

# Economic downturns and the Greek referendum of 2015: Evidence using night-time light data.

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## **A Appendix A**

### **A.1 Background to the Greek Referendum of 2015**

The Greek referendum of July 2015 was the culmination of a drawn out process of negotiation between the Tsipras' government, which came to power in January 2015, and the 'troika' of lenders (International Monetary Fund, the European Commission and European Central Bank). The largest coalition partner in that government Coalition of the Radical Left (SYRIZA), just short of a majority of seats in parliament, won the elections with an ambitious manifesto that promised to end austerity (implausibly through an increase in government spending and decrease of various taxes) and write off the larger part of the Greek debt; even if that meant having to enter on a collision course with Greece's lenders. The PM had made it clear that it was not part of his government's plan to exit the Euro. It is true however, that various influential figures and factions inside the party (essentially a patchwork of various groupings from the communist left to social democrats) did not rule out that possibility. The junior coalition party Independent Greeks (ANEL), an unlikely partner of the radical right, was offering a similar discourse about the need of liberation from foreign yoke and debt write off. With an isolationist, frequently racist and conspiracy theory type of discourse the party and its members were already channelling 'Trumpism'.

It is true that a coalition between a party of the left (SYRIZA) and a party, essentially of the radical right (ANEL), appears to be strange if traditional left right ideological positions are taken into account. Moreover in the construction of this coalition there is leapfrogging since the 'closest' party, the Panhellenic Socialist Party (PASOK), was never considered as a potential coalition partner. This apparent 'paradox' can be explained by three main reasons. First, and most importantly, the two parties coincided in their anti-austerity stance, the most salient (possibly the only salient) issue of the 2015 election. They were (along with the Greek Communist party and extreme right wing Golden Dawn) the only parties not to support memoranda 1 and 2 and they campaigned on the same platform of 'tearing up' these agreements between Greece and its creditors. Second, both parties share similar anti-establishment sentiments and populist rhetoric that pits the virtuous people against the corrupt elite. Finally, SYRIZA in its various iterations as a party of the left had been for years insistent in denouncing the corruption of the mainstream parties that alternated in government, for the most part of the 40 years since democratisation and led the country to its current dire state. In the eyes of the leadership getting into a coalition with PASOK would probably appear even more dissonant than a coalition with ANEL.

Opinion polls suggested that the expectations from Tsipras government (largely in line with the discourse of the leaders of the coalition partners themselves) were to negotiate better terms with lenders without endangering the country's prospects inside the Euro. Grexit was not part of the mandate. During and after the electoral campaign of

January 2015, members of the government or the coalition parties had hinted towards the option of a referendum if negotiations did not come to a desired conclusion. These negotiations moved at a very slow pace since February 2015 when essentially the lenders rejected Greece's demand for a wholesale renegotiation of the existing bail out terms and largely insisted on the 'pacta sunt servanta' principle. In the months that followed it became obvious that Tsipras would not be in a position to keep key campaign promises on taxes and spending and that SYRIZA's MPs were pressured to support legislation that was completely outside the ideological core of the party (e.g large scale privatisations). The newly formed government, even if the leadership would be in a position to accept terms, would likely be unable to pass through parliament the legislation needed to fulfil the lenders demands. Late on the 27th of June Prime Minister Alexis Tsipras called a referendum on the latest draft of the deal that was tabled by the troika on the 25th of June.<sup>1</sup> More specifically the Greeks were to accept or reject with a 'Yes' or 'No' the draft of the agreement that had been prepared by the troika as stated in two documents with the titles 'Reforms for the Completion of the Current Programme and Beyond' and 'Preliminary debt sustainability analysis'.<sup>2</sup> The referendum was to be held in less than ten days on the 5th of July 2015. To the surprise of some international observers PM Tsipras recommended a 'No' vote.

During the short campaign that followed polarisation was high and pressures to voters were immense. First, following Tsipras announcement and his support for a 'No' vote the ECB decided that it cannot provide, 'in good faith', Emergency Liquidity Assistance (ELA) to the Greek banks anymore. During the long drawn out negation process ever since January 2015 a slow but steady 'bank run' had been taking place. ELA was crucial for the banks not to run out of cash. After that development the Greek government announced a bank holiday between the 28th of June and the 6th of July and imposed capital controls. A daily limit of 60 euros was set on all ATM withdraws. Greeks essentially lost access to their savings in the run up to the referendum.

