Kerb-side enthusiasm

The determinants of voluntary waste separation effort in Malta

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INTRODUCTION

Imagine:

daily kerb-side collection of mixed municipal solid waste is free.

Introduce:

weekly voluntary kerb-side collection of separated waste at a fee

Requiring more space, more time, more money

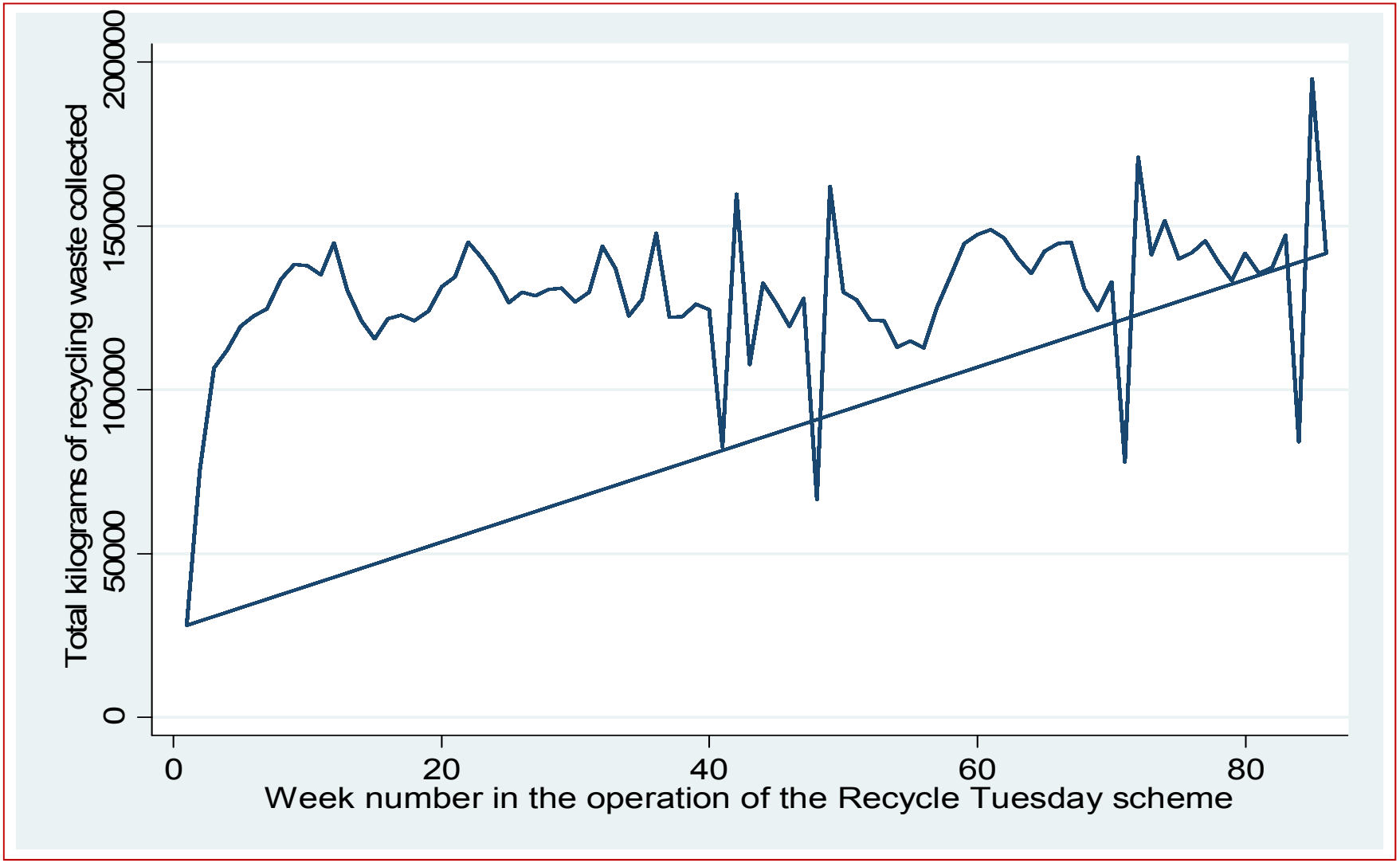
Outcome:

National kerb-side recycling scheme takes off…

….at different rates in different localities.

