Electricity consumption and weather variables: a case of Perm territory

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Motivation

1. In a short period prediction for every day is a necessary part of market operation

2. In a long period prediction is important, especially in case of global weather changes

Literature

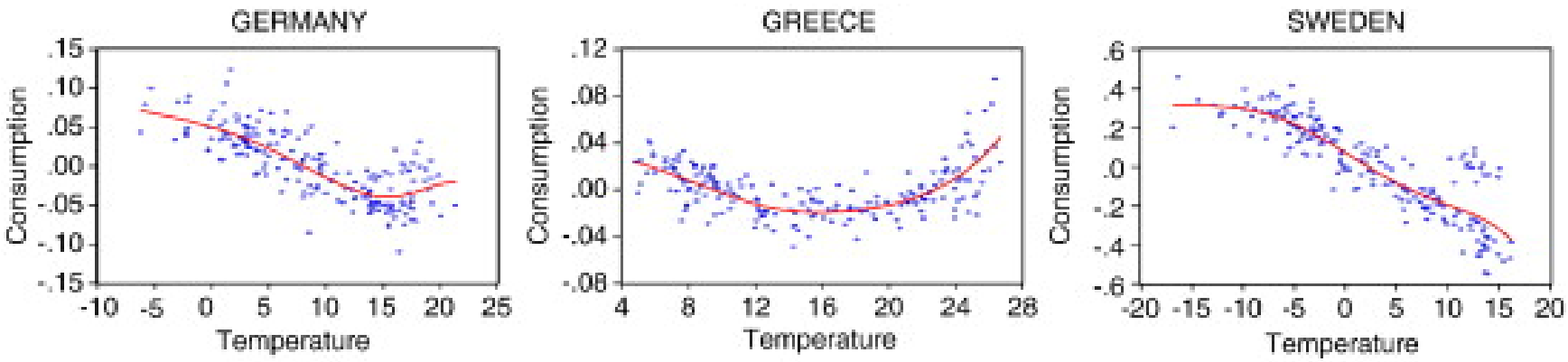
- a non-linear relationship between temperature and electricity:

V-shape form	Valor et al. (2001), Pardo et al. (2002). and Al-Iriani (2005)	Heating degree-days (HDD) and cooling degree-days (CDD)
U-shape form	Moral-Carcedo and Vicéns-Otero (2005)	Logistic transition function
	Engle (1986), Henley (1997)	Semiparametric compare with spline approximation

- Major research analyze only temperature, however Robinson (1997), Valo et al. (2001); Mirasgedis et al. (2006); Apadula et al. (2012) provide evidence that wind speed, relative humidity are significant.

Hypothesis

1. Consumption-temperature relation for Perm territory is the same as in "cold" European countries* with threshold level at 14 °C



