…
- … except the lack of an expected ”jump” 2001-2004
- Change in benefit taxation rules?
- Otherwise, GDP & price seem to explain much of the VMT trend

Centre for Transport Studies STOCKHOLM

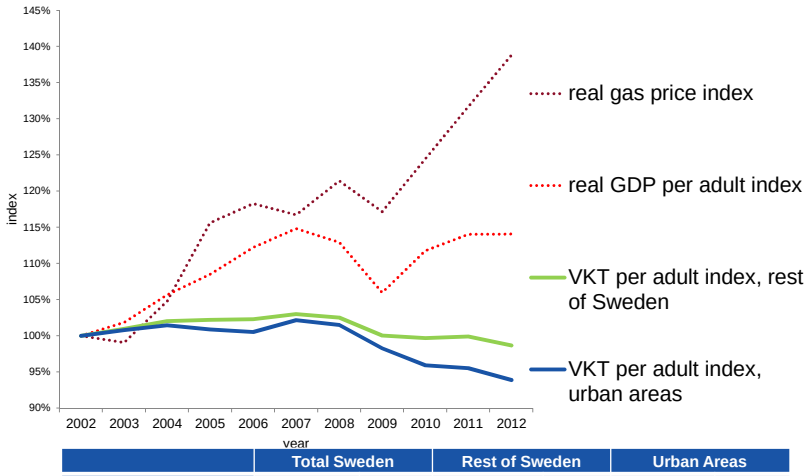
Person car traffic in Sweden (VKT)

(Bastian & Börjesson, 2015)



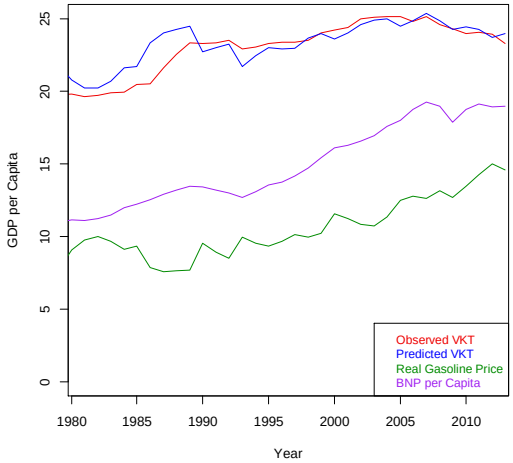
Centre for Transport Studies STOCKHOLM

Sweden – Bastian & Börjesson (2015)



	Total Sweden		Rest of Sweden		Urban Areas	
R-squared	0.77		0.77		0.82	
	Estimate	t stat	Estimate	t stat	Estimate	t stat
Intercept	0.89	1.52	1.22	2.68	0.46	0.57
log(GDP per capita)	0.52	4.35	0.44	4.76	0.63	3.81
log(gas price)	-0.30	-5.24	-0.23	-5.10	-0.45	-5.68

Validation of model on 1980-2012 period

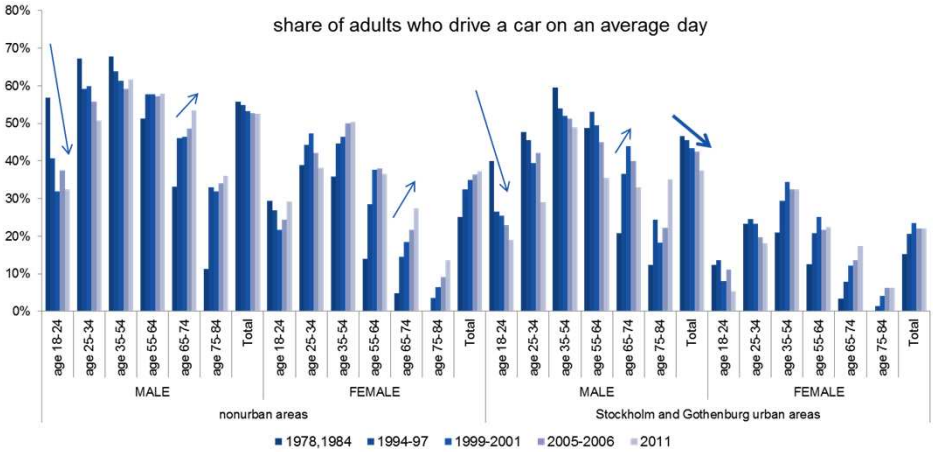


(Anne Bastian & Maria Börjesson, 2015)

