Valuing Transport Infrastructure:
A quantitative study of the factors defining the
social value of transport infrastructure in the UK

Nikos Kalyviotis, Chris Rogers & Miles Tight

Department of Civil Engineering
Edgbaston Birmingham B15 2TT
United Kingdom

Introduction

The final users of transport infrastructure are a "key stakeholder", since they elect the government   ... *Rodríguez-Pose, 2015, p.32*

The economic and the social value gained from the individual are difficult to calculate due to the different behaviour of each individual user – yet understanding of these values for the collective (the group that constitutes the users) is essential

The Aim of this research (which aligns with both the iBUILD & Liveable Cities projects) is to address the question:

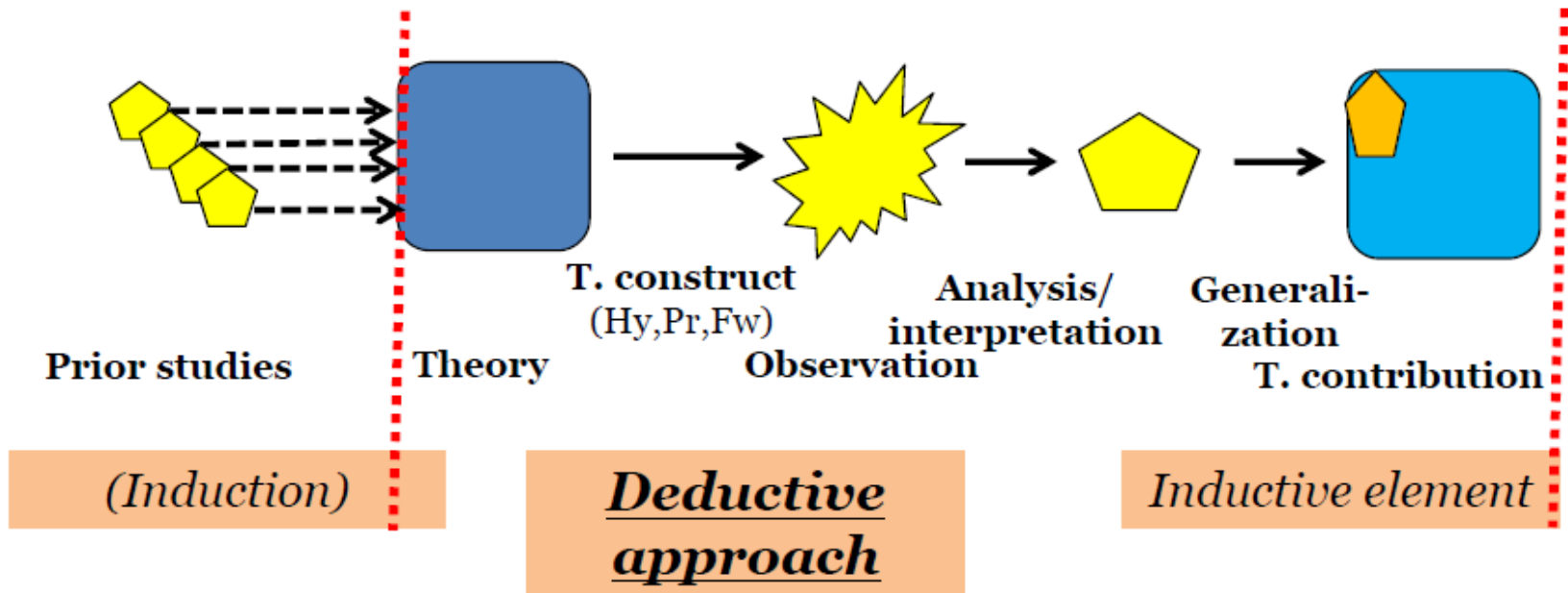**What is the Social Value of Transport Infrastructure?**

Theoretical Methodology

Scientific ideal: Positivism (*Wainwright & Forbes, 2000*)

- Hypothetico-deductive model
- Quantitative methods

Deductive approach (*May, 2011*)

Theoretical Frame of Reference

Human behaviour defines the social value
        ... and more specifically the needs