INTRODUCTION

Total Collected over 86 weeks



INTRODUCTION – motivation

- a case study in behavioural-environmental-economics
- co-operation in a social dilemma situation – in the field
- empirical analysis of effectiveness of intervention elements

…contribution to the Literature

- high-stakes issue (externalities, resources, EU obligations)
- potential for voluntary approach if enforcement too expensive.
- potential to examine if policy for rational egoists misdirected.

…contribution to Policy

LITERATURE – Overview

Behavioural Environmental Economics

e.g. Gsottberg e. 2011 (Behavioural environmental policy)

Shogren Taylor 2008 (Behavioural Environmental Economics)

Theoretical models for household recycling behaviour

e.g. Halvorsen 2008 (Moral motives)

Nyborg Rege 2003 (Crowding out/in)

Empirical studies on recycling

e.g. Sidique et al 2010 (Minnesota)

Hage and Söderholm 2008 (Sweden)

+ OECD 2008 (review) + 30 field studies

LITERATURE - Summary

Motives

Narrow self interest, Moral, Social

+ Non cognitive

Interventions

Pecuniary, Convenience, Communication

Socio Economics

Education, Gender, Income, Age, Political,

+ Dwelling/Community

MODEL

Household derives utility from consumption, leisure, environment, household space, moral well-being and perceived social respect. Conditional upon household characteristics.

$$U_i = U_i(x_i, l^c_i, e_i, a_i, s_i, v^c_i; d_i)$$

Recycling increases household's moral well-being. Positive in government communication.

$$a_i = a_i(w^r_i; GC^r). \text{ where } \delta a_i/\delta w^r_i > 0 \text{ and } (\delta a_i/\delta w^r_i)/\delta GC^r > 0$$

Perceived social-respect decreases in distance of the household's recycling from the norm. Positive in government communication and frequency of kerbside collection

$$s_i = s_i(|w^r_i - w^{rn}|\ (GC^r, GF^r)). \text{ where } \delta s_i/\delta w^r_i > 0,\ \delta w^{rn}/\delta GC^r > 0 \text{ and } \delta w^{rn}/\delta GF^r > 0$$

MODEL

Perceived environmental quality increases with recycling, decreases with waste. Positive in government communication and frequency (and hence visibility) of kerbside collection.

$$e_i = e_i\,[w^r_i,\ w^u_i,\ w^{rn}(GC^r, GF^r),\ w^{un}(GF^u)]$$

where $\delta e_i/\delta w^r_i > 0$, $\delta w^{rn}/\delta GC^r > 0$, $\delta w^{rn}/\delta GF^r > 0$, $\delta w^{un}/\delta GF^u > 0$

Waste collection comes at a price (as do all other goods and services)

$$m_i = GP^r.w^r_i + GP^u.w^u_i + x_i$$

Recycling diverts time from leisure. Government communication helps.

$$l^c_i = l^t_i - l^r_i(w^r_i; GC^r) \text{ where } \delta l^r_i/\delta w^r_i > 0 \text{ and } (\delta l^r_i/\delta w^r_i)/\delta GC^r < 0$$

Recycling consumes space. Frequency of waste collection helps

$$v^c_i = v^t_i - v^r_i(w^r_i; GF^r) - v^u_i(w^u_i; GF^u) \text{ where } \delta v^r_i/\delta w^r_i > 0,\ (\delta v^r_i/\delta w^r_i)/\delta GF^r < 0$$

Recycling is drawn from waste, a function of consumption $w^t_i(x_i) = w^u_i + w^r_i$