Centre for Transport Studies STOCKHOLM

Different trends in different groups

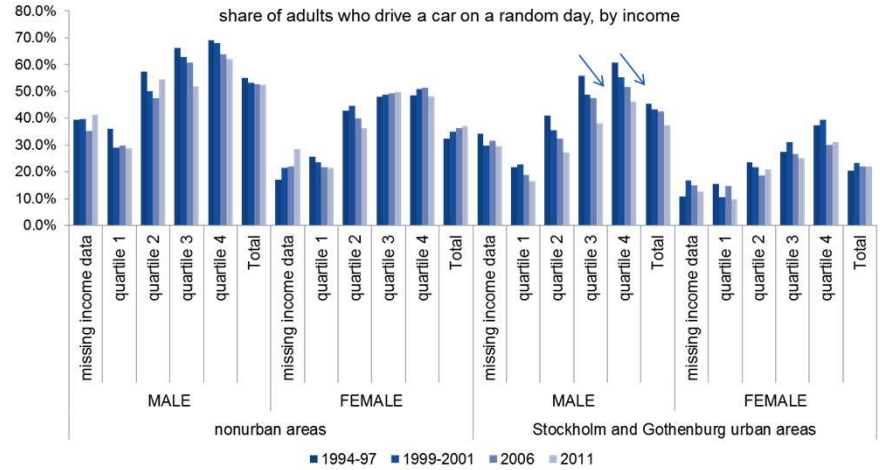
(Anne Bastian & Maria Börjesson, 2015)



Centre for Transport Studies STOCKHOLM

”Peak car for rich urban men”

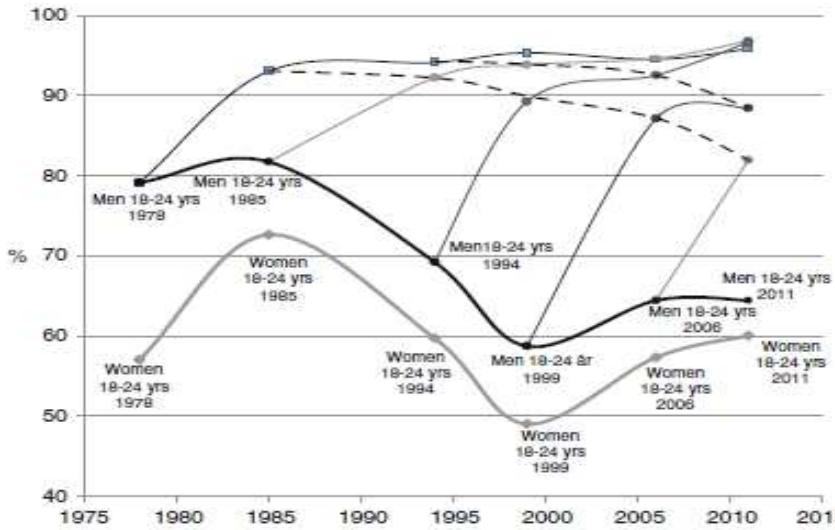
(Anne Bastian & Maria Börjesson, 2015)