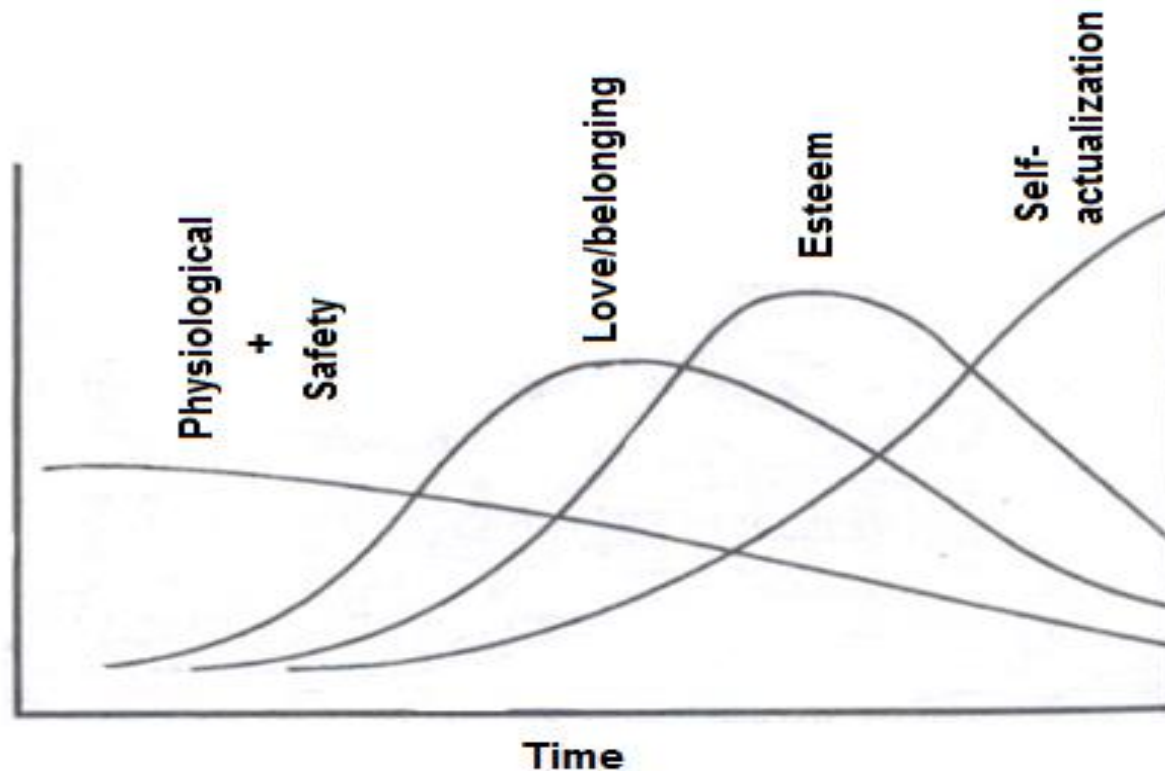According to Maslow's Hierarchy of Needs (1954), these needs belong to specific groups with the following hierarchy:

[1] physiological needs

[2] safety needs

[3] love and belonging

[4] esteem

[5] self-actualization

Theoretical Frame of Reference

Value curves of Maslow's Hierarchy of Needs (*Bourantas, 2002*)

The sum of curves gives a **sigmoid curve** (almost)

Theoretical Frame of Reference

Research proposition: Social Value of Transport Infrastructure

Winter *et al*. (2001) created a Transportation Hierarchy of Needs:

      [1] safety and security

      [2] time

      [3] societal acceptance
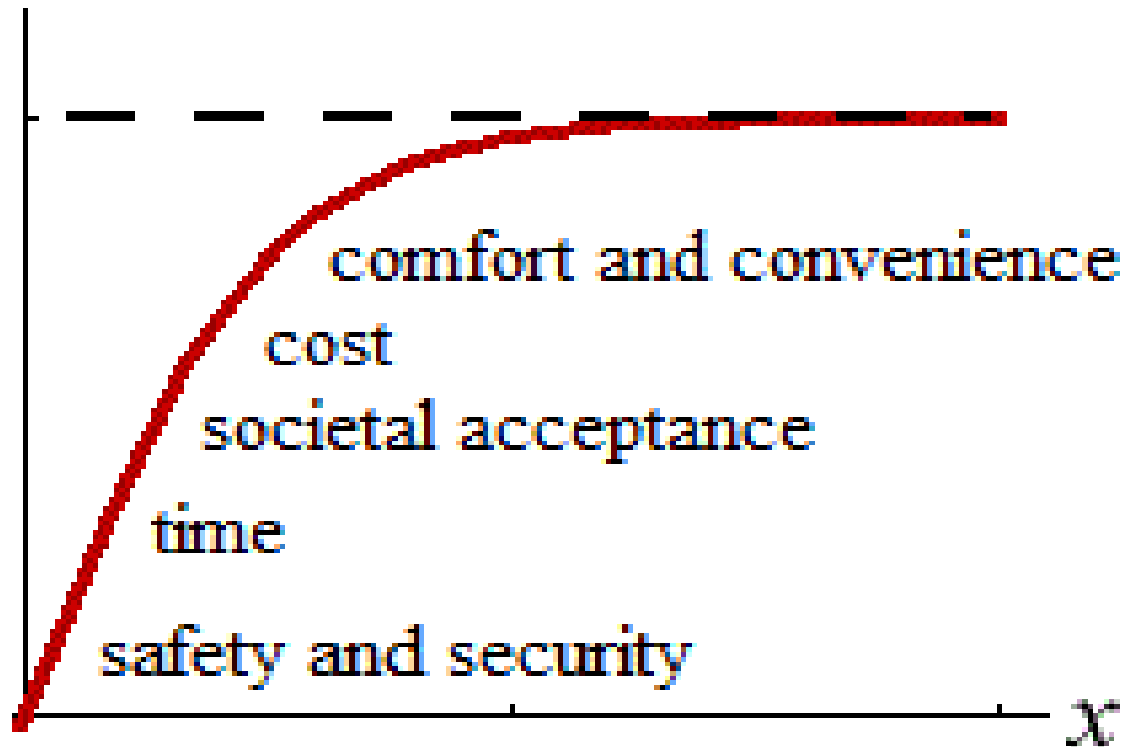
      [4] cost

      [5] comfort and convenience

Theoretical Frame of Reference

Research proposition: Social Value of Transport Infrastructure

So the value of the individuals **expected** to have an almost sigmoid curve relative to the needs covered by transport:

Practical Methodology

Initial findings from the Questionnaire Survey:

110 out of 300 individuals (880 out of 2400 evaluations)

1										Evaluation												
Postcode	Age	Ethnic	Gend.	Indiv.	Cars/ Veh.	Income (x1000)	Distan (Km)		Percent	Goods	Main	Walking	Cycling	Rail	Bus	Car	Taxi		Travel Time	Excess Time	Travel Cost	Confort & Conven.	Safety & Security
Birmingham B191L	20-29	White	F	2	0	0-10	7	Walking	15	x	Bus	4	-1	3	3	5	5	Walking	2	5	5	4	4
								Cycling										Cycling	0	4	1	-3	-3
								Rail										Rail	3	3	2	4	3
								Bus	80									Bus	3	4	4	-1	-1
								Car										Car	3	5	-1	4	4
								Taxi	5									Taxi	4	5	-2	4	4
Adjust to society:		Yes	Main reason:		Time				Trips	Distan													
Never cross the street if there is no zebra line								Air	1	311	General			Air		Water		Air	5	-1	0	4	4
								Water	4	186			4			4		Water	3	2	2	3	5

- Individuals were asked to evaluate the transport modes (8) and each social factor (i.e. the 5 hierarchy of needs) of each transport mode by assigning a value between -5 and 5.

