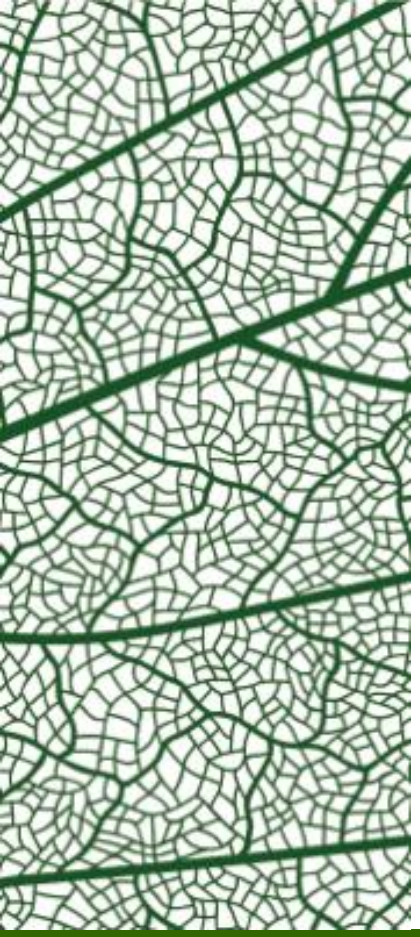

IRPET Istituto Regionale Programmazione Economica della Toscana

AISRe Associazione Italiana di Scienze Regionali

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When the Office Moves Home: Energy Demand Responses to the COVID-19 Lockdown in Italy

Edoardo Alberti[a] and Angela Parenti[b]

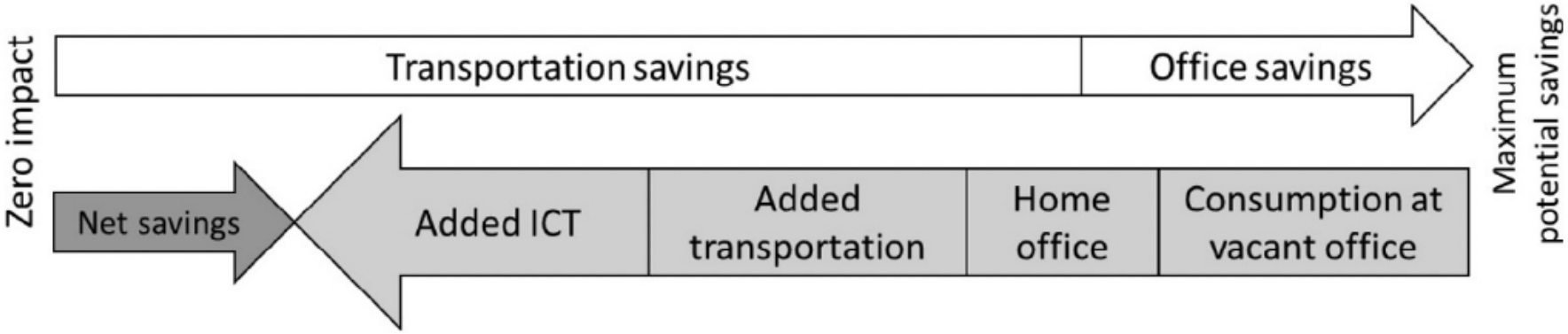
[a]*Researcher at Irpet (Istituto Regionale per la Programmazione Economica della Toscana)*

