



# **Spatial Disparities in Long-Term Care in Germany: Pattern, Determinants and Trends**

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Rostock Center for the Study of Demographic Change**



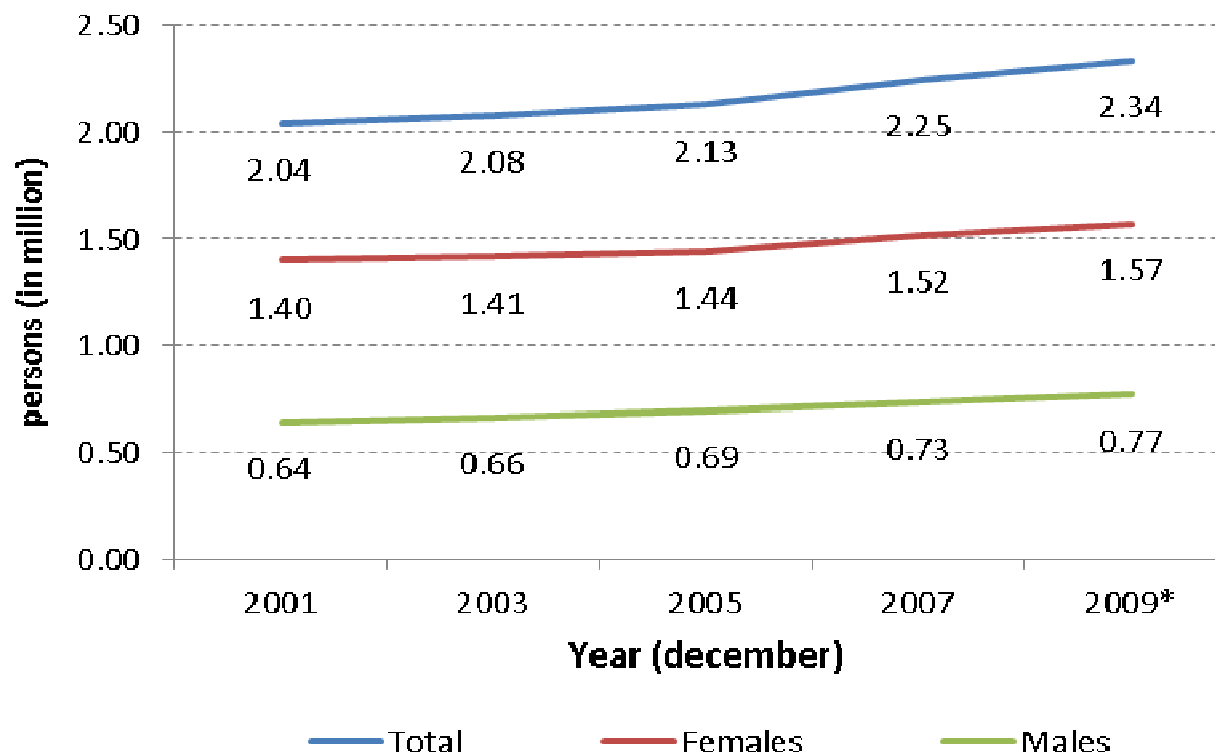
## Outline

1. Background
2. Data & Methods
3. Results
4. Summary & Outlook



# 1. Background

## Background – Trends in long-term care in Germany



Introduction of the long-term care insurance: 1995

## Spatial Disparities in Long-term Care?

1. Does the health ratio differ between the German counties?  
Cross-sectional perspective
2. Do macro factors explain the spatial patterns in the health ratio?
3. Are there significant changes in the spatial variance and level of the DFLE/DLY/HR over the observation period (2001-2009)?  
Longitudinal perspective
4. Do the health scenarios differ between the counties?

## Spatial Disparities in Long-term Care?

- **Basic assumption:** Ongoing increase of life expectancy

Health Scenario	Trends by Indicator over the Observation Period		
	Disability-Free Life Expectancy	Life Expectancy with Disability	Health Ratio
Absolute Expansion	▼	▲	▼
Relative Expansion	▲ =	▲	▼
Dynamic Equilibrium	▲	▲	=
Relative Compression	▲	▲ =	▲
Absolute Compression	▲	▼	▲

Note: ▼ : decrease; ▲ : increase; = : stable

Source: Own adaptation of Gruenberg (1977); Kramer (1980); Manton (1982); Manton et al. (1997); Fries (1983, 2003, 2005)



## 2. Data & Methods

## Data & Methods (Part 1 and 2)

### German Statutory Long-Term Care (SLTC) Census 2001-2009

- *Official census of all care receivers (~2 million persons / year) living in private households and institutions*
- *Number of care receivers by county, sex, age groups ('<1', '1-4', '5-9', '10-14',..., '85+'), and severity of disability (any disability vs. severe disability)*

#### ***Definition of disability:***

*Receiving benefits (money and/or personal assistance)  
from the German SLTC insurance system  
= officially diagnosed disability*



## Data & Methods (Part 1 and 2)

### **Additional data: Official regional database**

#### ***Life table estimation:***

- *Counts of deaths (by county, year, sex, and age groups), and*
- *Total population at the end of the year (by county, year, sex, and age groups)*

#### ***Selected macro factors:***

- *Four indicators of demographic and socio-economic composition and context of the 412 German counties*



## Data & Methods (Part 1 and 2)

- **Outcome/s:** Calculations based on Chiang's and Sullivan's method
  - Life expectancy (LE) based on 3-years death counts
  - Disability-free life expectancy (DFLE)
  - Disabled life years (DLY)
  - **Health ratio (HR)** (Proportion of DFLE in LE)

Persons at age 65+ by county, year, and sex  
412 counties (boundaries in 2009)



## Data & Methods (Part 1)

- Independent variables (regression models):
  1. **Regional economic context**  
Indicator: Disposable household income per capita
  2. **Socioeconomic composition**  
Indicator: Long-term unemployment rate
  3. **Settlement structure**  
Indicator: Population density (urbanity)
  4. **Health situation**  
Indicator: Level of premature mortality (age 1- 45)
- Grouped in **quintiles** with the first quintile (20% lowest values) as the reference group

## Data & Methods (Part 1)

- **Outcome:** Health ratio (HR) of any disability at age 65+ by sex in 2009
- Linear **meta-regression** models with random effects:
  - ecological regression (only information on macro level)
  - advantage of the method:  
county-specific precision of DFLE estimation considered

$$y_i = x_i \beta + u_i + \epsilon_i \quad \text{where} \quad u_i \sim N(0, \tau^2) \quad \text{(Harbord, Higgins 2008)}$$

and  $\epsilon_i \sim N(0, \sigma_i^2)$

## Data & Methods (Part 2)

- Definition: Trend

$$Trend_{LE} = \frac{(LE_{2007} + LE_{2009})}{2} - \frac{(LE_{2001} + LE_{2003})}{2}$$

$$Trend_{DFLE} = \frac{(DFLE_{2007} + DFLE_{2009})}{2} - \frac{(DFLE_{2001} + DFLE_{2003})}{2}$$

$$Trend_{DLY} = \frac{(DLY_{2007} + DLY_{2009})}{2} - \frac{(DLY_{2001} + DLY_{2003})}{2}$$

$$Trend_{HR} = \frac{(HR_{2007} + HR_{2009})}{2} - \frac{(HR_{2001} + HR_{2003})}{2}$$

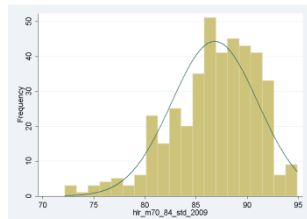
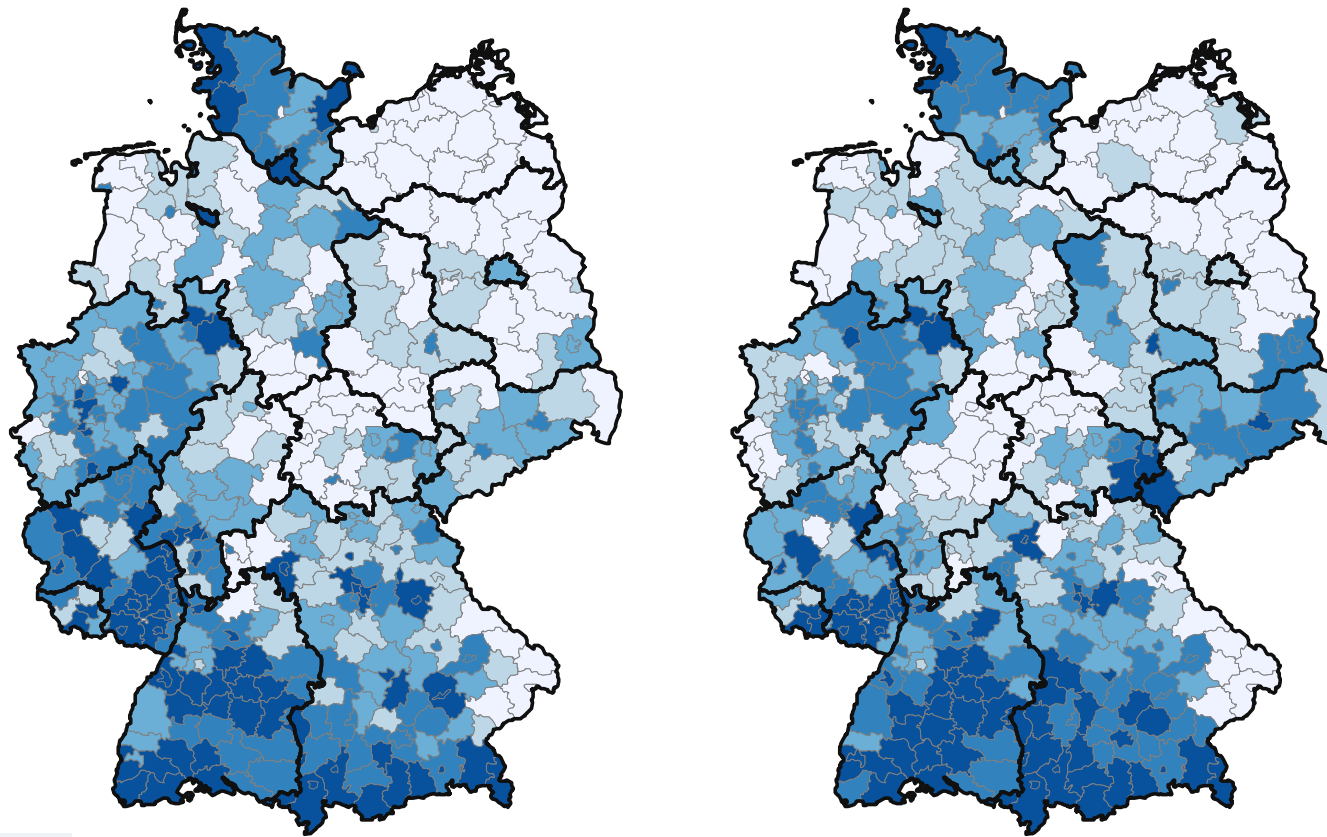


## 3. Results

## Spatial Disparities in Long-term Care?

1. **Does the health ratio differ between the German counties?**
2. Do macro factors explain the spatial patterns in the health ratio?
3. Are there significant changes in the spatial variance and level of the DFLE/DLY/HR over the observation period (2001-2009)?
4. Do the health scenarios differ between the counties?