Second, questions of constitutionality were raised regarding the actual referendum question (the Greek constitution does not allow referenda on economic issues), the length of the campaign and the conditions under which the campaign is taking place (i.e. under capital controls). These were quickly dismissed by the Council of State (the Supreme Administrative Court) but remained part of the public discussion and arguments made by international human rights watchdogs like the Council of Europe ([Reuters, 2015a](#)). Third, two different narratives emerged regarding the implications of a 'No' vote. On the part of the government the PM assured citizens that a 'No' vote would be a bargaining chip in the hands of the government to negotiate a much better agreement than the one on the table. The parliamentary opposition comprised by centrist parties PASOK and The River ('To Potami) and right wing New Democracy warned that a 'No' vote would eventually lead to Grexit. They also supported a sort of grassroots movement which organised demonstrations under a 'We belong to Europe' slogan.

Finally, the international community, at least at the early stages of the campaign piled up the pressure. Public statements from key figures in the process raised the stakes for the Greeks e.g Renzi's 'the euro vs the drachma. This is the choice' or Jean Claude Juncker's 'No' would mean that Greece is saying 'No' to Europe ([Guardian, 2015a](#)). In the latter stages though, tempers did not run so high. For Donald Tusk , head of the European Council, the referendum was not about Greece's Eurozone membership and there was 'no need for drama after a 'No' vote' ([Politico, 2015](#)). The IMF on the other side pushed for debt relief and more financial assistance to the Greek economy essentially siding with the Greek government on the unsustainability of the Greek debt ([Guardian, 2015b](#)). Under this backdrop Greeks went to the polls on the 5th of July 2015. Opinion polls had provided mixed signals about the outcome of the referendum. For most a 'Yes' vote was the most likely outcome, even if marginally, while others predicted a narrow 'No' win ([Reuters, 2015b](#)). None though, came even close to the resounding 61.3% in favour of 'No'.

## A.2 The NTL Measure

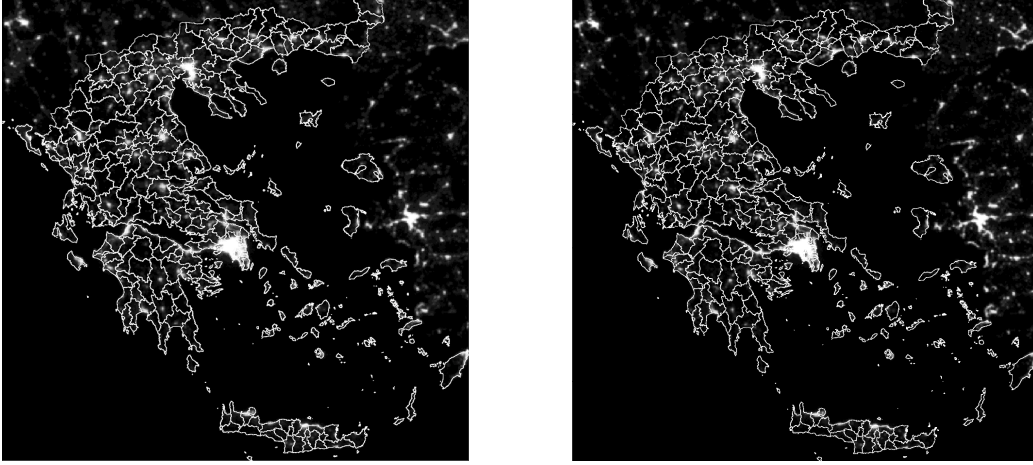


Figure A-1: DMSP-OLS time-stable lights for Greek Municipalities in 2008 (left) and 2012 (right). Brighter pixels correspond to higher values and vice versa.