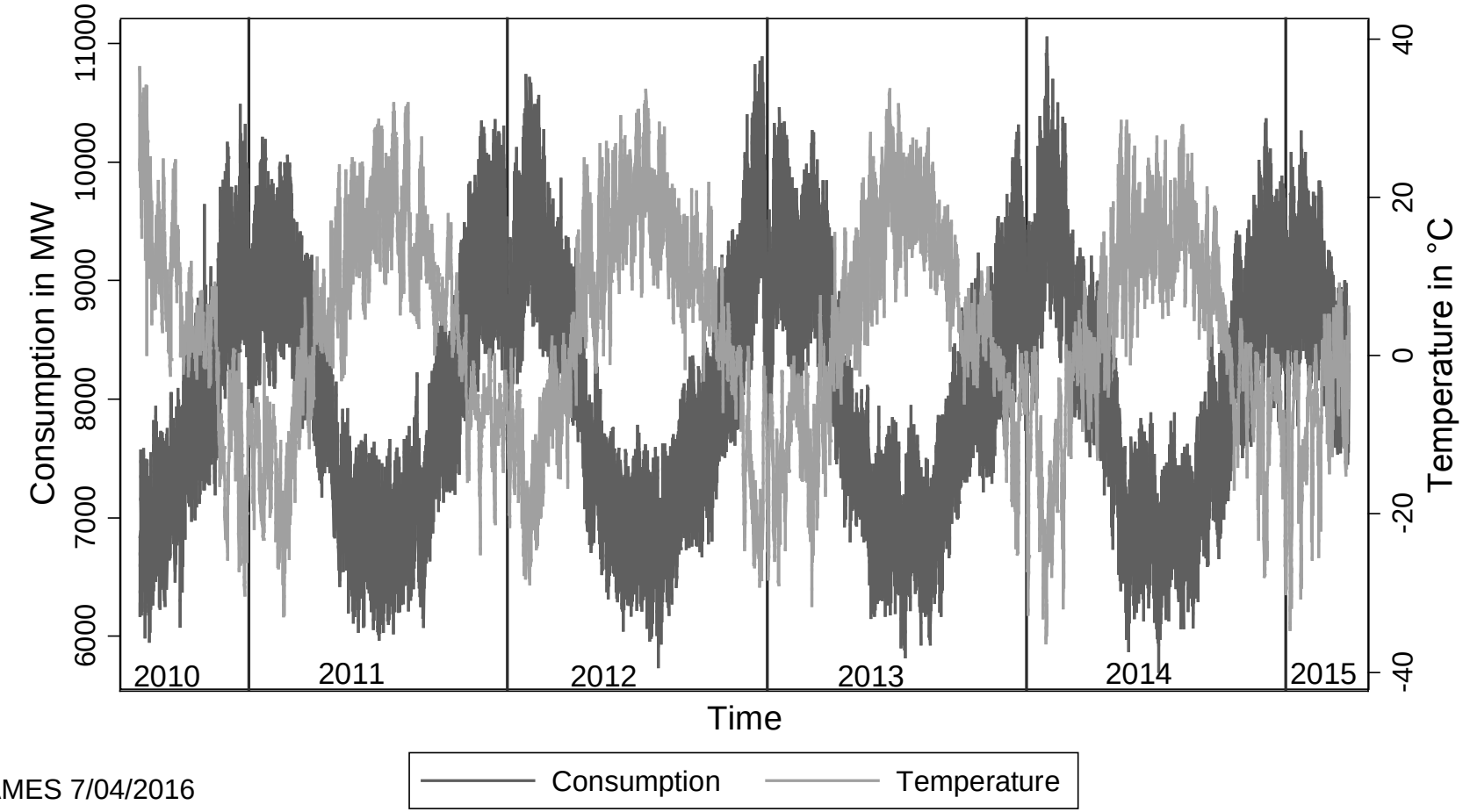
2. Other weather variables (wind speed and relative humidity) are important

* Bessec, M., & Fouquau, J. (2008). The non-linear link between electricity consumption and temperature in Europe: a threshold panel approach. Energy Economics, 30(5), 2705-2721