edoardo.alberti@irpet.it

[b]Associate Professor of Economics at University of Pisa

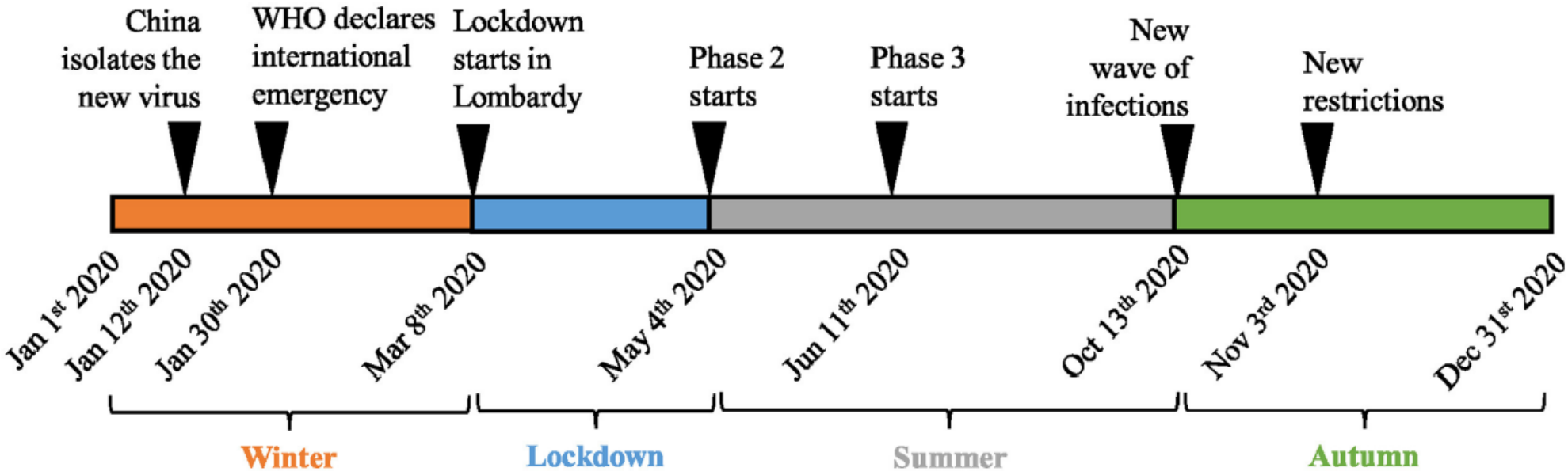
angela.parenti@unipi.it

Motivation: why remote work is an energy question



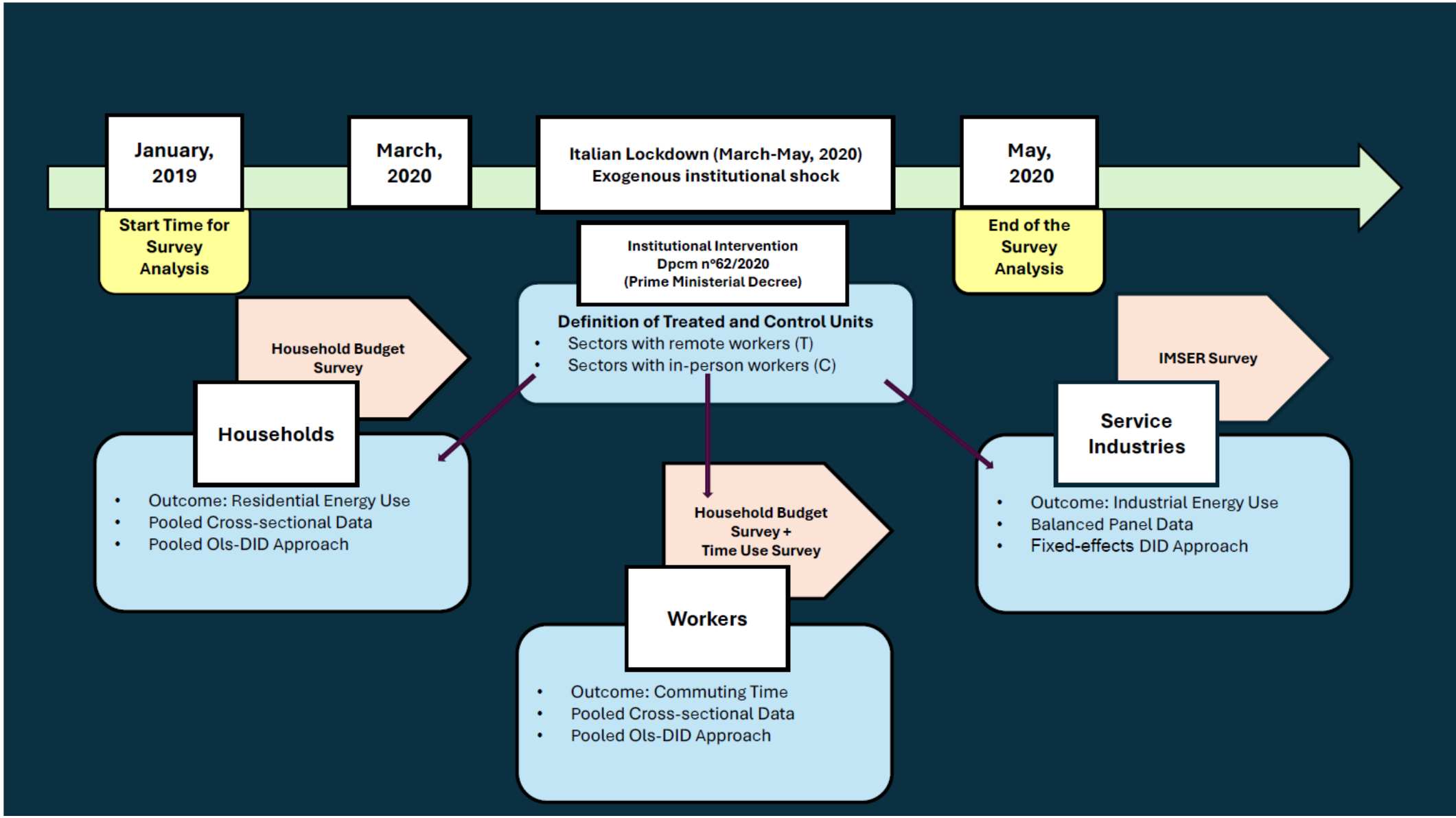
Conceptualization of the balance between the lack of impact from telework, indicating the absence of net energy benefits – and the maximum theoretical potential.