## Regional variation in HR(65+) in 2009



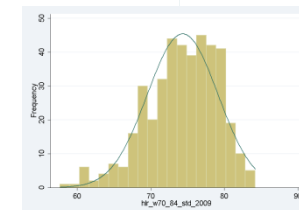
HR(65+) of males

- 1st Quintile (81.8-88.0%)
- 2nd Quintile (88.1-89.2%)
- 3rd Quintile (89.3-90.0%)
- 4th Quintile (90.1-91.0%)
- 5th Quintile (91.1-93.6%)

The darker,  
the healthier

HR(65+) of females

- 1st Quintile (72.2-81.0%)
- 2nd Quintile (81.1-83.0%)
- 3rd Quintile (83.1-84.5%)
- 4th Quintile (84.6-86.0%)
- 5th Quintile (86.1-89.7%)





## Spatial Disparities in Long-term Care?

1. Does the health ratio differ between the German counties? **Yes**
2. **Do macro factors explain the spatial patterns in the health ratio?**
3. Are there significant changes in the spatial variance and level of the DFLE/DLY/HR over the observation period (2001-2009)?
4. Do the health scenarios differ between the counties?

## Covariates of remaining HR (multivariate analyses)

<i>Covariates</i>		Males (65+)		Females (65+)	
		Coefficient	<i>p</i> -value	Coefficient	<i>p</i> -value
Constant		88.81	<0.001	83.51	<0.001
Disposable income of the private households per capita (quintiles)	<i>1st - lowest</i>	Ref		Ref	
	<i>2nd</i>	0.10	0.722	-0.62	0.139
	<i>3rd</i>	0.71	0.024	0.33	0.488
	<i>4th</i>	1.07	0.002	1.20	0.020
	<i>5th - highest</i>	1.27	<0.001	1.28	0.013
Long term unem- ployment rate (quintiles)	<i>1st - lowest</i>	Ref		Ref	
	<i>2nd</i>	-0.29	0.278	-0.38	0.349
	<i>3rd</i>	-0.81	0.003	-1.47	<0.001
	<i>4th</i>	-0.68	0.021	-1.65	<0.001
	<i>5th - highest</i>	-1.08	0.002	-2.24	<0.001

[adjusted for population density and level of premature mortality]

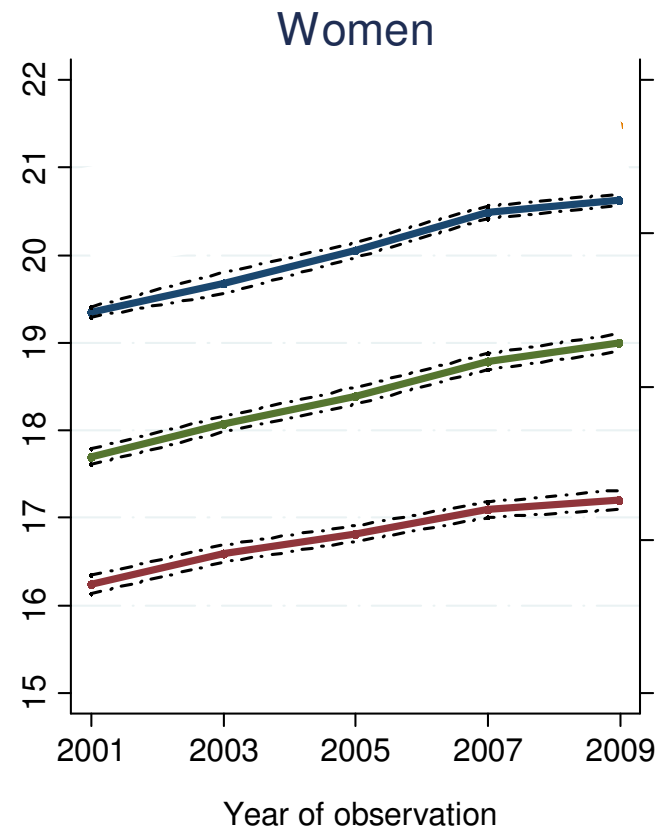
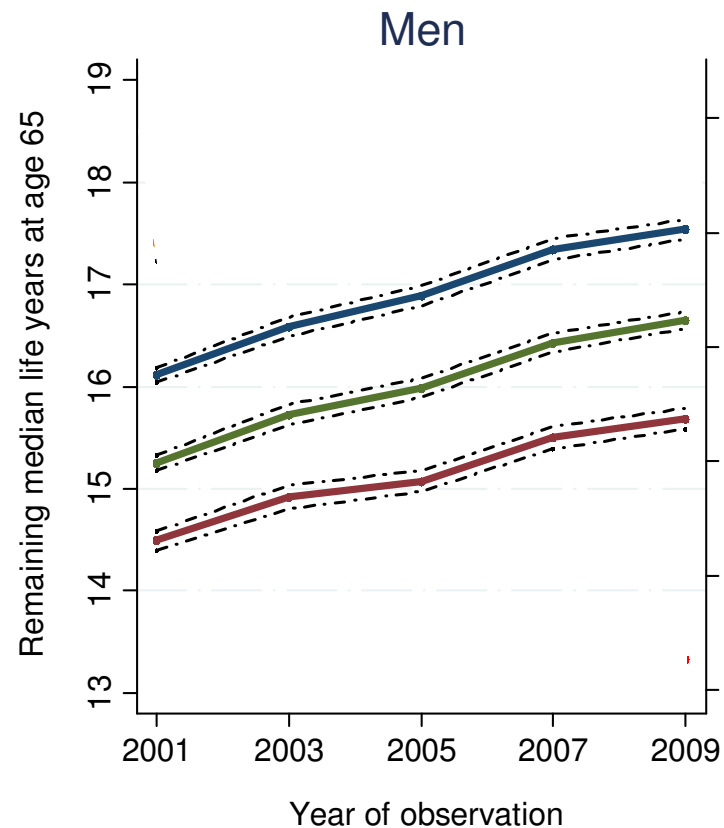
## Covariates of remaining HR (multivariate analyses)

<i>Covariates</i>		<b>Males (65+)</b>		<b>Females (65+)</b>	
		<b>Coefficient</b>	<b>p-value</b>	<b>Coefficient</b>	<b>p-value</b>
<b>Constant</b>		88.81	<0.001	83.51	<0.001
<b>Population density (quintiles)</b>	<i>1st - lowest</i>	Ref		Ref	
	<i>2nd</i>	0.36	0.167	0.37	0.345
	<i>3rd</i>	0.78	0.007	0.66	0.129
	<i>4th</i>	0.96	<0.001	1.04	0.016
	<i>5th - highest</i>	1.53	<0.001	2.19	<0.001
<b>Level of premature mortality (quintiles)</b>	<i>1st - lowest</i>	Ref		Ref	
	<i>2nd</i>	-0.19	0.461	-0.38	0.331
	<i>3rd</i>	0.09	0.726	0.28	0.479
	<i>4th</i>	-0.31	0.231	-0.46	0.242
	<i>5th - highest</i>	-0.72	0.007	-0.80	0.051
<b>Adjusted R<sup>2</sup></b>		28.46%		26.74%	

[adjusted for disposable income and long-term unemployment rate]