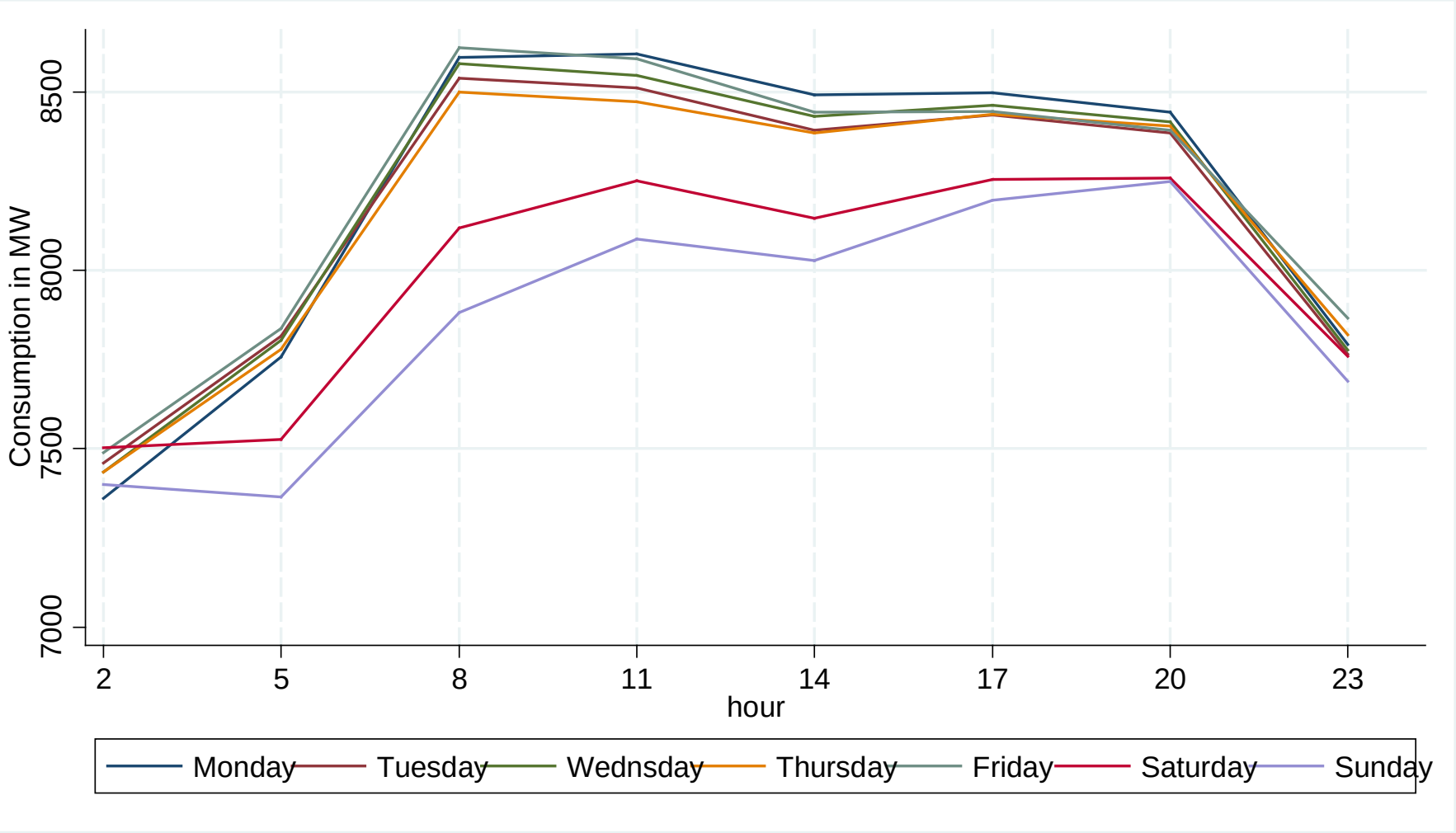
Data

August 2010 till March 2015 for every 3 hours (13631 observation)

- Total region consumption (MW)
- Temperature (in ºC)
- Relative humidity (%) and wind speed (m/s)



Consumption intro-day dynamics



Methodology

$$Load_t = \beta_0 + \theta(Temp_t) + \beta_1 Wind_t + \beta_2 Humidity_t + \beta_3 Holiday_t + \beta_4 trend +$$
$$+ \sum_{t=1}^{6} \gamma_i Day_{i,t} + \sum_{t=1}^{7} \eta_i Hour_{i,t} + \varepsilon_t$$