Centre for Transport Studies STOCKHOLM

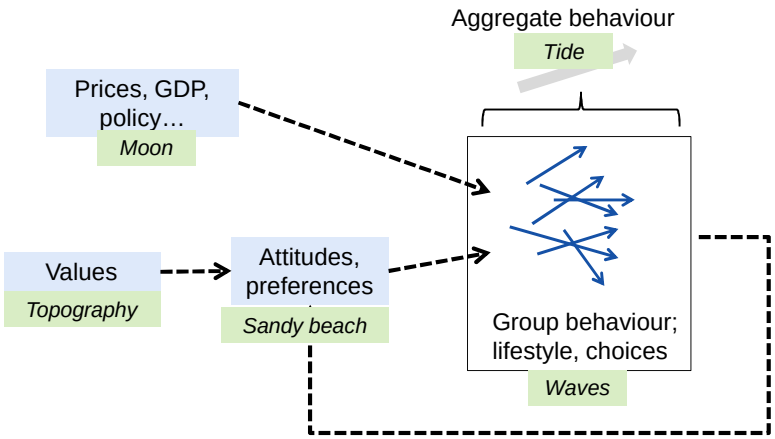
We get our driver’s licenses later

(Frändberg & Vilhelmsson, 2014; Kågeson, 2014: immigrants low licensing)



STOCKHOLM

Behaviour, attitudes, values and policy



Centre for Transport Studies STOCKHOLM

Lessons

- Fuel price affects driving
- Larger effect when alternatives are good (large cities)
- Attitudes, lifestyles partly consequence of economic incentives
- Little evidence of anything else than GDP and fuel price
  - no need to assume ”attitude shifts”

- So pricing policies work (good)
- Little effects *in addition* to price/policy incentives (pity)
- Let’s create societies where it’s easy to adapt when/if driving becomes more expensive

Centre for Transport Studies STOCKHOLM

Agglomeration effects in transport appraisal

Centre for Transport Studies STOCKHOLM

Are agglomeration effects captured by CBA?

- Better accessibility = larger ”effective city size” => higher wages (because of higher productivity)
- Part of ”wider economic impacts” of transport projects
  - Other things too, but this is the biggest
- UK, Sweden add this to standard CBA; more are planning to
- We show that this is at least partly double-counting

Centre for Transport Studies STOCKHOLM

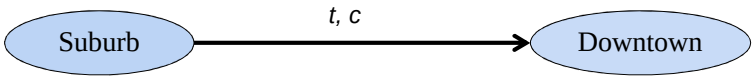
Sources of agglomeration effects

Urban wage premium can be caused by

- Matching: workers and workplaces are matched more efficiently => average worker productivity increases => wages increase
- Spillovers: workers learn from each other (or share resources) => average worker productivity increases => wages increase
- … and possibly other mechanisms too

A small model

Workers live in the suburb
Choose where to work and the number of working hours *W*



Wage w_0

Individual, heterogeneous wage offers *w*
Distribution *f(w;N)*
Increases with number of commuters *N*

$$u_S^*(w_0, 0, 0) = \max_W u(x, L) \quad \text{such that} \quad x \leq w_0 W + Y, \quad L + W \leq T$$

$$u_D^*(w, t, c) = \max_W u(x, L) \quad \text{such that} \quad c + x \leq wW + Y, \quad L + W + t \leq T$$

Three sources of agglomeration effects

- Lower *t* or *c* → average wage increases

Because of:

- **Labour supply**: shorter commuting time → more working hours
- **Matching**: lower commuting time → more commute → higher average wage rate
- **Spillovers:** lower commuting time/cost → more commute → higher wage rate offers (for *all* commuters)

- First two *will* be captured by standard CBA
- Third one will *not*
- Hence, *source* of agglomeration matters

Centre for Transport Studies STOCKHOLM

Welfare effect of travel time reduction

- No spillovers among workers (wage offers constant)

$$TB = \int_{\widetilde{w'}}^{\infty} \frac{1}{\lambda} u^*(w, t - dt, c) f(w) dw - \int_{\widehat{w}}^{\infty} \frac{1}{\lambda} u^*(w, t, c) f(w) dw \approx N_D * \overline{w} dt + ½ dN * \widehat{w} dt$$

$$=$$

Standard rule-of-half

- No matching (workers equally productive), but spillover effect:

$$TB \approx (W dw + w dt) N_D + ½ dN * \widetilde{w} dt = TB_{CBA} + (W N_D + ½ dN dt) dw$$

Standard rule-of-half *Extra term*

Centre for Transport Studies STOCKHOLM

Sources are indistinguishable in an aggregate view!