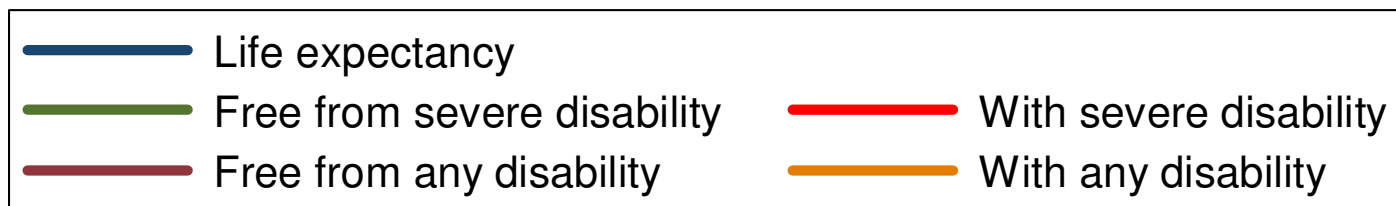
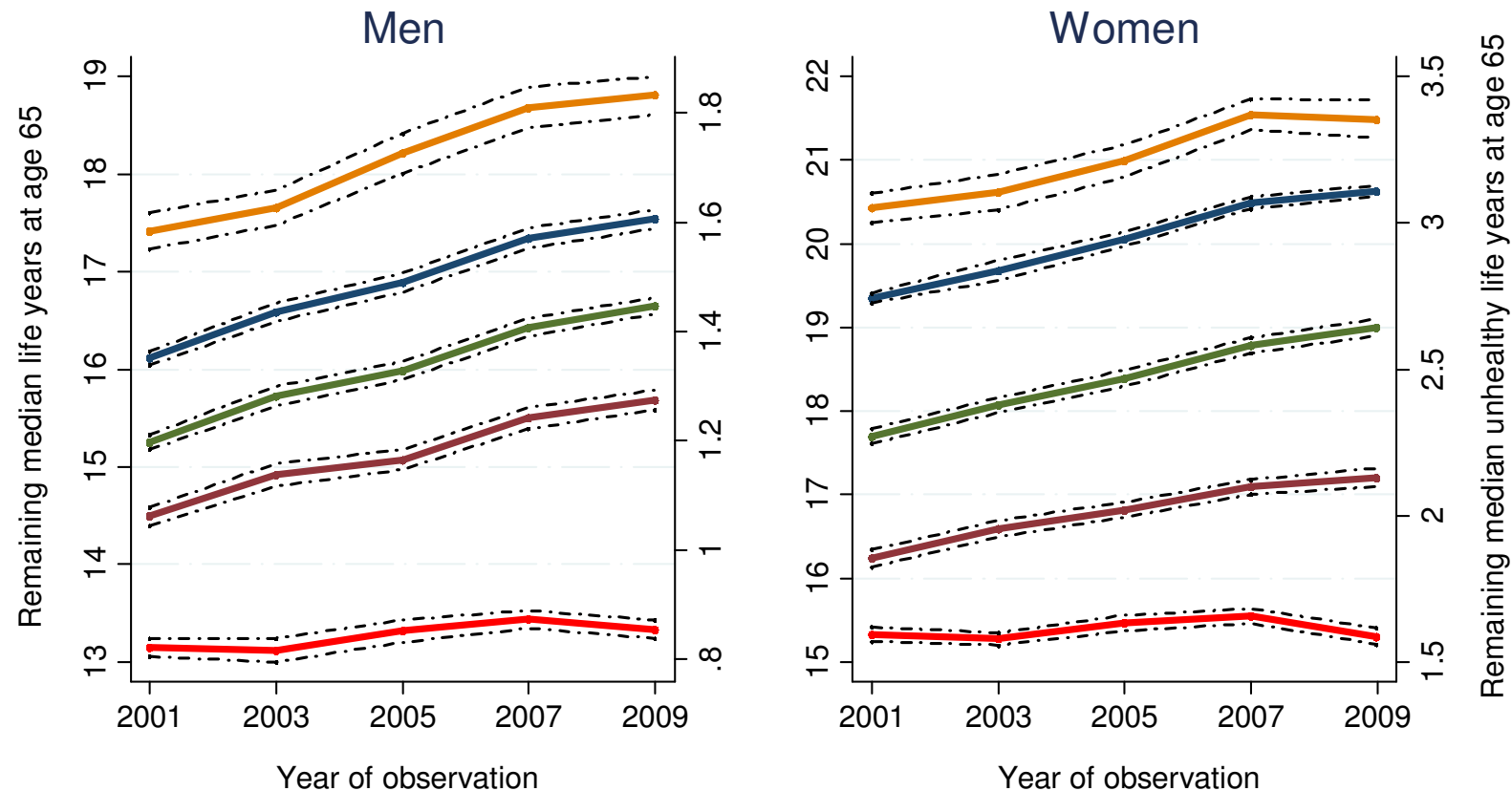
## Spatial Disparities in Long-term Care?

1. Does the health ratio differ between the German counties? **Yes**
2. Do macro factors explain the spatial patterns in the health ratio? **Yes, partly**
3. **Are there significant changes in the spatial variance and level of the DFLE/DLY/HR over the observation period (2001-2009)?**
4. Do the health scenarios differ between the counties?

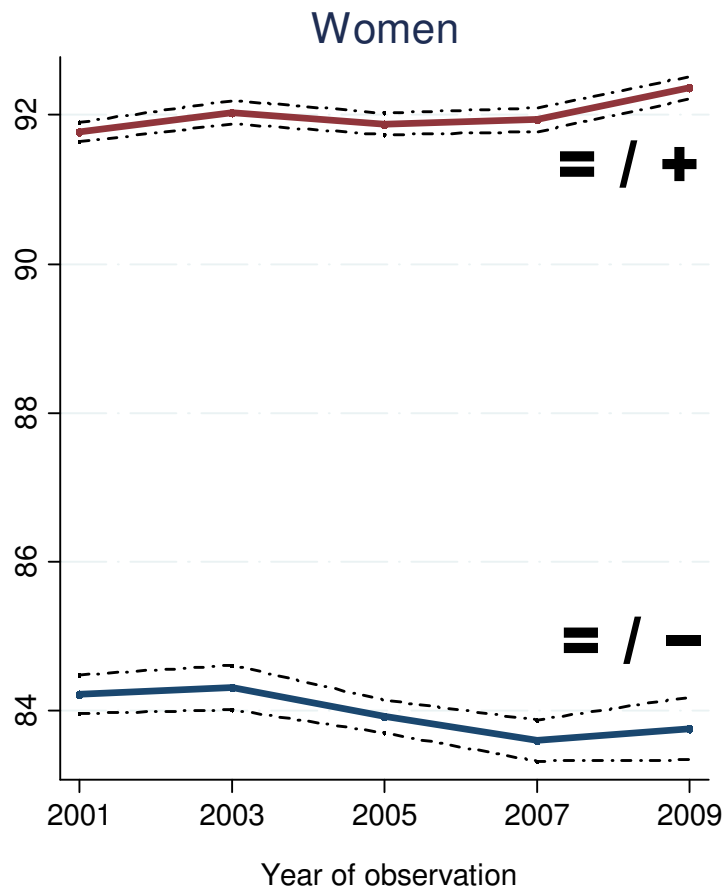
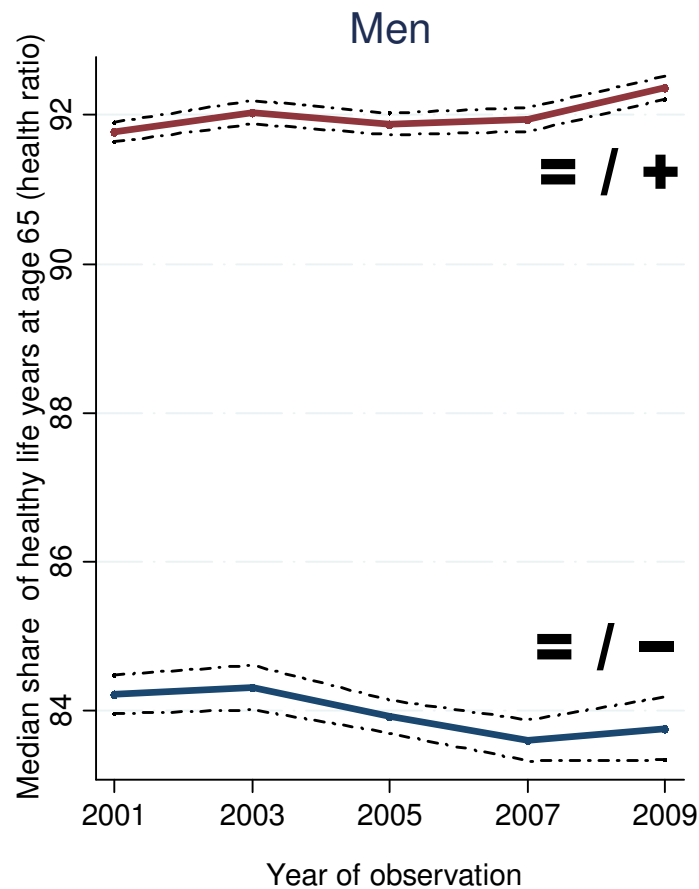


- Life expectancy
- Free from severe disability
- Free from any disability

Bonett-Price 95% CI included

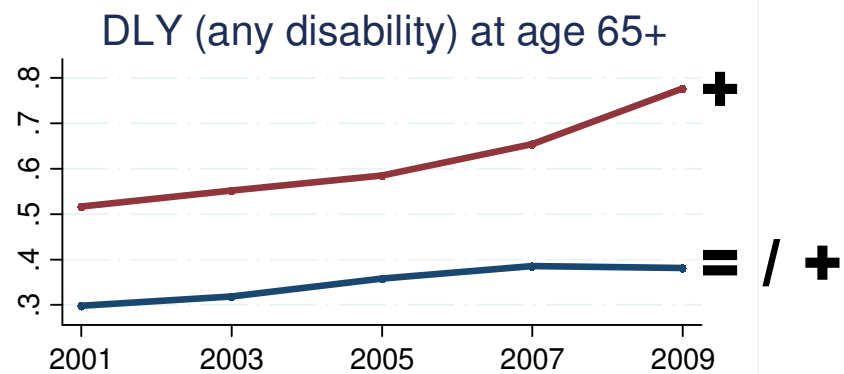
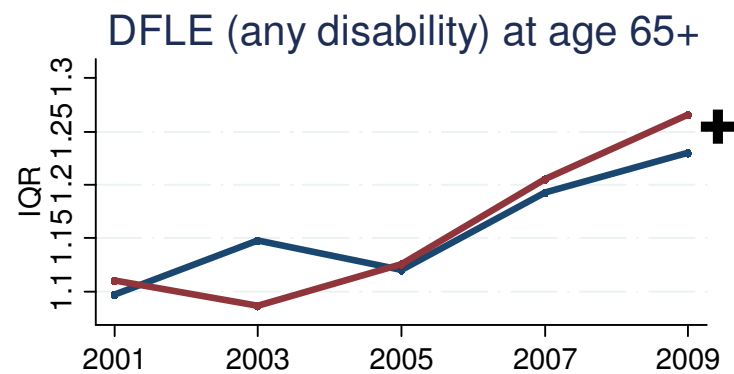
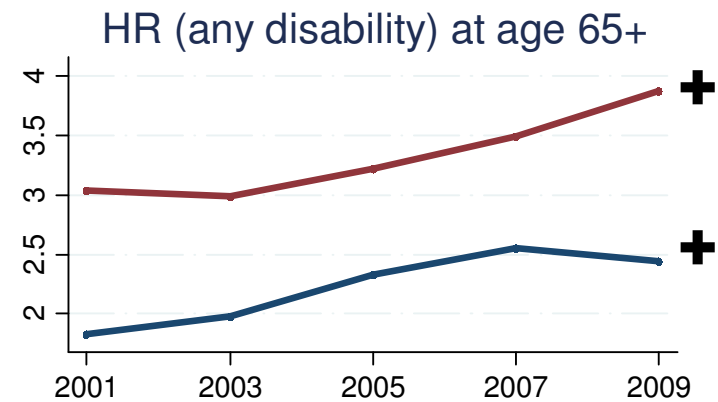
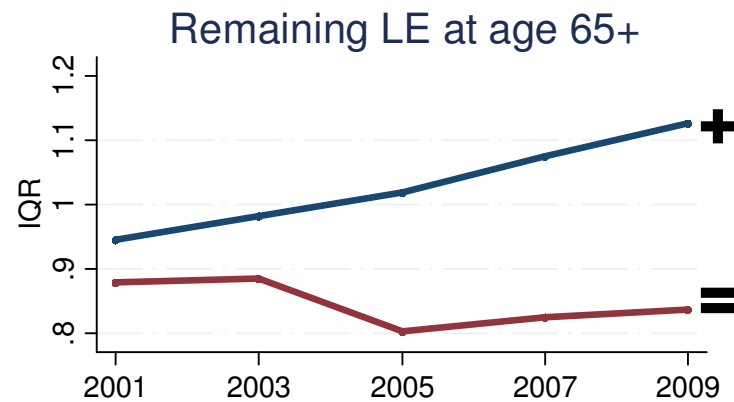