Institutional shock: Italy's first lockdown



Timeline of the COVID-19 development and interventions during the year 2020.

Research design



Research design

Covariate group	Description
Housing characteristics	Housing type; number of rooms; dwelling size in square meters; ownership status; construction period; internet availability
Socio-demographic and economic characteristics	Source of income; income decile; age of household head; gender of household head; education level
Labour-market characteristics	Occupation; job position
Energy market	Electricity price
Geographical controls	Type of municipality; region
Weather controls	Average maximum temperature; average minimum temperature; wind speed; rainfall; solar radiation; cooling degree days; heating degree days

Model variables description. This Table presents the variables included in Models 1 and 2.

Research design

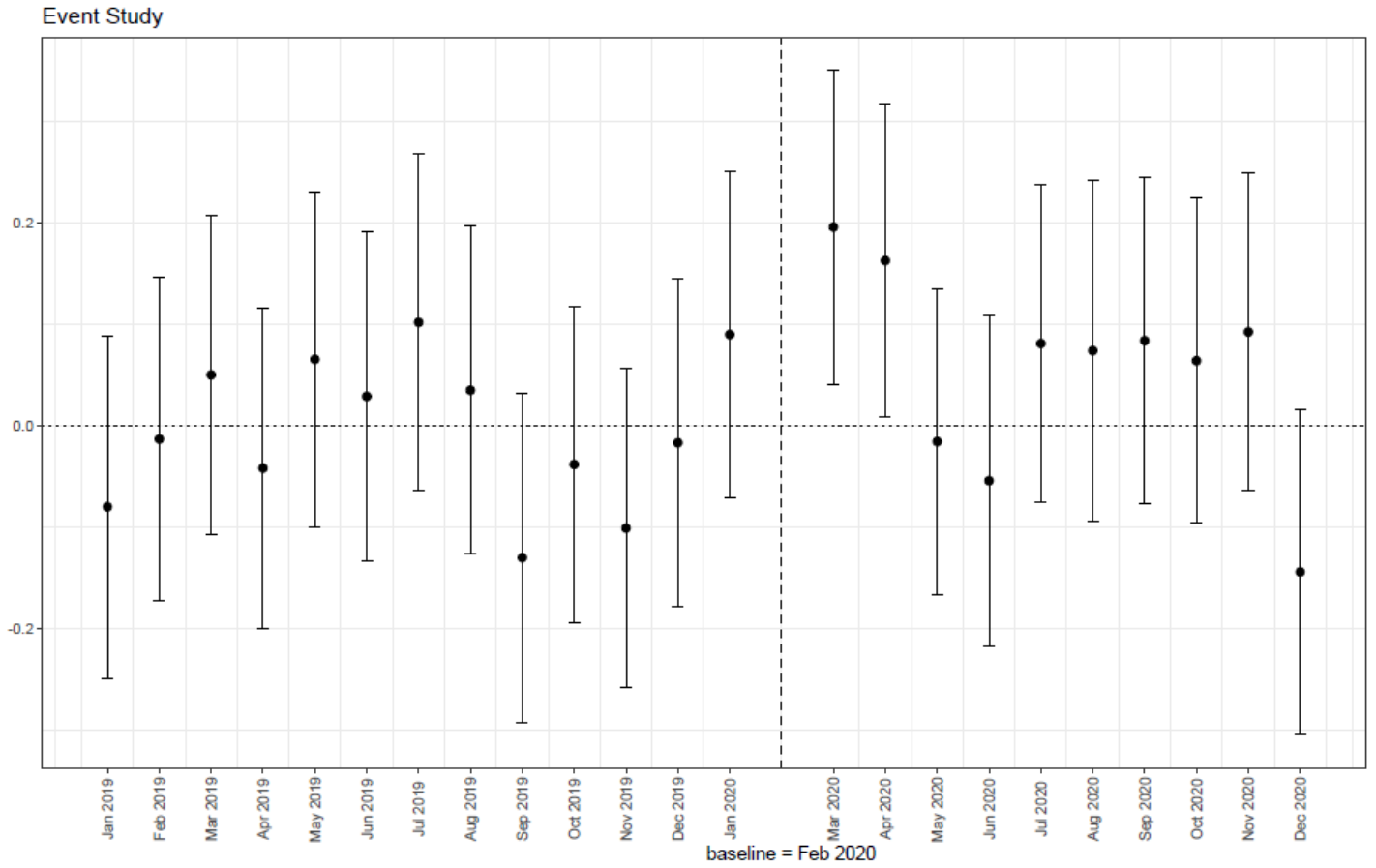
ATECO Codes (1-digit)	IMSER Survey	Description	Treatment Indicator
8 Trasporto e magazzinaggio	Trasporto e magazzinaggio	Transportation and storage	Controlled
10 Servizi di informazione e comunicazione	Informazione e comunicazione	Information and communication services	Controlled
11 Attività finanziarie e assicurative	Finanza e assicurazione	Financial and insurance activities	Controlled
12 Attività immobiliari	Immobiliare	Real estate activities	Treated
13 Attività professionali, scientifiche e tecniche	Attività professionali, scientifiche e tecniche	Professional, scientific and technical activities	Treated