MODEL - Formal

1. $U_i = U_i(x_i, l^c_i, e_i, a_i, s_{i,} v^c_{i,}; d_i)$

2. $a_i = a_i\ (w^r_i; GC^r)$. where $\delta a_i/\delta w^r_i > 0$ and $(\delta a_i/\delta w^r_i)/\delta GC^r > 0$

3. $s_i = s_i(|w^r_i - w^{rn}|\ (GC^r, GF^r))$. where $\delta s_i/\delta w^r_i > 0$, $\delta w^{rn}/\delta GC^r > 0$ and $\delta w^{rn}/\delta GF^r > 0$

4. $e_i = e_i\ [w^r_{i,} w^u_i, w^{rn}\ (GC^r, GF^r)_{,} w^{un}\ (GF^u)]$ where $\delta e_i/\delta w^r_i > 0$, $\delta w^{rn}/\delta GC^r > 0$, $\delta w^{rn}/\delta GF^r > 0$, $\delta w^{un}/\delta GF^u > 0$

5. $U_i = U_i\ (x_i, l^c_i, v^c_{i,} w^r_i, w^u_i, w^{rn}(GC^r, GF^r), w^{un}\ (GF^u); d_{i\ ,} GC^r)$

6. $m_i = GP^r.w^r_i + GP^u.w^u_i + x_i$

7. $l^c_i = l^t_i - l^r_i\ (w^r_i; GC^r)$ where $\delta l^r_i/\delta w^r_i > 0$ and $(\delta l^r_i/\delta w^r_i)/\ \delta GC^r < 0$

8. $v^c_i = v^t_i - v^r_i\ (w^r_i; GF^r) - v^u_i\ (w^u_i; GF^u)$ where $\delta v^r_i/\delta w^r_i > 0$ and $(\delta v^r_i/\delta w^r_i)/\delta GF^r < 0$

9. $w^t_i\ (x_i) = w^u_i + w^r_i$

MODEL

Solving (Lagrangian s.t. conditions), yields typical predictions about extent of recycling **by the optimising household** and allows us to make hypothesis about effect of interventions and constraints on voluntary recycling

+ Implications of intervention if optimisation conditions are relaxed

MODEL - Estimation

Expressing recycling as **a linear function of the exogenous variables** provides the basis for the empirical estimation

$$Y_{it} = \alpha + \beta_1 G_{it} + \beta_2 X_{it} + \beta_3 C_{it} + u_{it}$$

Y_{it}	kilograms of separated waste per capita
G_{it}	vector of interventions (convenience, price, communication)
X_{it}	vector of constraints (space, time, income)
C_{it}	captures a number of relevant controls including SES
u_{it}	represents the error term.
i	indexes locality of observation; t indexes time units (week)