Bonett-Price 95% CI included



Free from any disability Free from severe disability

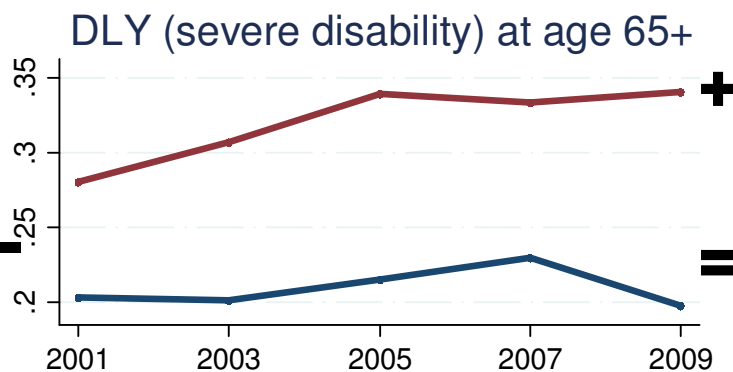
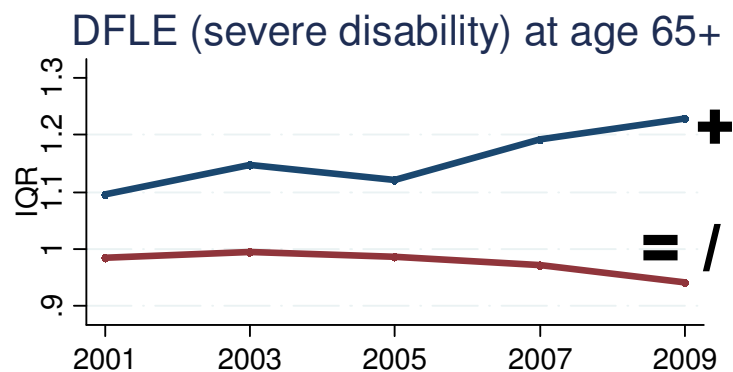
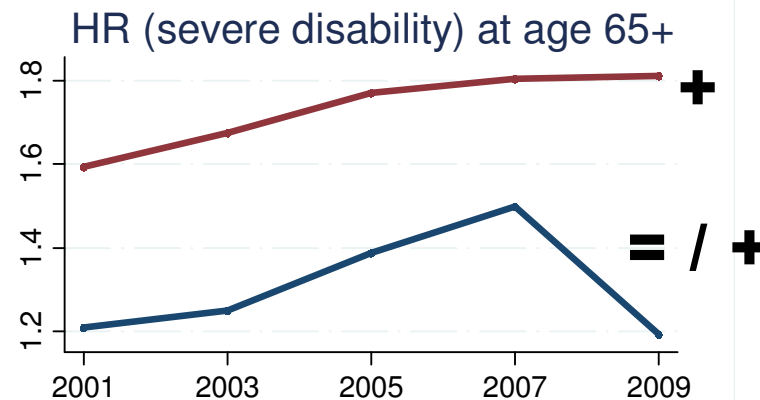
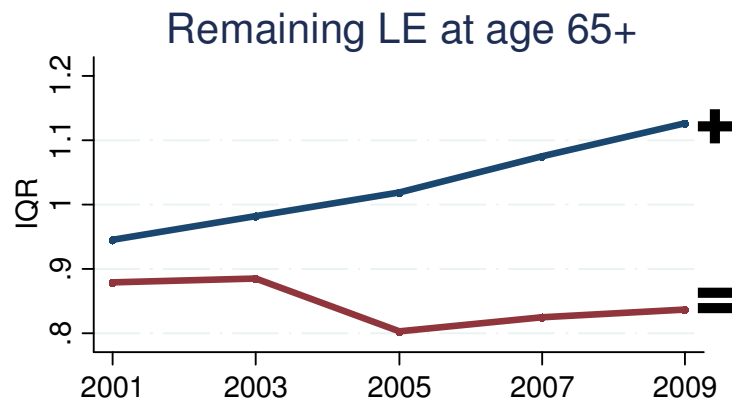
Bonett-Price 95% CI included



— Men — Women

Note: IQR = Interquartile  
range ( $Q_{75}-Q_{25}$ )





Year of observation

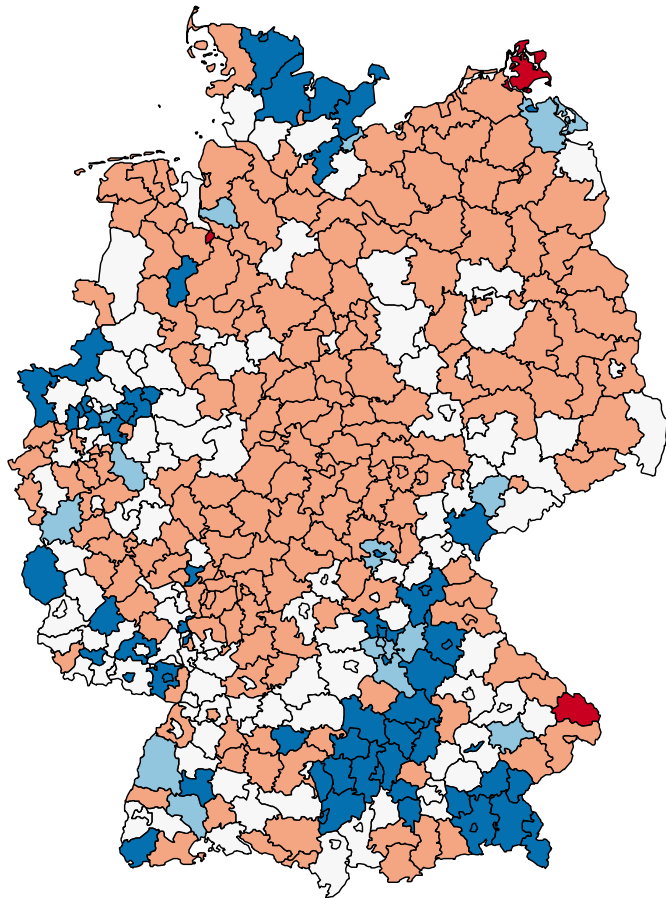
Year of observation



Note: IQR = Interquartile range ( $Q_{75}-Q_{25}$ )

## Spatial Disparities in Long-term Care?

1. Does the health ratio differ between the German counties? **Yes**
2. Do macro factors explain the spatial patterns in the health ratio? **Yes, partly**
3. Are there significant changes in the spatial variance and level of the DFLE/DLY/HR over the observation period (2001-2009)? **Yes, partly**
4. **Do the health scenarios differ between the counties?**



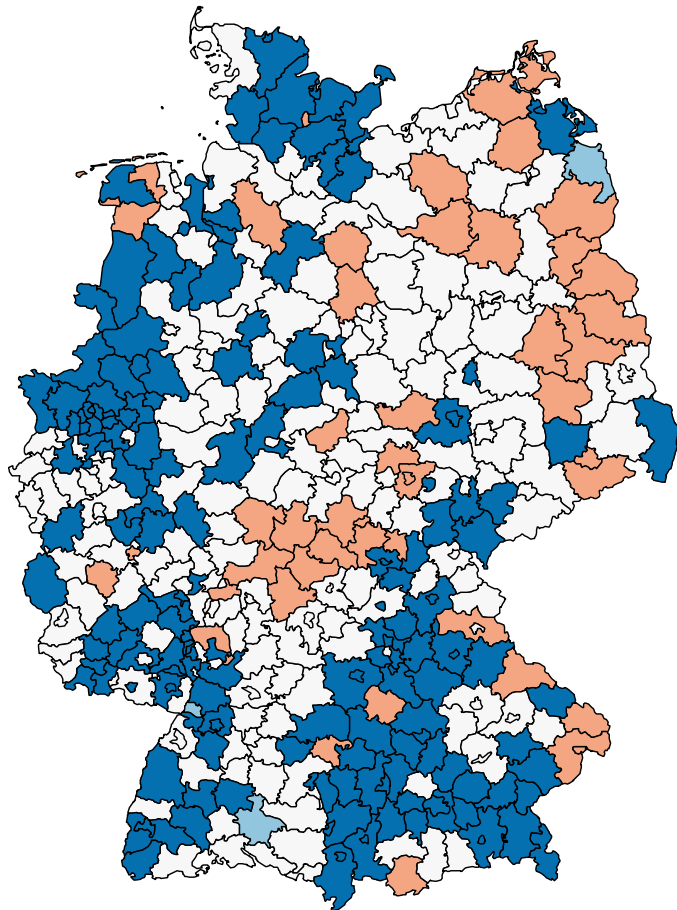
Clusters by trend in morbidity  
(all types of disability)

- Absolute Expansion
- Relative Expansion
- Dynamic Equilibrium
- Relative Compression
- Absolute Compression

## Any Disability

	Number of counties
Absolute Expansion	5
Relative Expansion	<b>208</b>
Dynamic Equilibrium	119
Relative Compression	17
Absolute Compression	63

	Disability-Free Life Expectancy	Life Expectancy with Disability	Health Ratio
Absolute Expansion	▼	▲	▼
Relative Expansion	▲ =	▲	▼
Dynamic Equilibrium	▲	▲	=
Relative Compression	▲	▲ =	▲
Absolute Compression	▲	▼	▲



Clusters by trend in morbidity  
(severe disability)