- Checks were made on each individual's accessibility to each transport mode by using their postcode

Practical Methodology

Demographic analysis of the sample

Area	Population	Percentage	Expected
Belfast	585,996	1%	3
Birmingham	3,701,107	12%	36
Bristol	1,006,600	3%	9
Cardiff	1,097,000	3%	9
Edinburgh	1,339,380	4%	12
Glasgow	1,858,517	6%	18
Leeds	2,302,000	7%	21
Liverpool	2,241,000	7%	21
London	13,879,757	43%	129
Manchester	2,794,000	9%	27
Newcastle	1,650,000	5%	15
Total	32,455,357	100%	300

Age	Total Percentage (%)	Survey (%)	Expected
0-15	17.6	0	0
15-19	6.3	7.65%	23
20-29	13.6	16.50%	50
30-39	13.1	15.90%	48
40-49	14.6	17.72%	53
50-59	12.2	14.81%	44
60-65	6	7.28%	22
65+	16.6	20.15%	60
Total	100	100.00%	300

Gender	Percentage	Expected
Male	49.11%	147
Female	50.89%	153
Total	100.00%	300

Ethnic group	Percentage	Expected
White	87.17%	262
Asian	6.92%	21
Black	3.01%	9
Other	2.90%	8
Total	100%	300

Practical Methodology

Distance covered in Metropolitan areas

Transport Means	National	Expected		Percentage	Difference
Walking	3%	3.09%	Walking	5.44%	2.35%
Cycling	1%	1.03%	Cycling	6.30%	5.27%
Rail	10%	10.31%	Rail	12.19%	1.88%
Bus	5%	5.15%	Bus	10.68%	5.53%
Car/Taxi	78%	80.41%	Car/Taxi	64.44%	-15.02%
Other	3%	-		0.94%	
Total	100%	100.0%	Total	100%	0.0%

Practical Methodology

Initial findings from the Questionnaire Survey:

110 out of 300 individuals (880 out of 2400 evaluations)

1											Evaluation													
Postcode	Age	Ethnic	Gend.	Indiv.	Cars/ Veh.	Income (x1000)	Distan (Km)		Percent	Goods	Main	Walking	Cycling	Rail	Bus	Car	Taxi			Travel Time	Excess Time	Travel Cost	Confort & Conven.	Safety & Security
Birmingham B191L	20-29	White	F	2	0	0-10	7	Walking	15	x	Bus	4	-1	3	3	5	5	Walking	2	5	5	4	4
								Cycling										Cycling	0	4	1	-3	-3
								Rail										Rail	3	3	2	4	3
								Bus	80									Bus	3	4	4	-1	-1
								Car										Car	3	5	-1	4	4
								Taxi	5									Taxi	4	5	-2	4	4
Adjust to society:		Yes	Main reason:		Time				Trips	Distan													
Never cross the street if there is no zebra line								Air	1	311	General	Air			Water			Air	5	-1	0	4	4
								Water	4	186		4			4			Water	3	2	2	3	5

These datasets allowed the social factors to be evaluated for each of the eight modes of transport:

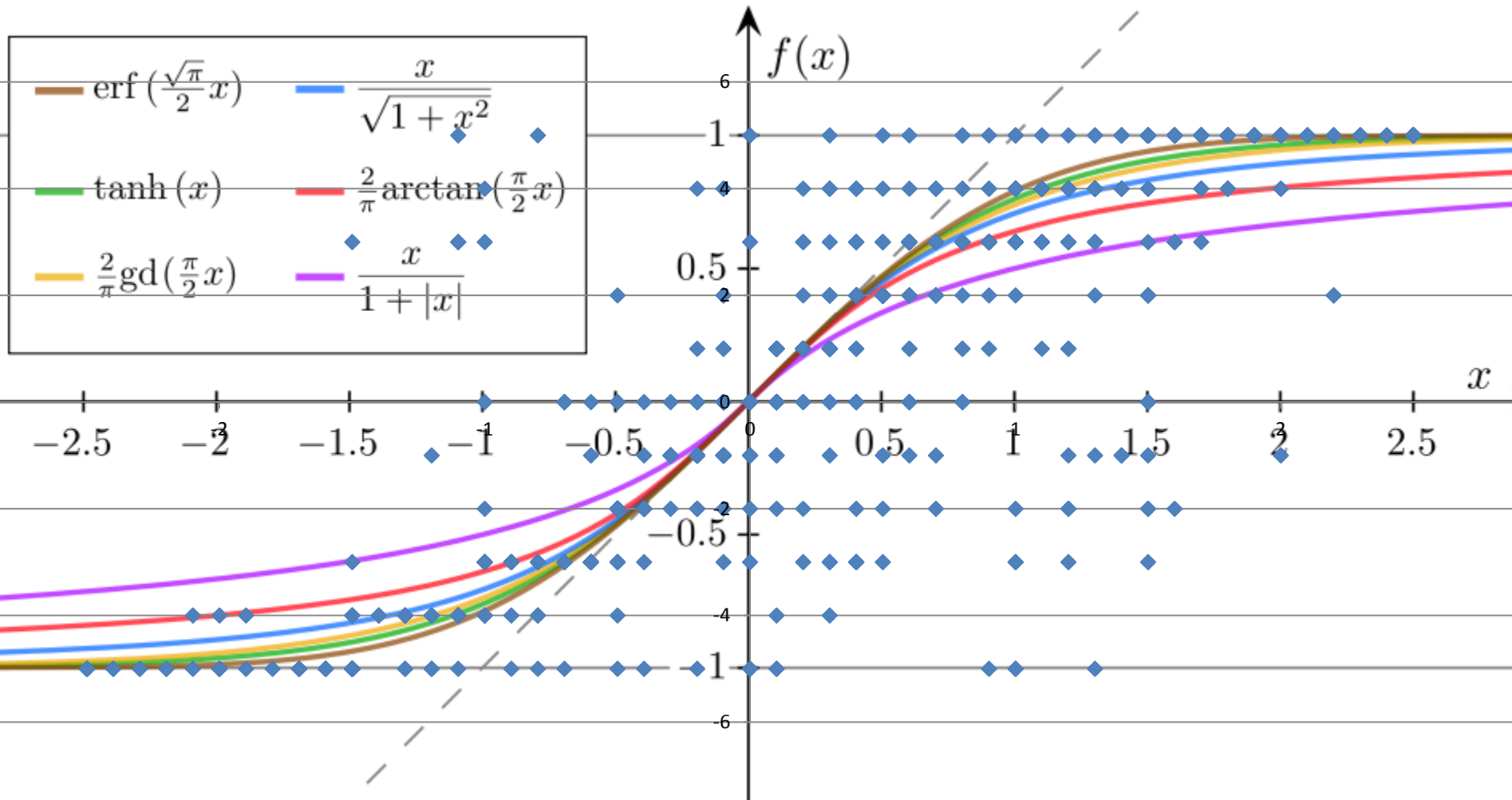Walking, Cycling, Rail, Bus, Car, Taxi, Air and Water.