Model - Hypotheses

The a-priori expectation is that Yit (recycling) increases with

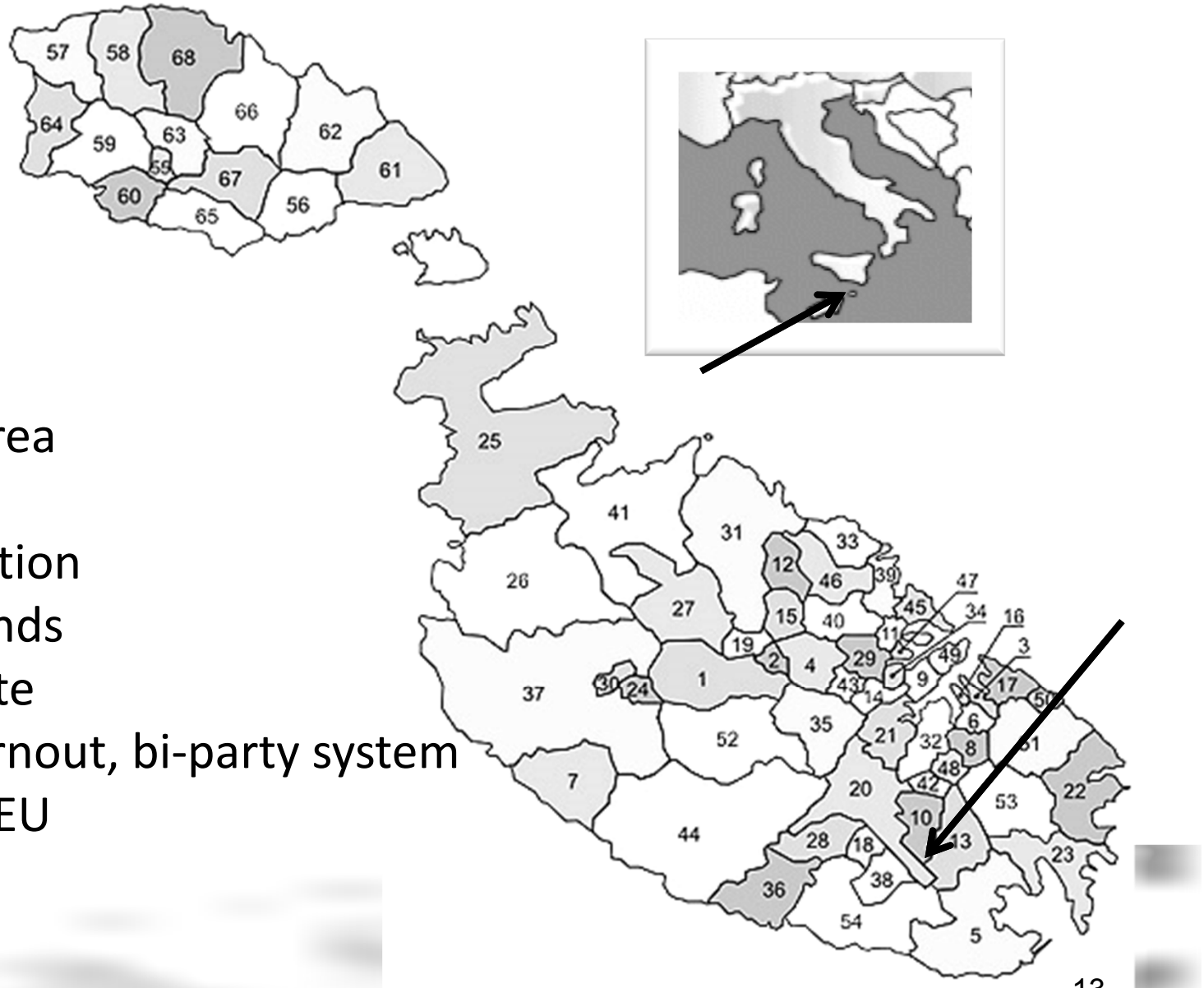
Government communication, frequency of collection, lower fees

Lower opportunity cost of time, space, price

Stronger norm/moral prefs e.g. efficacy belief, homogeneity

Habit over time

DATA - Context



MALTA

316 km^2 total area

68 locations

410,000 population

2 inhabited islands

EU member state

V. high voter turnout, bi-party system

Lowest r in the EU

DATA - Context

THE SCHEME

Recycling “Tuesdays”