- Relative Expansion
- Dynamic Equilibrium
- Relative Compression
- Absolute Compression

## Severe Disability

	Number of counties
Absolute Expansion	0
Relative Expansion	51
Dynamic Equilibrium	194
Relative Compression	3
Absolute Compression	164

	Disability-Free Life Expectancy	Life Expectancy with Disability	Health Ratio
Absolute Expansion	▼	▲	▼
Relative Expansion	▲ =	▲	▼
Dynamic Equilibrium	▲	▲	=
Relative Compression	▲	▲ =	▲
Absolute Compression	▲	▼	▲



## 4. Summary and Outlook



## Results

### *Question 1:*

- Identification of marked spatial long-term care disparities
- Consistent spatial patterns in HR of males and females

### *Question 2:*

- **Low health ratio (poor health situation) in counties with:**
  1. A high long-term unemployment rate and
  2. A (very) high level of premature mortality
- **High health ratio (good health situation) in counties with:**
  1. A high disposable household income and
  2. A high population density

## Results

### Question 3:

Sex	Outcome	Level (all types)	Variance (all types)	Level (only severe)	Variance (only severe)
Men	LE	+	+		
	DFLE	+	+	+	+
	DLY	+	=	=	=
	HR	= / -	+	= / +	= / +
Women	LE	+	=		
	DFLE	+	+	+	= / -
	DLY	+	+	=	+
	HR	= / -	+	= / +	+

→ Spatial disparities increased due to mortality (men) and morbidity (women)

## Results

### *Question 4:*

**Health scenarios:** Very high heterogeneity in the trends in morbidity among the German counties

In case of any disability:

Most counties show a relative expansion

In case of severe disability:

Most counties show a dynamic equilibrium or an absolute compression





## Outlook

- To explain the regional varying health scenarios:  
Decomposition of trends in DFLE in effects of morbidity and effects of mortality
- Detection of potential determinants of the trends in DFLE  
(e.g. correlations with cause-specific mortality patterns)



Thank you for your attention!

Daniel Kreft

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## Limitations

- Problems with the study design and interpretation of the results:
  1. Only effects on aggregate level (problem of ecological fallacy)  
→ Only correlation and no separation of effects of composition (selection) and context (causation)
  2. Problem with assessment of care need status: underestimation of persons in need of care expected  
(Official recognised care receiver < all disabled persons)
  3. Unclear interpretation of the macro indicators
  4. 2001-2009: Too short time period (trends or random fluctuations?)

## Background – Theoretical framework (Glass & Balfour 2003)

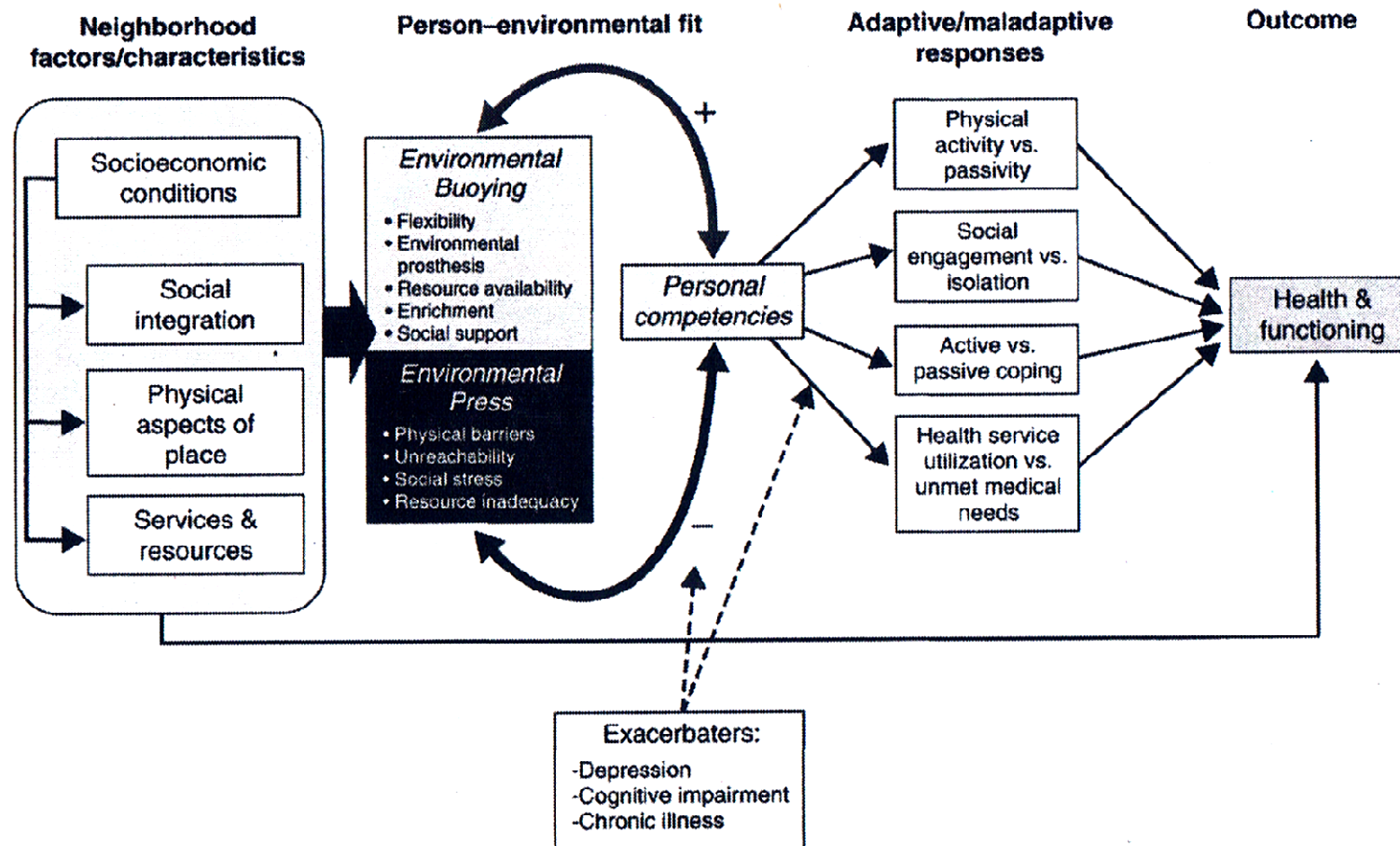
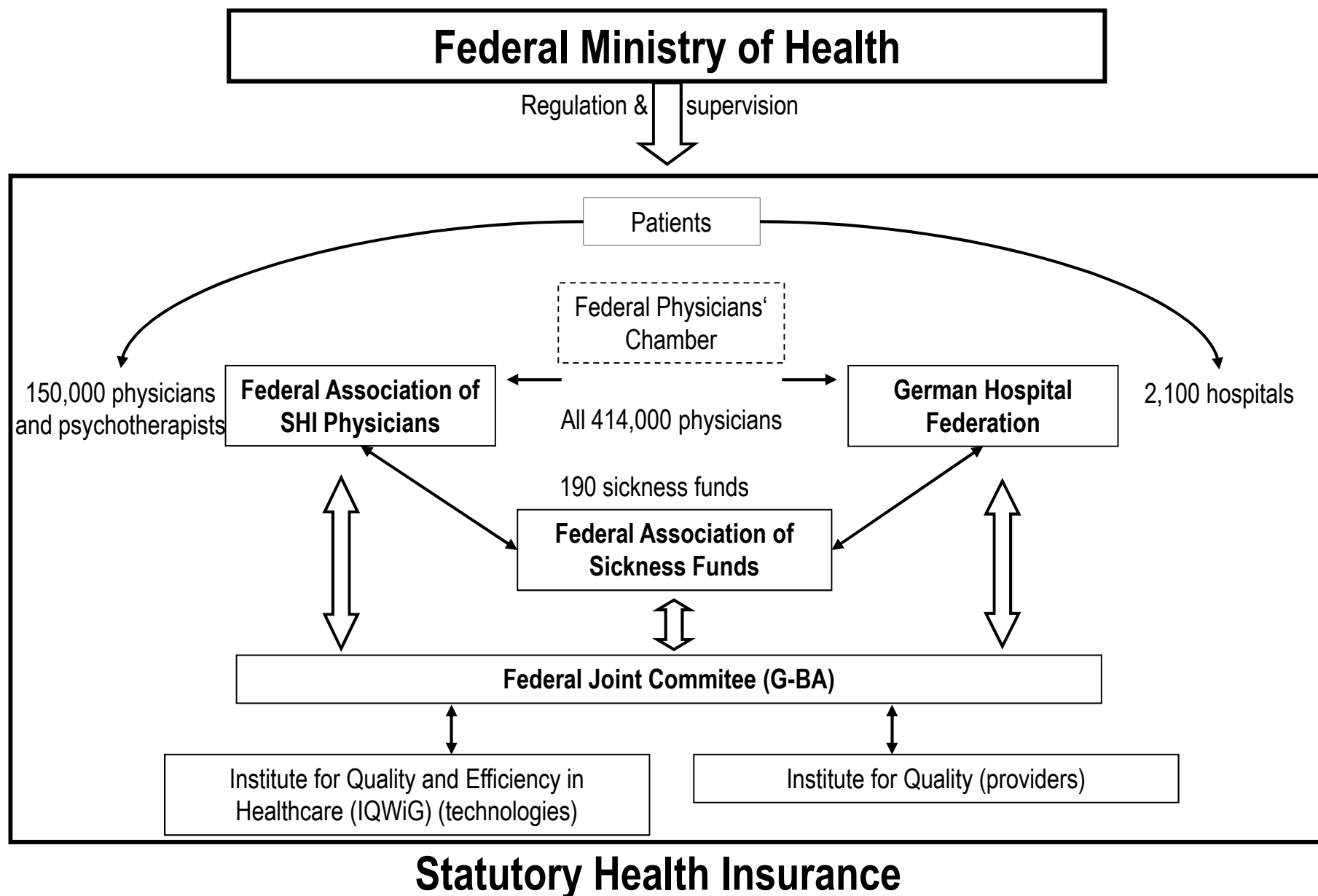


FIGURE 14-2. Causal model of neighborhood effects on aging (an extension of the EMA).

Source: Glass, T.A. & Balfour, J.L. (2003): Neighborhoods, Aging, and Functional Limitations.