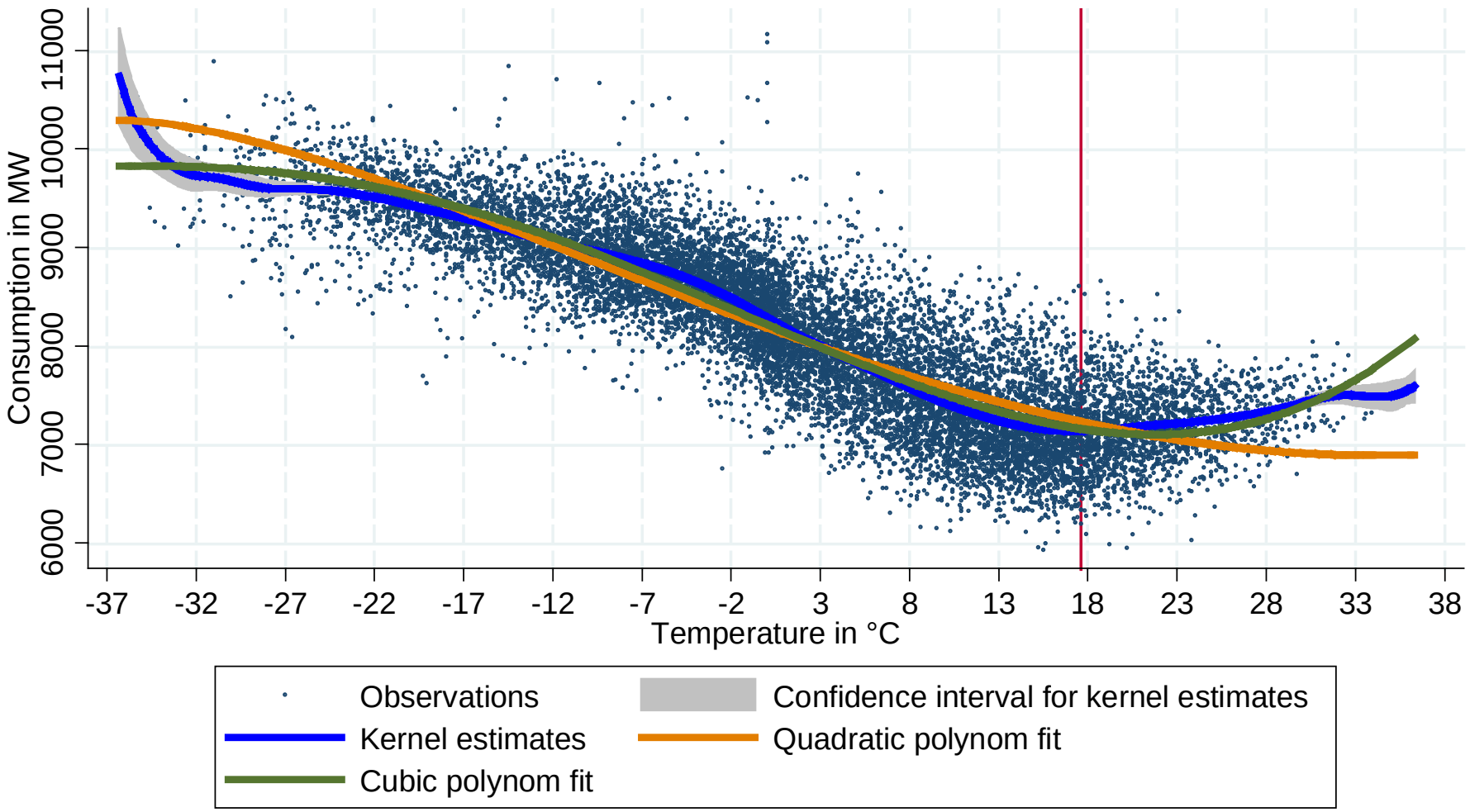
- OLS regression with $\theta(Temp_t)$ as lineal form, quadratic and cubic polynomial

- Following semiparametric approach by Robinson (1988): $\theta(Temp_t)$ is identified by kernel regression $E[Load_t | W_t, H_t, Hol_t, trend, Day_t, Hour_t]$ on $Temp_t$.

Empirical results

	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) Kernel
Wind speed	73.65***	78.08***	73.33***	62.34***	
	(-5.520)	(-2.208)	(-2.299)	(-2.125)	
Humidity	17.86***	1.811***	1.337***	1.886***	
	(-0.469)	(-0.197)	(-0.207)	(-0.191)	
Temperature		-67.56***	-67.45***	-84.84***	-40.86
		(-0.253)	(-0.253)	(-0.419)	
(Temperature)^2			-0.123***	-0.179***	
			(-0.017)	(-0.016)	
(Temperature)^3				0.044***	
				(-0.001)	
Control variables	Day hour, day type, holidays, Trend	Day hour, day type, holidays, trend	Day hour, day type, holidays, trend	Day hour, day type, holidays, trend	Day hour, day type, holidays, trend
R^2	0.233	0.878	0.878	0.897	0.910
Observation	13588	13588	13588	13588	13588