3 streams of waste

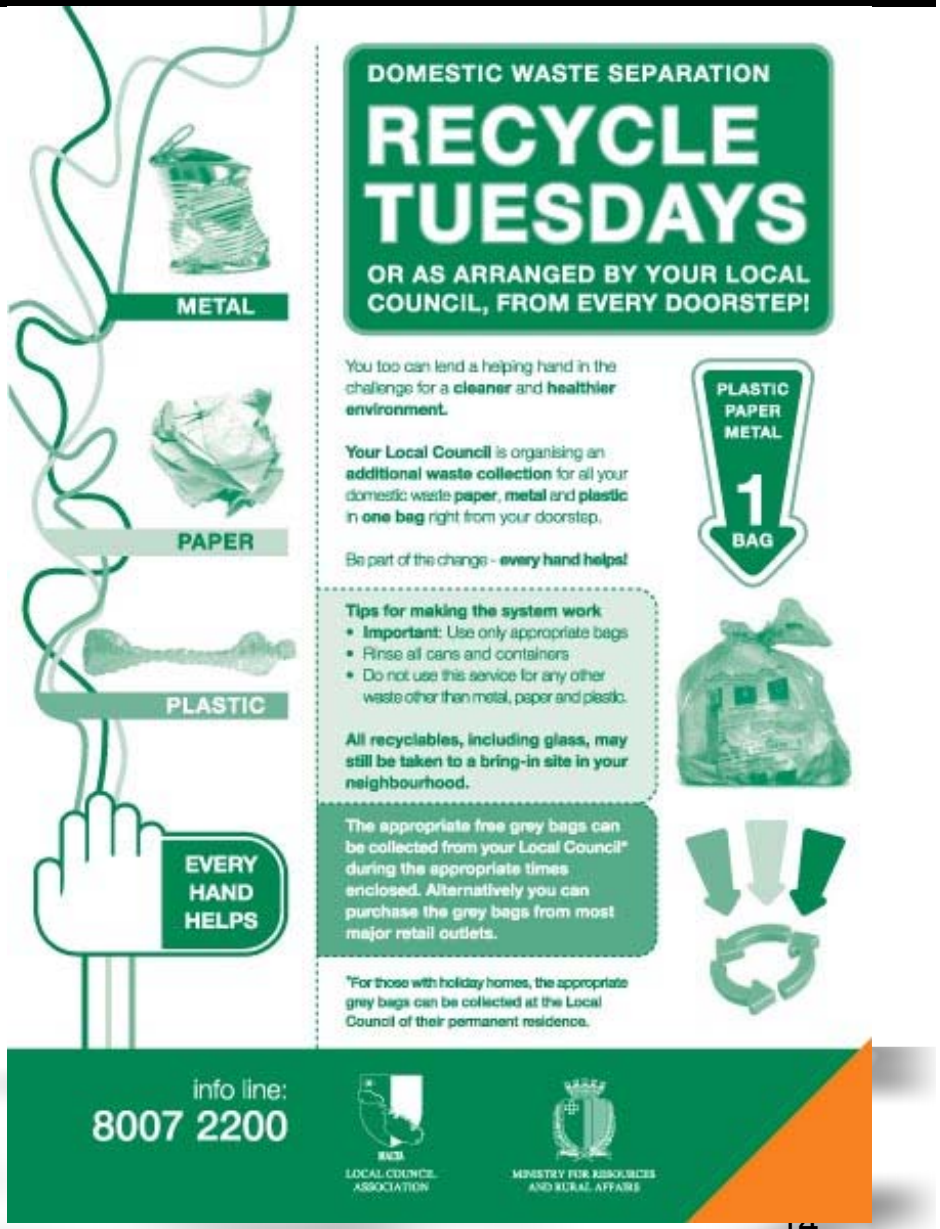
In a grey bag

At the kerbside

At 0.08 euro per bag