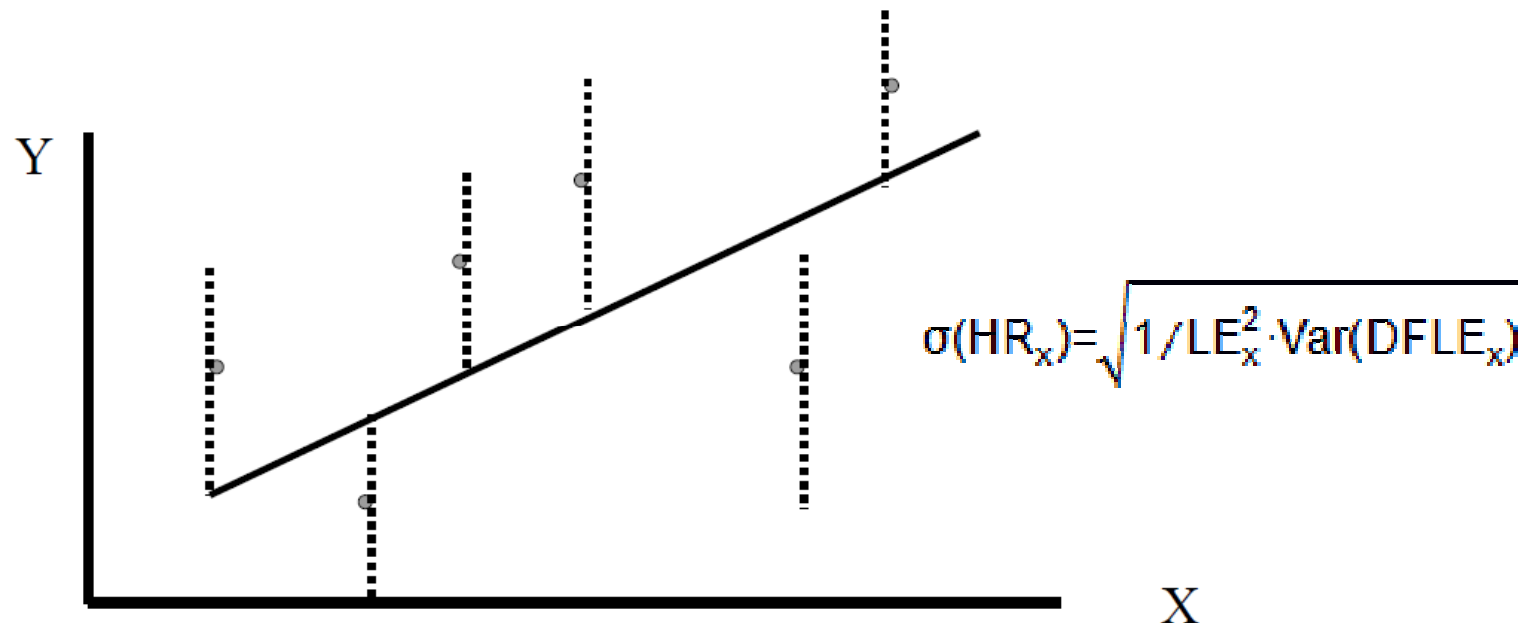
In: Kawachi, I. & Berkman, L.F. (Eds.) Neighborhoods and Health. Oxford University Press: 303-334.

# German Health System



Source: Richard Busse, "The Health System in Germany—Combining Coverage, Choice, Quality, and Cost-Containment," PowerPoint Presentation, 2008.  
Updated April 13, 2009.

# Random-effects regression



Model:  $y_i = \beta_1 + \beta_2 x_i + d_i + e_i$   $e_i$  independent and  $e_i \sim N(0, \sigma_i^2)$

$$\beta = \frac{\sum w_i^* (y_i - \bar{y})(x_i - \bar{x})}{\sum w_i^* (x_i - \bar{x})^2}$$

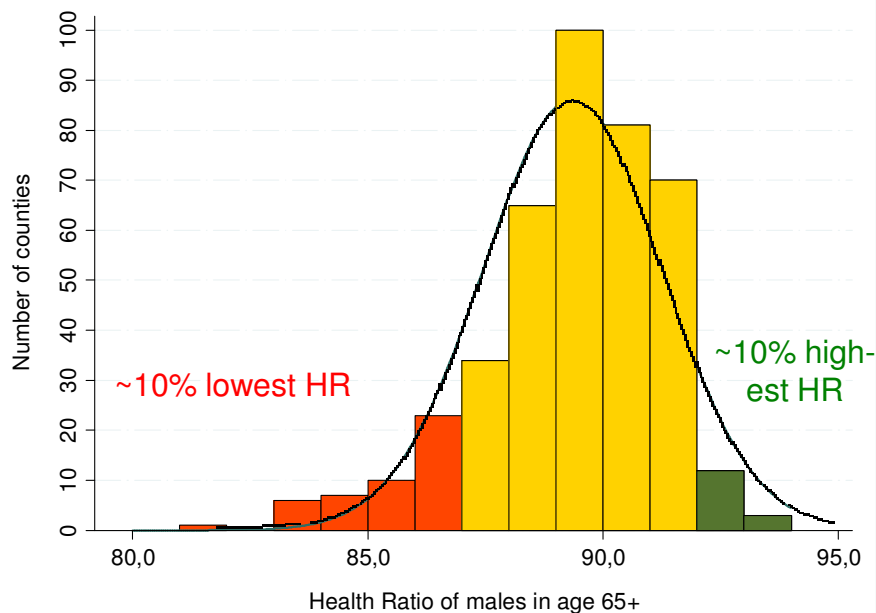
$d_i$  independent and  $d_i \sim N(0, \tau^2)$

$$w_i^* = 1/(\tau^2 + s_i^2)$$

Source: Stoto (2008)

## Regional variation in HR(65+) in 2009

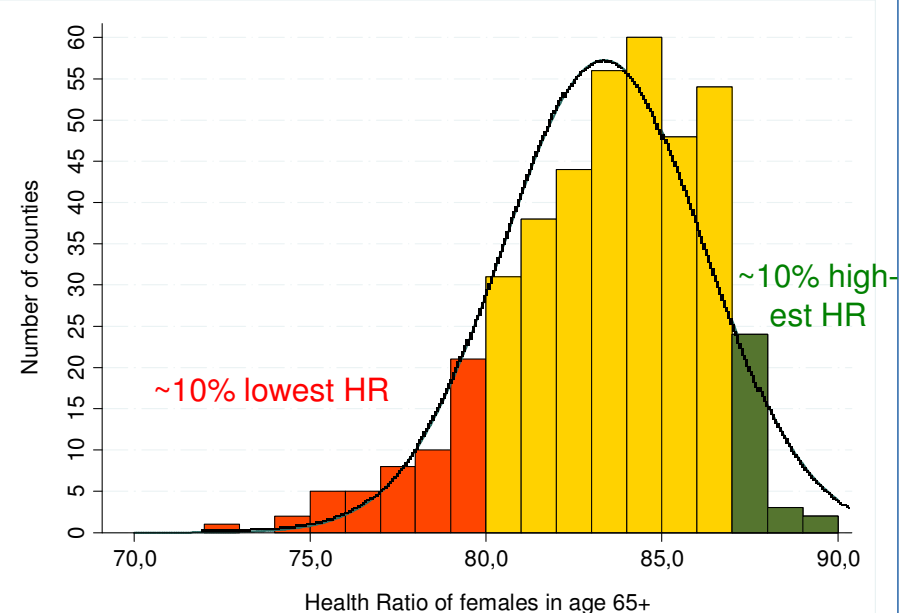
HR (65+) of males



Mean = 89.4  
Median = 89.6  
SD = 1.9

n = 412

HR (65+) of females



Mean = 83.4  
Median = 83.8  
SD = 2.9

n = 412

## Descriptives (2009)

Covariates	Mean (SD)	Median	Minimum	Maximum	N
<i>Disposable income of the private households per capita (in 1,000 Euro)</i>	18.59 (2.39)	18.44	13.90	31.02	412
<i>Long-term unemployment rate (in persons per 10.000)</i>	19.75 (16.71)	16.37	1.62	236.92	412
<i>Population density (in inhabitants per km<sup>2</sup>)</i>	519.55 (672.80)	198.64	37.59	4,282.21	412
<i>Level of premature mortality (in deaths in age 1 - &lt;45 per 100,000)</i>	1,445.99 (388.80)	1,412.43	168.92	2,741.47	412



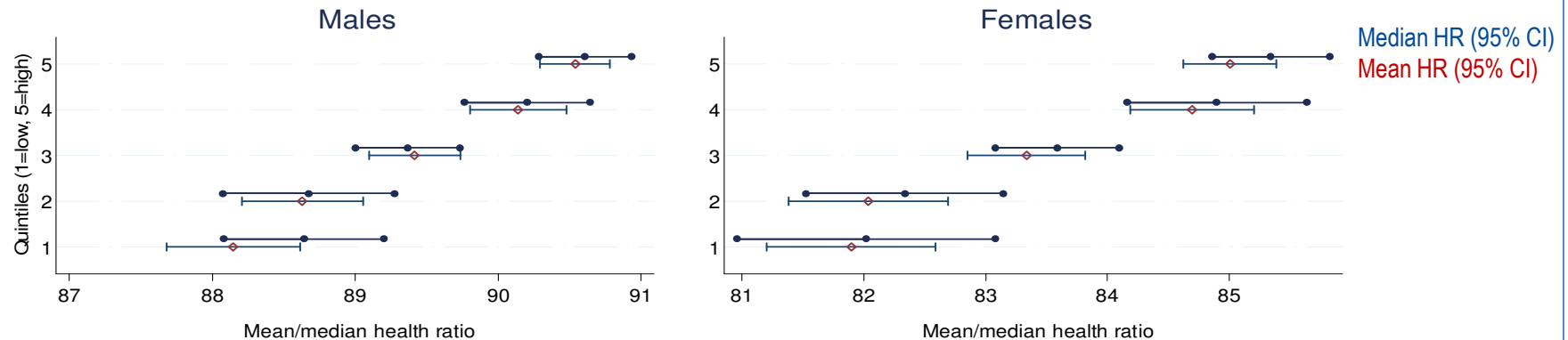
## Descriptives (2009)