15 Amministrazione pubblica e difesa	Amministrazione pubblica e difesa	Public administration and defense; compulsory social security	Controlled
16 Istruzione	Istruzione	Education	Treated
17 Sanità e assistenza sociale	Sanità e assistenza sociale	Human health and social work activities	Controlled

Composition of treatment and control group across service sectors.

Covariate group	**Variables included in the industry model**
Meteorological controls	Temperature, wind speed, rainfall, solar radiation, heating degree days, cooling degree days
Energy price control	National wholesale electricity price, PUN
Pandemic intensity controls	Confirmed new COVID-19 cases: Monthly regional cases per 100,000 inhabitants, lagged by one month
Pandemic pressure controls 1	Patients in intensive care: Monthly regional ICU patients per 100,000 inhabitants, lagged by one month
Pandemic pressure controls 2	Hospitalized patients with symptoms: Monthly regional hospitalized patients per 100,000 inhabitants, lagged by one month

Regressors included in the model on energy consumption in commercial buildings in the services sub-sectors.

Result 1: households consume more electricity



Event-study estimates of treatment effects on log monthly energy consumption.

Result 1: households consume more electricity

	Regression Table
Intercept	2.94 (0.51)***
Treated	-0.06 (0.02)***
Post	-0.03 (0.05)
Treated * Post	0.11 (0.06)*

$(e^{\beta} - 1) * 100\% = 0{,}11 = +12\%$

Pooled-DiD regression results.