Empirical Findings and Analysis
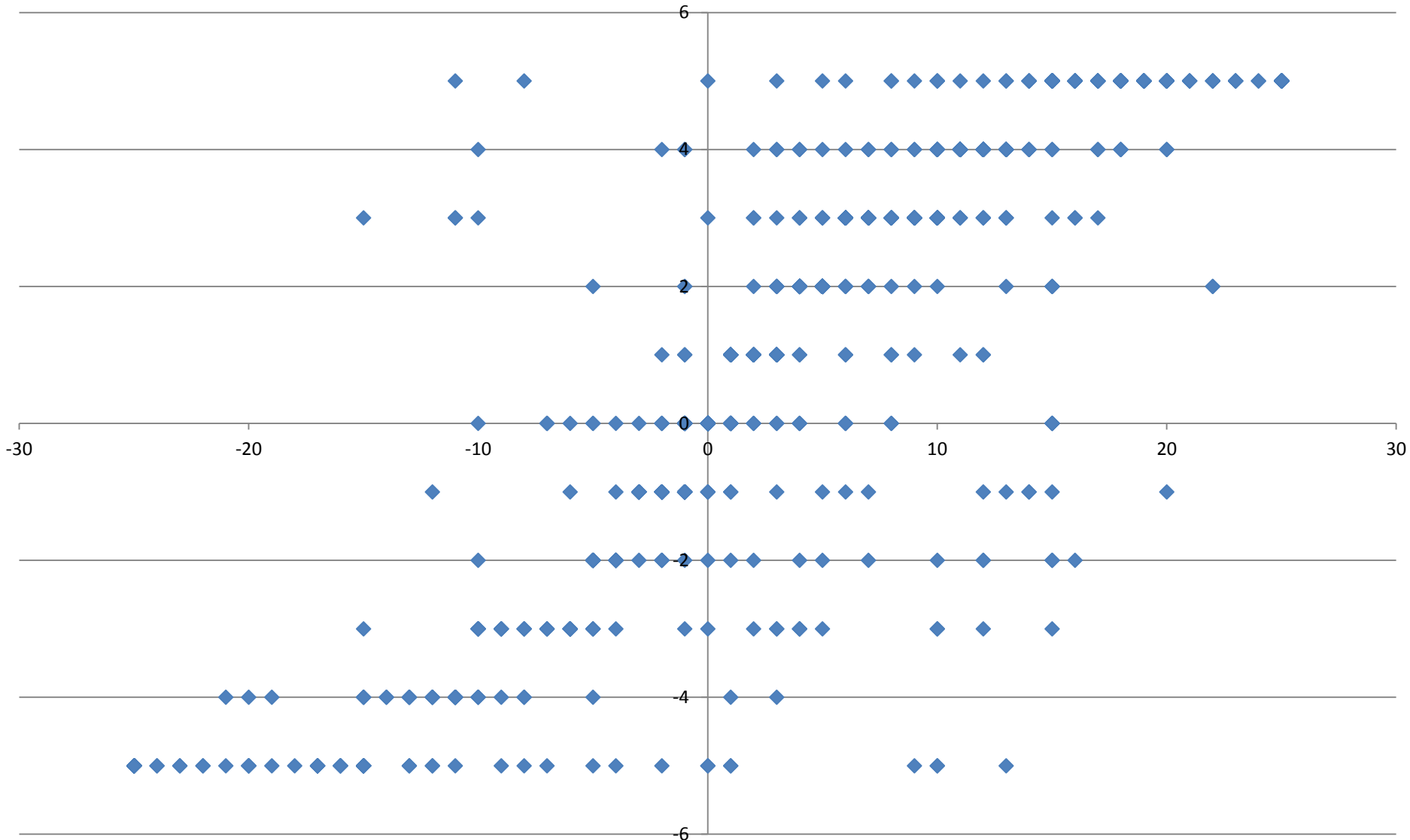
Empirical Findings and Analysis

Empirical Findings and Analysis

Evaluation alignment without excluding the outliers:

- 68.52% (603 out of 880 evaluations) explained with $f(x) = \operatorname{erf}(\frac{\sqrt{\pi}}{2}x)$

- 68.41% (602 out of 880 evaluations) explained with $f(x) = \tanh(x)$

- 62.84% (553 out of 880 evaluations) explained with $f(x) = \frac{2}{\pi}gd(\frac{\pi}{2}x)$

- 55.91% (492 out of 880 evaluations) explained with $f(x) = \frac{x}{\sqrt{1+x^2}}$

- 28 out of 880 explained only with $f(x) = \frac{2}{\pi}gd(\frac{\pi}{2}x)$ and/or $f(x) = \frac{x}{\sqrt{1+x^2}}$

Conclusions and Recommendations

- The numerical expression $f(x) = \tanh(x)$ explains 68.41% of the results and is a good fit to the data

- If the results from the second and the fourth quarters are removed as outliers, then $f(x) = \tanh(x)$ explains more than 75% of the data

So the hypothesis was verified

- Other conclusions for the Metropolitan Areas:

  - Walking, Cycling, Rail and Bus usages in the Questionnaire Survey were found to be greater than the national usage by 2.4%, 5.3%, 1.9% & 5.5%, respectively.

  - Car and Taxi usage in the Questionnaire Survey was found to be less than the national usage by 15.0%

Conclusions and Recommendations

- Other findings for the Metropolitan Areas

  - The greatest car usage is in Birmingham and Manchester

  - The greatest rail usage is in Newcastle and Glasgow, where the rail got the highest "score"

  - The individuals have a **positive opinion** for the **Rail Network** all over the United Kingdom **EXCEPT** London (maybe because of the underground)

Conclusions and Recommendations

Thank you for your attention!