Counties	Mean (SD)	Q25	Median	Q75	Minimum	Maximum	N
<b>Total population</b>	198043.2 (228418.5)	102671.0	140556.5	234271.0	34317.0 [Zweibrücken]	3437175.0 [Berlin]	412
<b>%Population 75+</b>	9.0 (1.09)	8.3	8.9	9.7	6.1 [Freising]	12.6 [Baden-Baden]	412
<b>Area (sqkm)</b>	866.8 (635.69)	263.5	798.5	1266.5	35.7 [Schweinfurt]	3058.3 [Uckermark]	412
<b>Sex Ratio (females / males)</b>	1.038 (0.03)	1.018	1.034	1.053	0.981 [Cloppenburg]	1.150 [Würzburg]	412

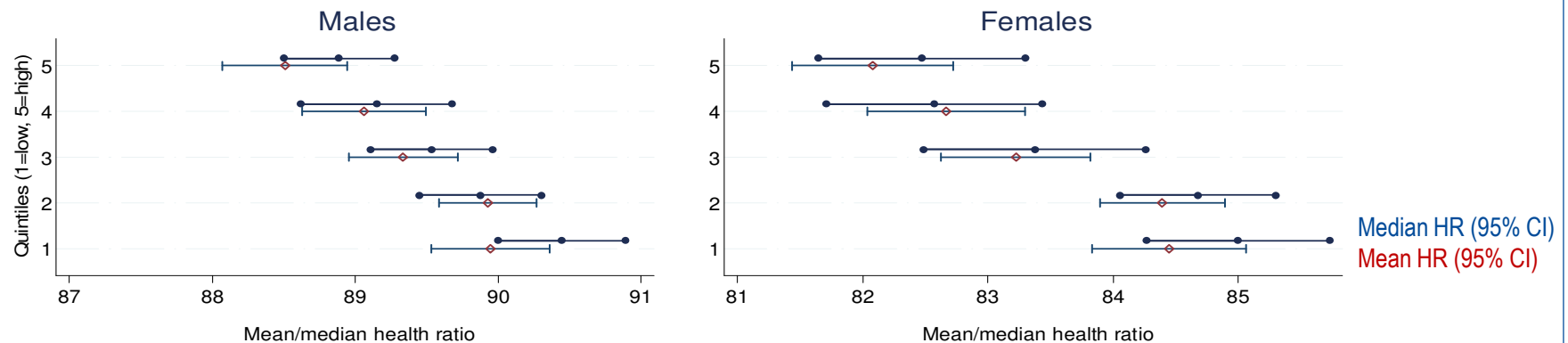
Pearson Correlation	1)	2)	3)	4)
1) <i>Disposable income of the private households per capita (in 1,000 Euro)</i>	1			
2) <i>Long-term unemployment rate (in persons per 10.000)</i>	-0.07 0.131	1		
3) <i>Population density (in inhabitants per km<sup>2</sup>)</i>	0.12 0.016	0.49 0.000	1	
4) <i>Level of premature mortality (in deaths in age 1 - &lt;45 per 100,000)</i>	-0.31 0.000	-0.05 0.306	-0.13 0.008	1

## Covariates of remaining HR (bivariate analyses)

Disposable income of the private households per capita



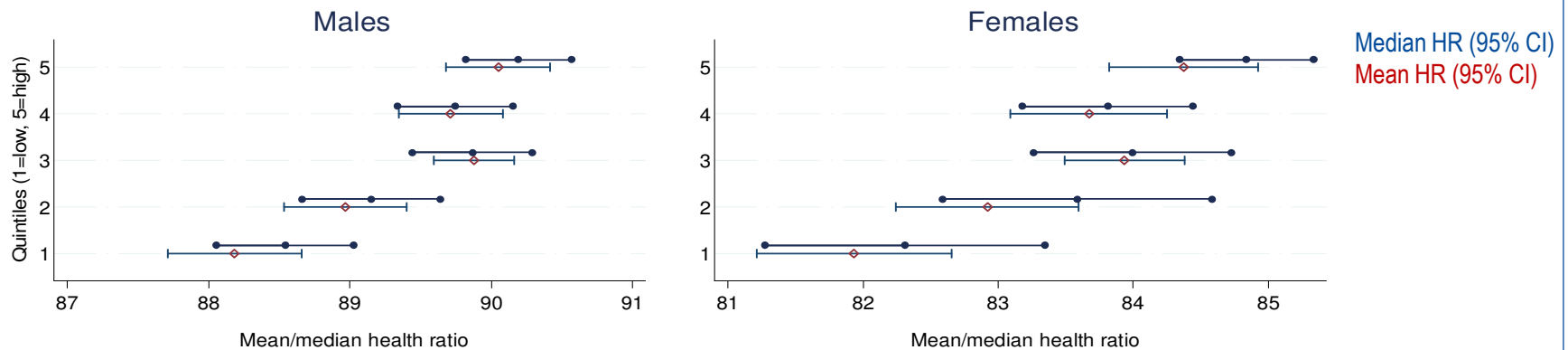
Long term unemployment rate



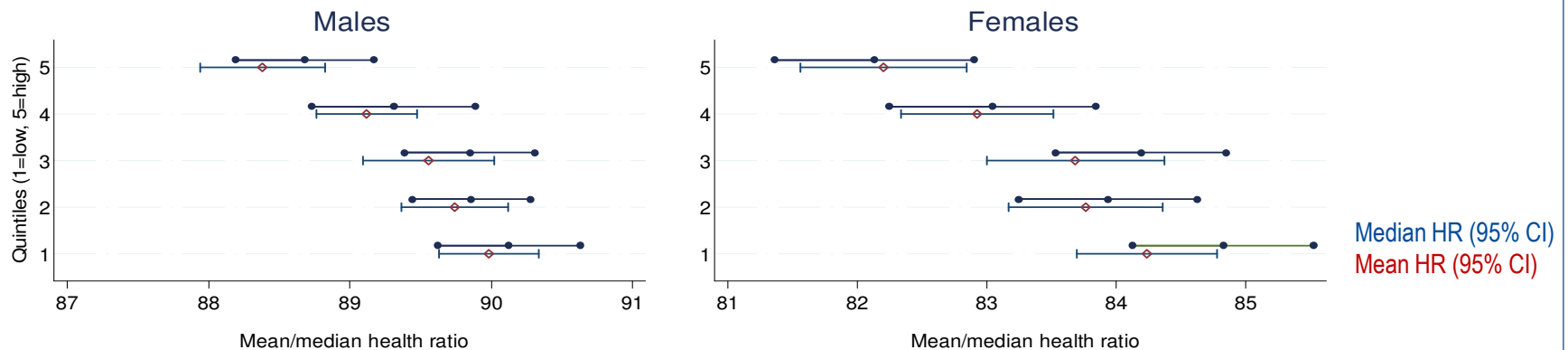
Source: Statistische Bundesämter des Bundes und der Länder; Pflegestatistik 2009;  
Regional database 2013; own calculation and plotting

## Covariates of remaining HR (bivariate analyses)

### Population density



### Level of premature mortality



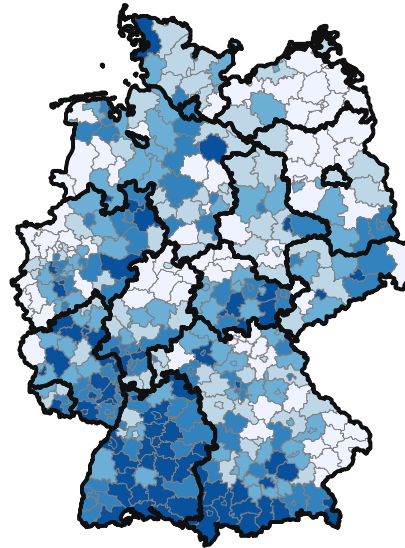
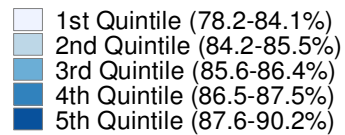
Source: Statistische Bundesämter des Bundes und der Länder; Pflegestatistik 2009;  
Regional database 2013; own calculation and plotting

<u>Outcome: Disabled life years</u>		<b>Males (65+)</b>		<b>Females (65+)</b>	
<i>Covariates</i>		<b>Coefficient</b>	<b><i>p-value</i></b>	<b>Coefficient</b>	<b><i>p-value</i></b>
Constant		1.95	<0.001	3.42	<0.001
Disposable income of private households per capita (quintiles)	<b>1<sup>st</sup> - lowest</b>	<b>Ref</b>		<b>Ref</b>	
	<b>2<sup>nd</sup></b>	0.01	0.780	0.10	0.139
	<b>3<sup>rd</sup></b>	-0.08	0.155	-0.03	0.488
	<b>4<sup>th</sup></b>	-0.12	0.030	-0.21	0.020
	<b>5<sup>th</sup> - highest</b>	-0.16	0.006	-0.22	0.013
Long-term unemployment rate (quintiles)	<b>1<sup>st</sup> - lowest</b>	<b>Ref</b>		<b>Ref</b>	
	<b>2<sup>nd</sup></b>	0.03	0.501	0.08	0.306
	<b>3<sup>rd</sup></b>	0.11	0.020	0.28	0.001
	<b>4<sup>th</sup></b>	0.07	0.140	0.27	0.002
	<b>5<sup>th</sup> - highest</b>	0.12	0.035	0.40	<0.001
Population density (quintiles)	<b>1<sup>st</sup> - lowest</b>	<b>Ref</b>		<b>Ref</b>	
	<b>2<sup>nd</sup></b>	-0.04	0.420	-0.07	0.396
	<b>3<sup>rd</sup></b>	-0.09	0.076	-0.10	0.279
	<b>4<sup>th</sup></b>	-0.12	0.016	-0.17	0.049
	<b>5<sup>th</sup> - highest</b>	-0.20	<0.001	-0.39	<0.001
Level of premature mortality (quintiles)	<b>1<sup>st</sup> - lowest</b>	<b>Ref</b>		<b>Ref</b>	
	<b>2<sup>nd</sup></b>	-0.04	0.406	-0.03	0.692
	<b>3<sup>rd</sup></b>	-0.03	0.510	-0.02	0.845
	<b>4<sup>th</sup></b>	0.02	0.599	0.09	0.299
	<b>5<sup>th</sup> - highest</b>	0.06	0.189	0.11	0.197