Term	Estimate	Std.error	P-value
β_{-14}	-0.08	0.102542	0.435326
β_{-13}	-0.01319	0.096895	0.891752
β_{-12}	0.050102	0.095722	0.600719
β_{-11}	-0.0419	0.096071	0.662759
β_{-10}	0.065403	0.100546	0.515426
β_{-9}	0.028908	0.098451	0.76906
β_{-8}	0.101891	0.101108	0.313647
β_{-7}	0.034957	0.098384	0.722373
β_{-6}	-0.13015	0.0988	0.18782
β_{-5}	-0.03822	0.094828	0.686922
β_{-4}	-0.10108	0.095408	0.289454
β_{-3}	-0.0169	0.098311	0.863506
β_{-2}	0.08987	0.098175	0.360044
β_0	0.195793	0.094003	0.037337
β_1	0.162752	0.094075	0.083715
β_2	-0.01574	0.091702	0.863758
β_3	-0.05425	0.099094	0.584066
β_4	0.081029	0.094904	0.393273
β_5	0.073954	0.101874	0.467924
β_6	0.083881	0.097839	0.391315
β_7	0.063988	0.097376	0.511144
β_8	0.092419	0.095425	0.332859
β_9	-0.14421	0.097501	0.139219

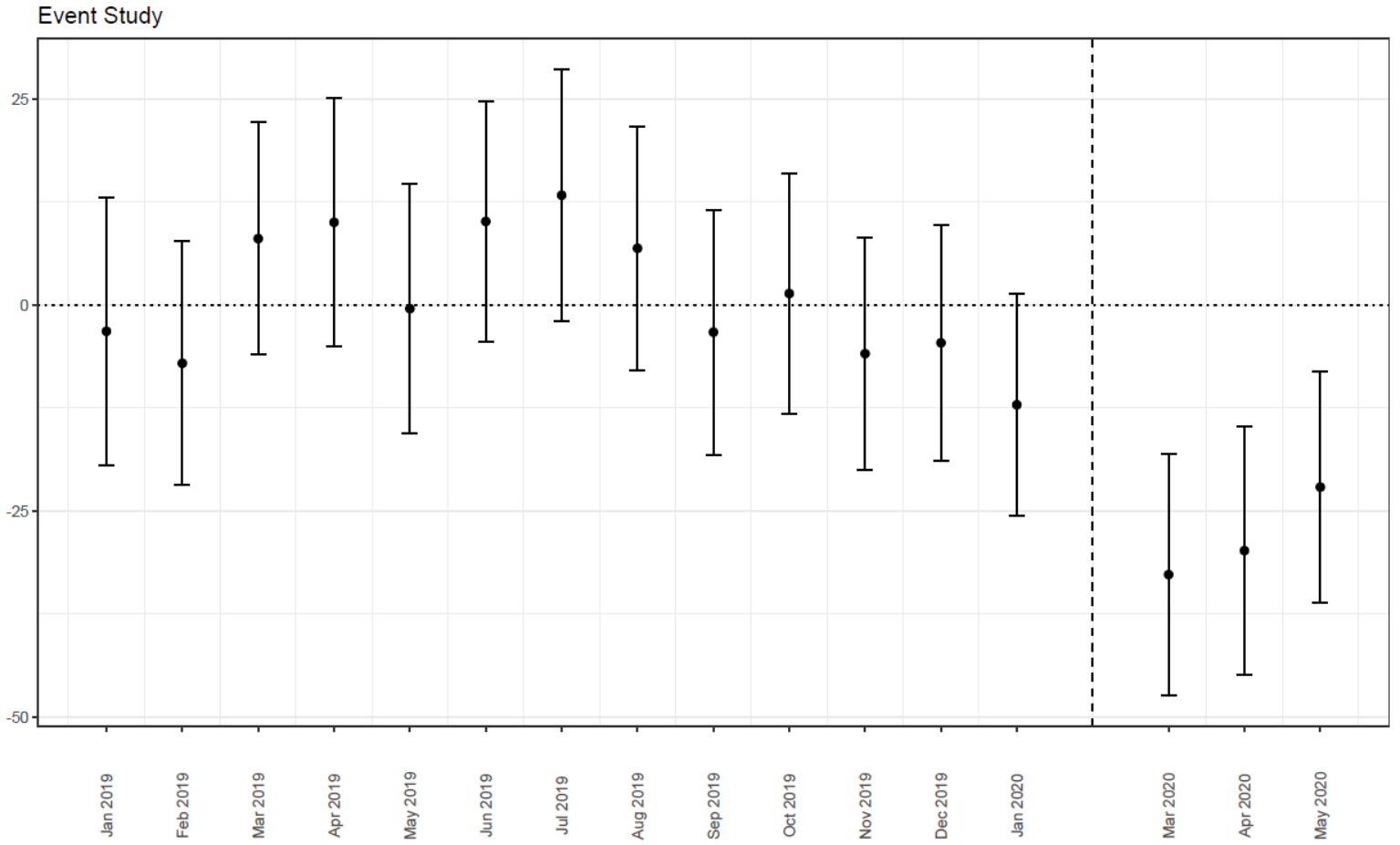
Event-study dynamics of treatment effects on log monthly energy consumption.