86 weeks

March 2008



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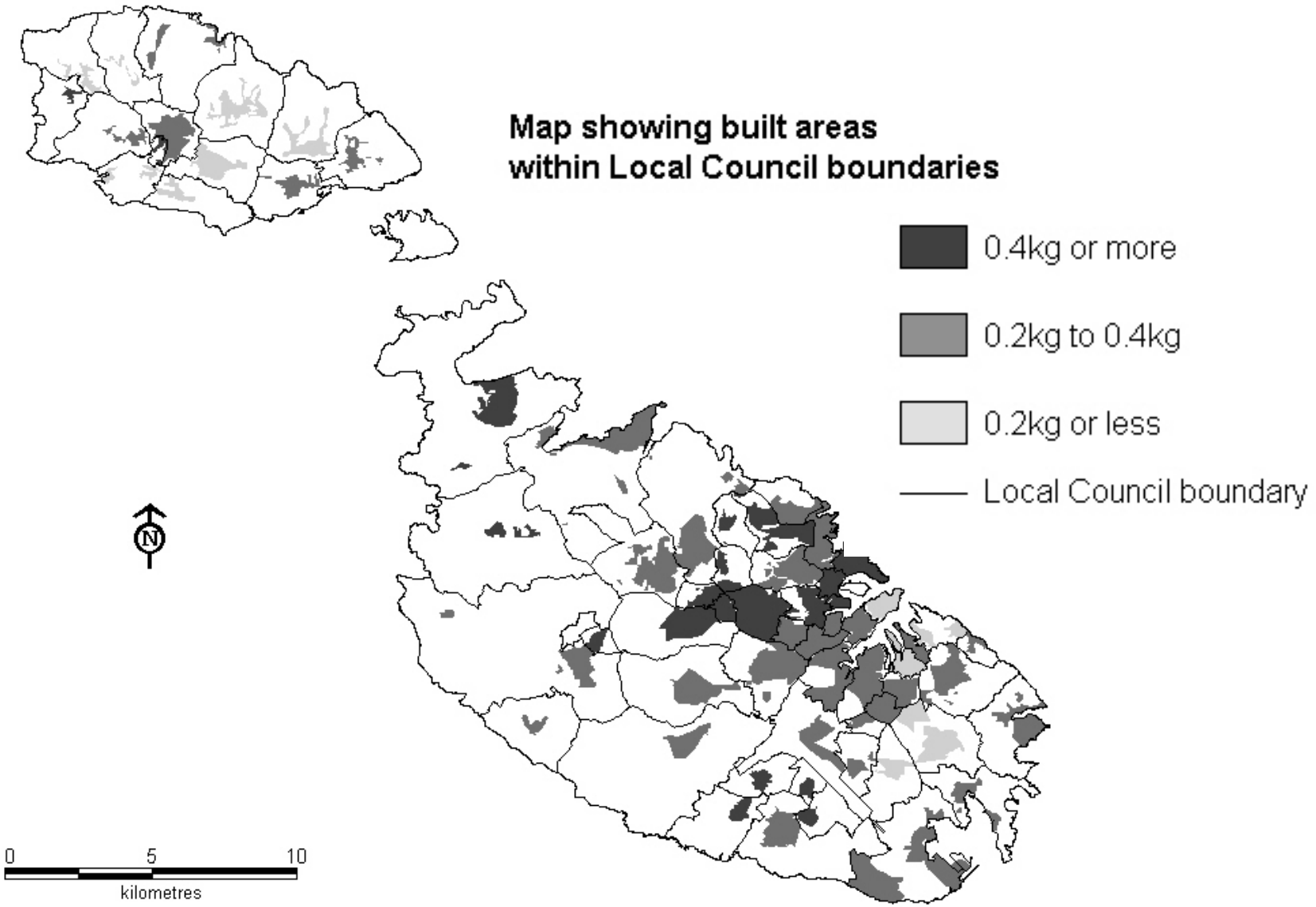