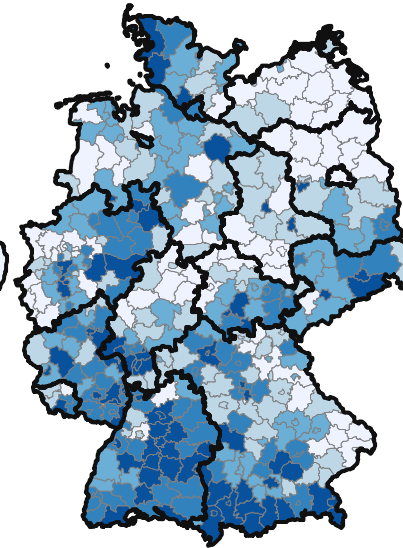
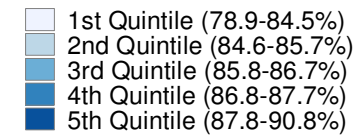
Source: Statistische Bundesämter des Bundes und der Länder; Pflegestatistik 2009;  
Regional database 2013; own calculation

## Results

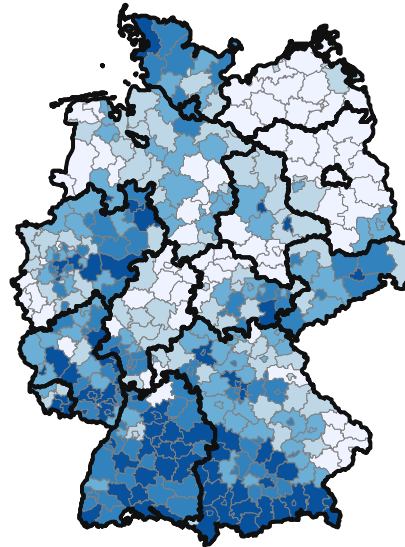
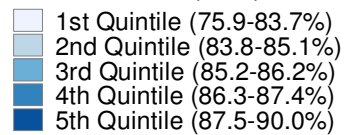
Health ratio (65+) 2001



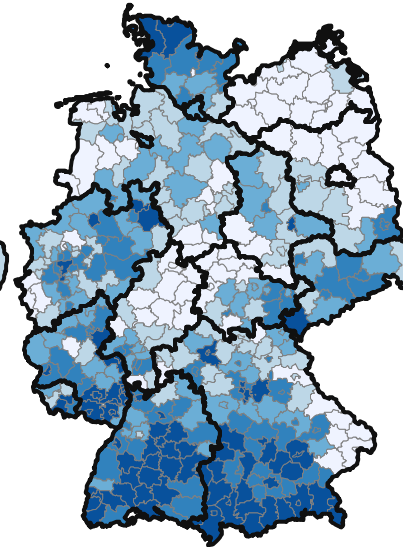
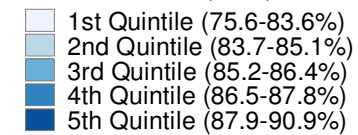
Health ratio (65+) 2003



Health ratio (65+) 2007

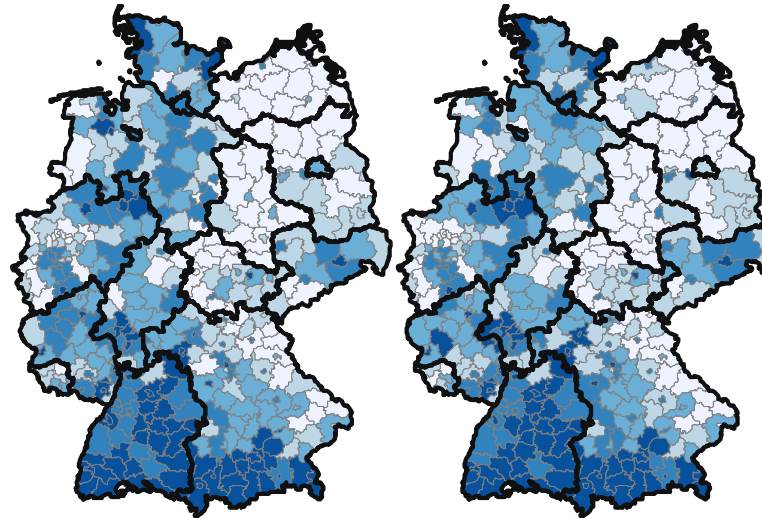
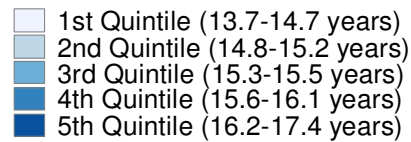


Health ratio (65+) 2009

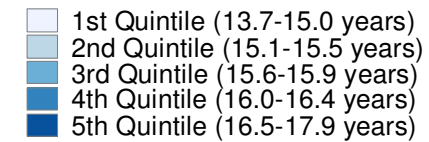


## Results

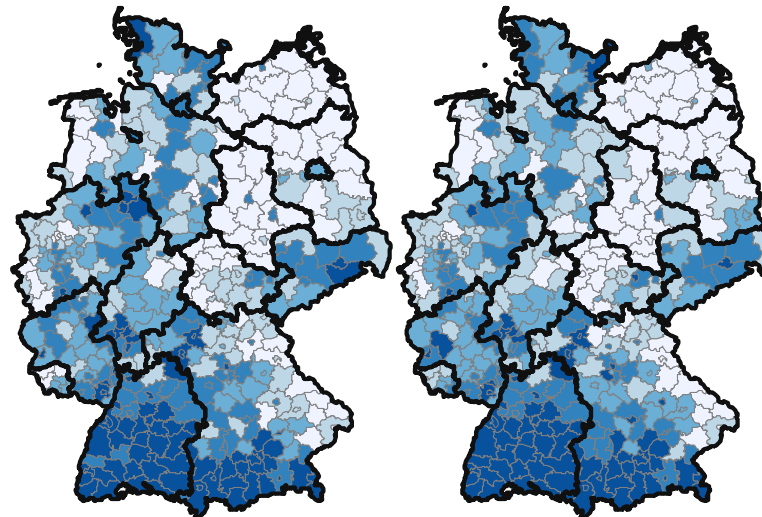
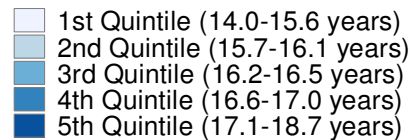
Disability-free  
life years (65+) 2001



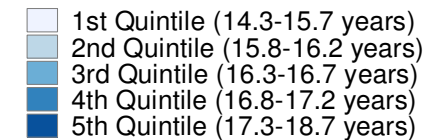
Disability-free  
life years (65+) 2003



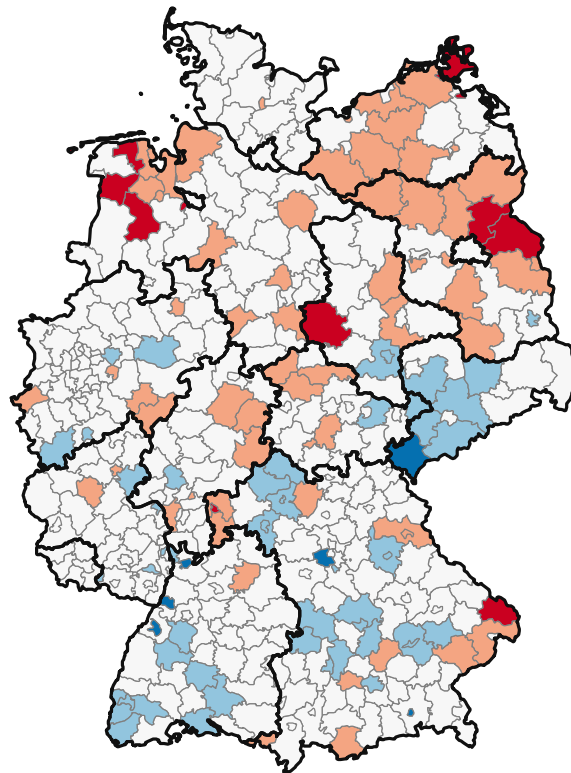
Disability-free  
life years (65+) 2007



Disability-free  
life years (65+) 2009



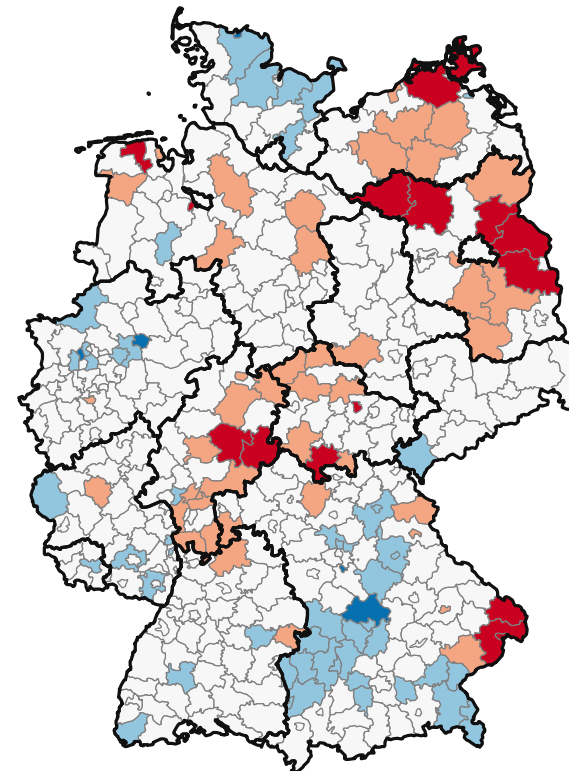
## Results



Trend (2001/03 - 2007/09) in HLE(65+)

- Very low (>2 SD below change on country-level)
- Low (>1 SD below change on country-level)
- Average
- High (>1 SD above change on country-level)
- Very high (>2 SD above change on country-level)

Change on country-level=0.81 life years  
Region-level SD=0.31 life years



Trend (2001/03 - 2007/09) in DLY(65+)

- Very low (>2 SD below change on country-level)
- Low (>1 SD below change on country-level)
- Average
- High (>1 SD above change on country-level)
- Very high (>2 SD above change on country-level)

Change on country-level=0.25 life years  
Region-level SD=0.25 life years