- **Heterogeneous effects** are detected:

The residential effect is not uniform. It varies by:

- ✓ occupation;
- ✓ dwelling type;
- ✓ income group;

Result 2: commuting time collapses



Event-study estimates of treatment effects on daily commuting time (in minutes).

Result 2: commuting time collapses

Variable	Estimates (SE)
Intercept	24.15 (35.75)
Treated	-2.42 (1.98)
Post	4.94 (3.36)
Treated * Post	-28.13 (4.3)***

Pooled-DiD regression results for commuting time (in minutes).

❖ Steps to turn time savings into energy savings:

✓ Allocate time saved by transport mode
✓ Convert minutes into kilometres using average speed
✓ Convert kilometres into kWh using mode-specific energy intensity
✓ Weight by transport-mode incidence
✓ Scale to Italian workers and 24 working days/month

❖ **Result**

- Commuting-related energy use: **–48%**
- Monthly energy saving: **about –1.24 billion kWh**

Result 3: service-sector workplaces consume less

Variable	Estimate (SE)
Intercept	1.53 (3.41)
treated	-3.59 (0.21)***
Post	-0.21 (0.24)
Treated * Post	-0.60 (0.22)***

$(e^{\beta} - 1) * 100\%$
$= -0{,}45$
$= -45\%$

DiD regression results for sectoral energy consumption. The dependent variable is the log of monthly regional sectoral energy consumption.

- **Caveat**
  This also may capture changes in business intensity and operating conditions.

Net effect: the three channels together

$$\Delta Net = \Delta R + \Delta P + \Delta S.$$

$$\%\Delta Net = \frac{\Delta R + \Delta P + \Delta S}{\bar{Y}_{R0} + \bar{Y}_{P0} + \bar{Y}_{S0}} \times 100.$$

ΔR: residential change
ΔP: commuting-energy change
ΔS: service-sector change

$\bar{Y}_{R0}$: *pre-treatment residential electricity baseline*
$\bar{Y}_{P0}$: pre-treatment commuting-energy baseline
$\bar{Y}_{S0}$: pre-treatment service-sector electricity baseline

$$\Delta R = \left(e^{\hat{\beta}_1} - 1\right) \bar{Y}_{R0}.$$

$$\Delta S = \left(e^{\hat{\beta}_3} - 1\right) \bar{Y}_{S0}.$$

$$\Delta P = \Phi(\hat{\beta}_2).$$

ΔR: residential change
ΔP: commuting-energy change
ΔS: service-sector change
$\Delta P = \Phi(\widehat{\beta_2})$: conversion from commuting minutes to kWh