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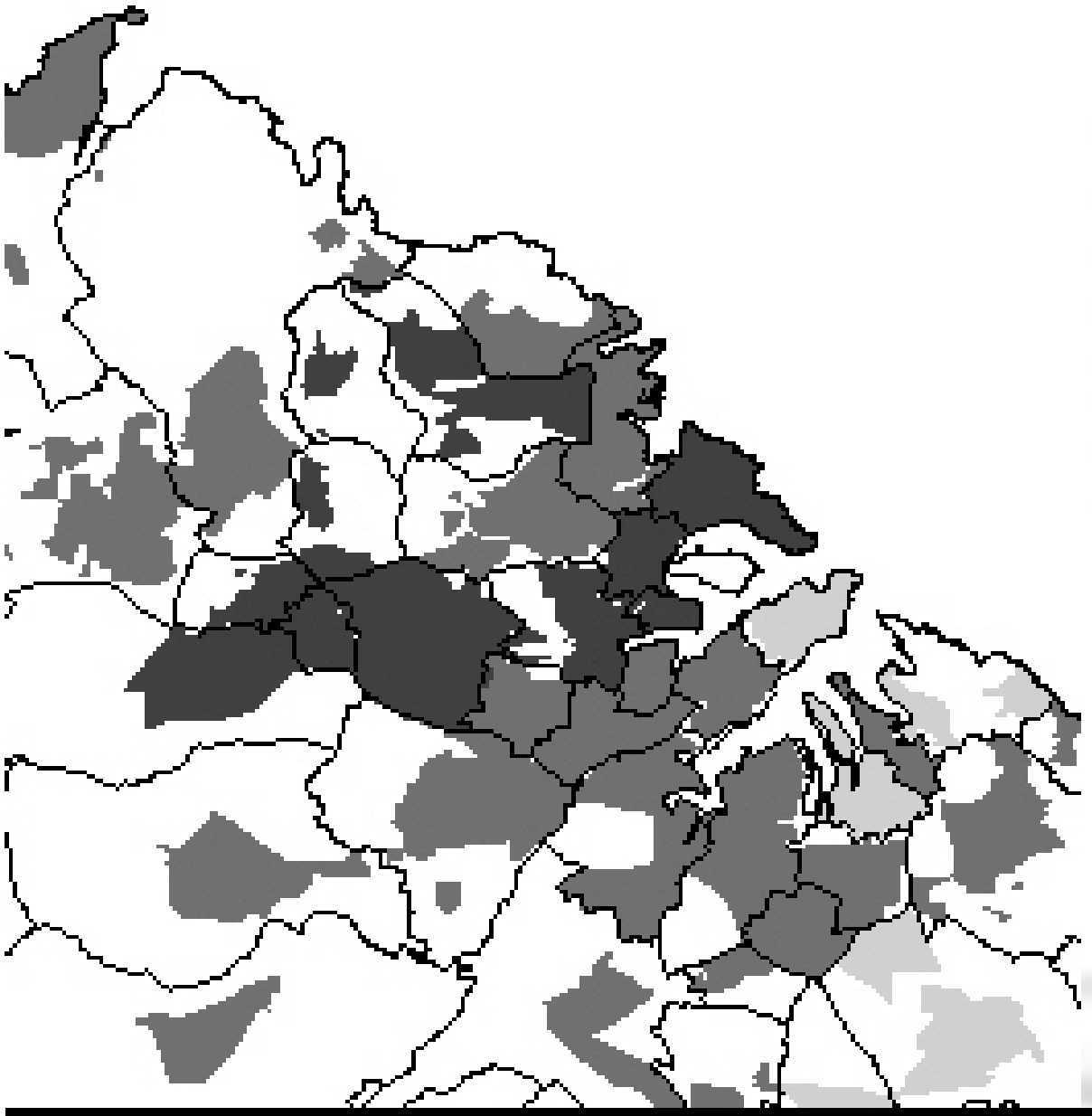

Map showing built areas within Local Council boundaries

- 0.4kg or more
- 0.2kg to 0.4kg
- 0.2kg or less
- Local Council boundary

DATA - Sources

Data available on:

Recycling waste volumes by locality, week
Intervention design elements by locality, week
Constraints by locality
Socio economic characteristics by locality
Controls by locality, week

FROM:
Malta Environment and Planning Authority
68 Local Councils
National Statistics Office
Department of Information
Malta Tourism Authority
The Diocese of Malta
interalia

Data – Variables

The dependent variable "Yit"

Tonnes of separated waste in 68 localities/population (recpc)	PANEL

The explanatory variables "Git"

GC dummy variable extent of promotional effort (recpr) (recprXvote)	CROSS
GP dummy variable weeks of free bags (freebag)	TIME
GP dummy variable for period with tax on bags (mswtax)	TIME
GF variables for frequency of collection (recfreq), (mswfreq)	PANEL
GF dummy variable for missed collections (holiday)	PANEL

The constraints "Xit"

TIME for leisure (oldpc) (teredupc)	CROSS
SPACE (densitybuilt)	CROSS
INCOME (spapc)	CROSS

The moral/social preferences "C"