Semiparametric approach



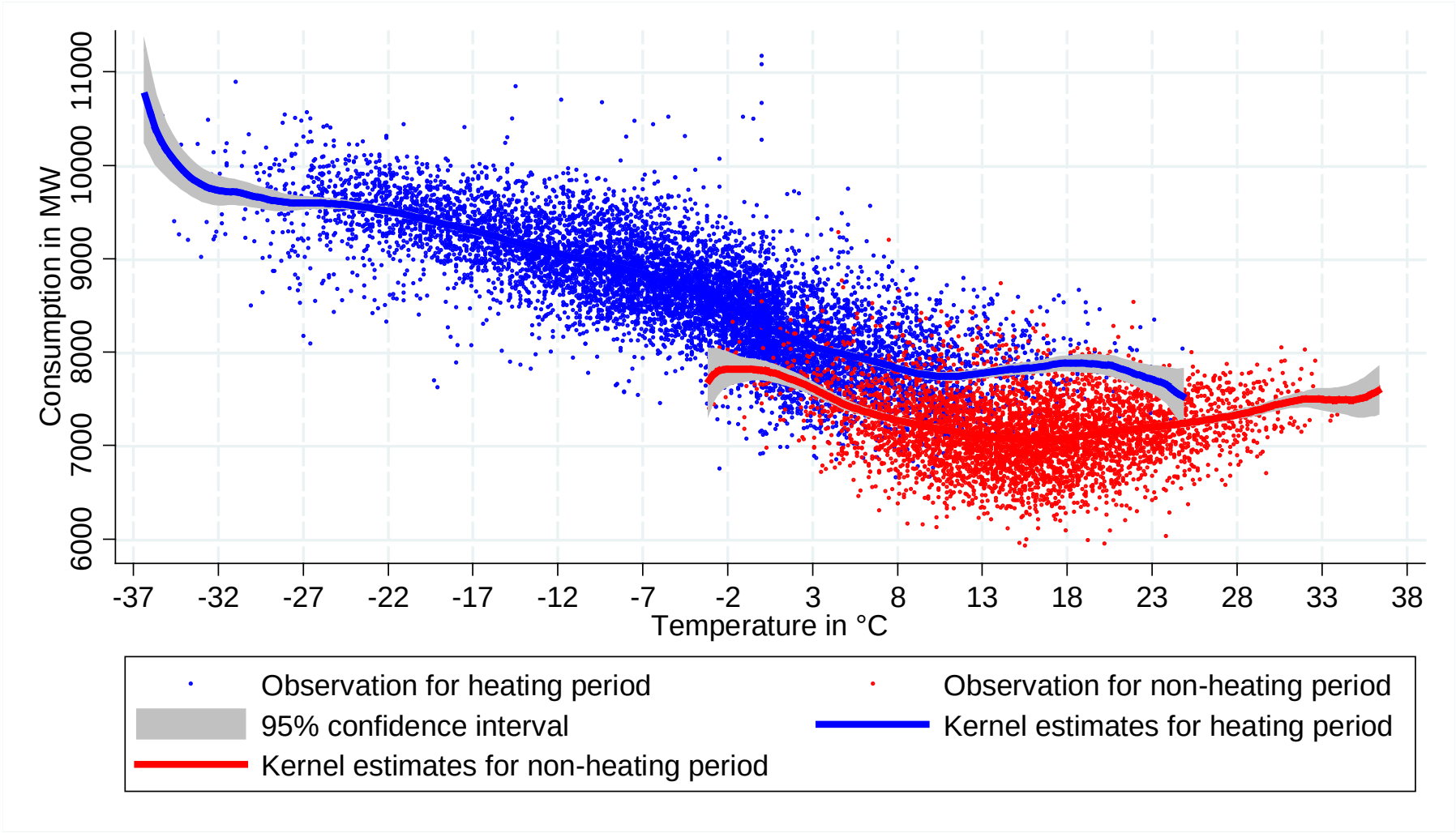
Central heating

In 2008 central heating covers roughly 77% of the region.

Central heating is on:

- September 13, 2010 till May, 9 2011
- September 15, 2011 till April, 22 2012
- September 15, 2012 till May, 7 2013
- September 16, 2013 till April, 27 2014
- September 15, 2014 till May, 5 2011

Semiparametric approach with heating



Results

- Temperature is the most significant weather variable, while humidity and wind speed significant but have less explanatory power.

- Threshold value for Perm territory is 17.6 °C.

- Central heating matters:
  - For heating period there is only “heating effect”
  - For non-heating period both “heating” and “cooling” effects appear

Thank you for your attention!

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