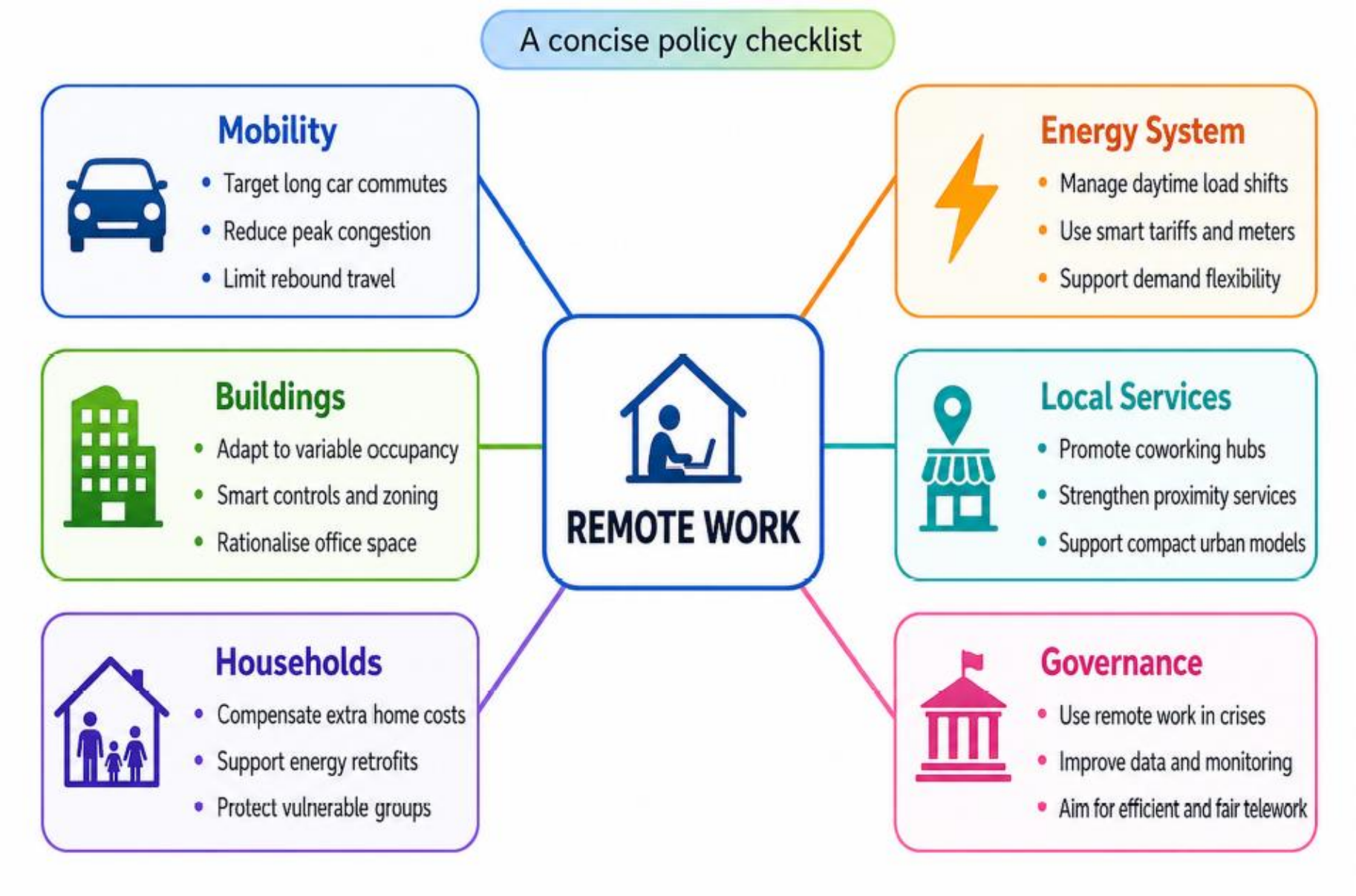
$\widehat{\beta_1}$: household DiD estimate
$\widehat{\beta_2}$: commuting-time DiD estimate
$\widehat{\beta_3}$: service-sector DiD estimate

Net effect: the three channels together

Impact of the Lockdown on Energy Dimensions		
Residential (A)	**Services (B)**	**Commuting (C)**
Total average monthly residential electricity consumption before treatment	Total average monthly pre-treatment consumption in the services sector	Total average monthly commuting fuel consumption before treatment
62,919,817 kWh	150,633,333 kWh	2,579,095,573 kWh
ATET on residential consumption	ATET on sectoral consumption	ATET on commuting fuel consumption
+0.12	-0.45	-0.48
Impact on residential consumption	Impact on sectoral consumption	Impact on commuting fuel consumption
7,021,851.58 kWh	-67,965,759.85 kWh	-1,242,399,679.45 kWh

Net Effect of the Lockdown (a proxy for remote work)
Consumption Change
-1,303,343,587.72 kWh
Baseline Consumption (A+B+C)
2,792,648,723 kWh
Net effect (as a share)
-0.47

Conclusion and policy message



Thank You for Your Attention!

For further details:
edoardo.alberti@irpet.it

Any questions or concerns?