SOCIAL – (diversity) diversity index (tourists, singles, social cases)	PANEL
MORAL - (votepnpc)	CROSS

+ Control variable

TIME week number in the scheme (week)	TIME

Estimation - specification

$$Recpc_{it} = B_{0+} recpr_i B_1 + freebag_t B_2 + mswprice_t B_3 + recfreq_{it} B_4 + mswfreq_{it} B_5 + holiday_{it} B_6 + densitybuilt_i B_7 + spapc_i B_8 + teredupc_i B_9 + oldpc_i B_{10} + votepnpc_i B_{11} + diversity_i B_{12} + week_t B_{13} + u_{it}$$

That is, recycling per capita is a function of government interventions (price, frequency, communication), household constraints (space, income, time), moral preferences, normative effects and time.

Estimation – statistics

Variable	N	Mean	SD	Min	Max
recpc	4469	0.368	0.302	0	2.980198
freebag	4469	0.162	0.369	0	1
mswprice	4469	0.500	0.500	0	1
recfreq	4469	1.030	0.170	1	2
mswfreq	4469	5.784	1.257	0	7
holiday	4469	0.035	0.183	0	1
recpr	4469	0.577	0.494	0	1
densitybuilt	4469	7.385	2.806	2.370	19.031
spapc	4469	0.071	0.038	0.011	0.188
teredupc	4469	0.079	0.041	0.022	0.187
oldpc	4469	0.220	0.072	0.070	0.378
votepnpc	4469	0.436	0.151	0.198	0.831
diverse	4469	0.107	2.386	-3.057	6.701
week	4469	43.517	24.819	1	86

GOZO COUNCILS LEFT OUT

Estimation – Random Effects

Freebag	0.0127	0.0088	
Mswprice	-0.0767	0.0101	***
Recfreq	0.183	0.0286	***
Mswfreq	0.0321	0.0104	***
Holiday	-0.198	0.0134	***
Recpr	0.121	0.0353	***
densitybuilt	-0.0194	0.0063	***
Spapc	-2.075	1.235	*
teredupc	-2.611	1.057	**
Oldpc	0.317	0.474	
votepnpc	0.821	0.191	***
diverse	-0.0187	0.00951	**
week	0.00221	0.00024	***
Constant	-0.058	0.118	
Notes: *** p<0.01, ** p<0.05, * p<0.1 N: 4469; Councils 52; r2_o 0.187; r2_b 0.233; chi2 383.3; sigma_u 0.113; sigma_e 0.156; rho 0.343			

DISCUSSION : INTERACTING PR WITH VOTE

freebag	0.0128	0.00881
mswprice	-0.0768	0.0101***
recfreq	0.179	0.0286***
mswfreq	0.0315	0.0102***
holiday	-0.198	0.0134***
recpr	-0.139	0.0968
densitybuilt	-0.0189	0.00599***
spapc	-1.422	1.194
teredupc	-2.143	1.016**
oldpc	0.198	0.452
votepnpc	0.531	0.208**
diverse	-0.0246	0.00926***
week	0.00221	0.000242***
recprXvote	0.605	0.212***
Constant	0.0125	0.115

Estimation - tests

Random Effects?

Breusch and Pagan LM test

Hausmann Test

Multicollinearity?

Pair-wise reveal some high correlations.

Endogeneity?

Price: Freebag, time dummy

Promotion: Recpr, cross section dummy.

Frequency: Recfreq and mswfreq not much variation in time.

Robust SE?

CONCLUSION - limitations

1. Regional data: Inferences about households/individuals? More households/individuals or more recycling?

2. Contamination of data: (regions, streams, sources for recpc) and reporting lag.

3. Reliance on time/cross section dummies for identification, omitted variables?

CONCLUSION - strengths

1. Employs rich spatial and temporal panel data set with low level of aggregation, based on actual recycling, no influence on data collection processes, no distortion between reported and actual.

2. Documents recycling uptake w/o of pecuniary incentive and confirms role of intervention design other than price.

3. Finds importance of pro-government sentiment – for further research.

Thank You

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