- Model 1: Only wage heterogeneity
- Model 2: Only spillover (+heterogeneity in preferences)

	Model 1	Model 2
Mean wage rate ($/h)	7.32	5.42
Mean working hours (h)	7.86	7.97
Mean income ($/day)	57.41	43.12
Elasticity of travel wrt. time	-0.22	-0.23
Elasticity of mean wage rate wrt. accessibility	-0.044	-0.047
Wider economics benefits: benefits outside CBA relative to standard CBA	-1%	+42%

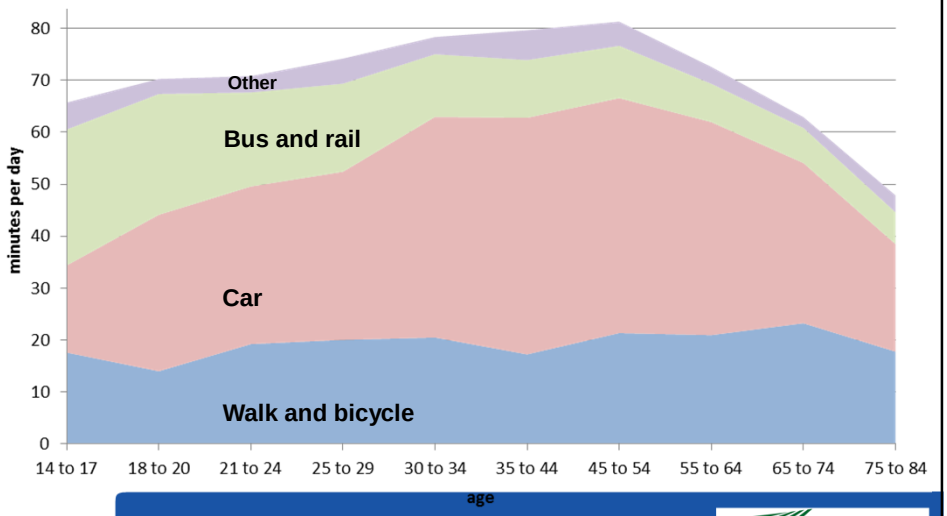
Impossible to know whether ”wider economic impacts” are really ”wider”- but you should *not* add the whole W.E.I.

Centre for Transport Studies STOCKHOLM

Travel patterns across life

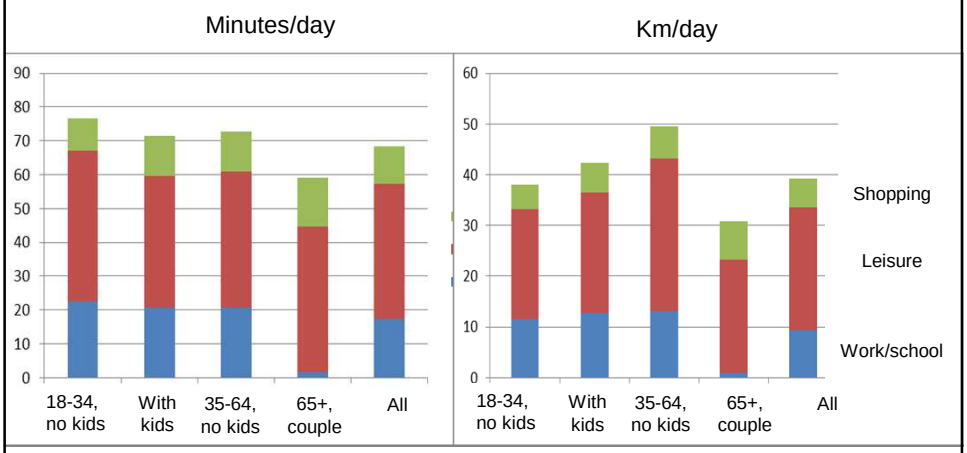
Centre for Transport Studies STOCKHOLM

Total travel time rather stable across life



Centre for Transport Studies STOCKHOLM

Work and school trips only 25% of travel



Centre for Transport Studies STOCKHOLM

Km/ day

Minutes /day