We obtained Version 4 DMSP-OLS time stable night-time lights (NTL). In particular, we use the "Average Visible, Stable Lights, & Cloud Free Coverages". The data was cleaned by removing the following pixels: pixels with ephemeral events (such as fires), pixels covered by clouds, pixels with aurora or solar glare, pixels lit by the moon, pixels of locations where the sun sets late during summer (Michalopoulos and Papaioannou, 2018, 386). Because different satellites use different sensors, the data was calibrated across satellites and years using coefficients from Elvidge et al. (2014).

Further investigating the distribution of the full sample over the entire time period (2004-2013), we can see in the Box Whisker plot of the raw data (Figure A-2, upper panel) that most of our data is located at the lower end of the distribution. This is not surprising because Greece has not many metropolitan areas other than the Attica region that would account for such high values. We can also see a consistent downward trend after 2009 in the distribution of the third quartiles, the 95% confidence intervals, and the outliers at the top of the distribution. Using the logarithmic transformation (Figure A-2, lower panel), we see that the distribution is more centered. We can still observe the downward trend that was characteristic of the original distribution, however, less pronounced. The measure of NTL change is constructed by subtracting pre crisis levels of NTL (a five year average between 2004 and 2009) from those that have prevailed during the crisis (a four year average between 2010 to 2013, the year of the last available NTL data). We have tested a number of alternative measures of change in NTL. For example, shorter or longer year averages pre-crisis, or absolute changes between 2009 (or 2010) and 2013. The results reported here are not, for the most part, sensitive to alternative calculations of the change variable.

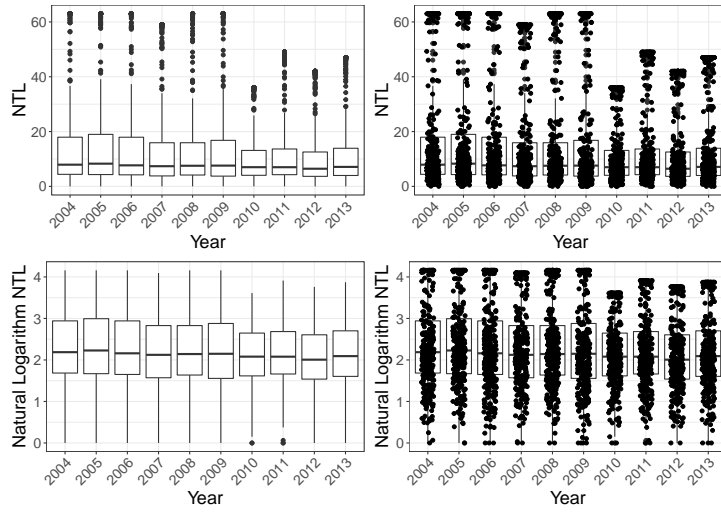


Figure A-2: Four Box Whisker Plots (Tukey, 1977) of Version 4 DMSP-OLS night-time lights composites (NTL) 2004-2013. The lower panel displays the natural logarithm. The right plots displays the same Box Whisker Plot as the left-hand side but also includes jittered raw data.

### A.3 NTL change in Greece

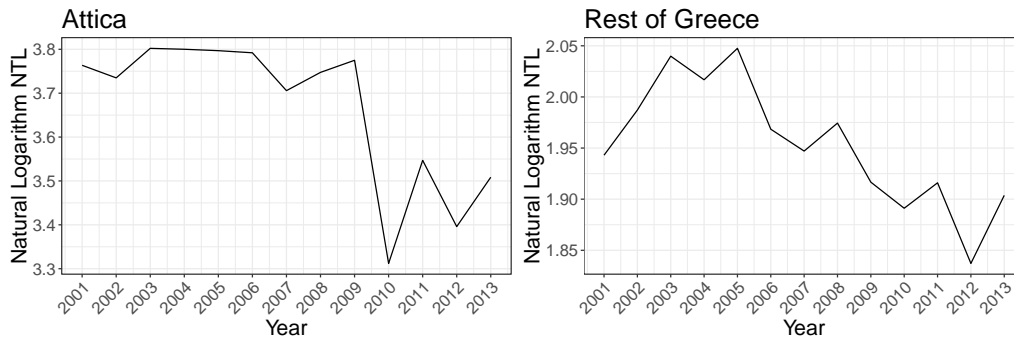


Figure A-3: NTL across time in Attica and Rest of Greece

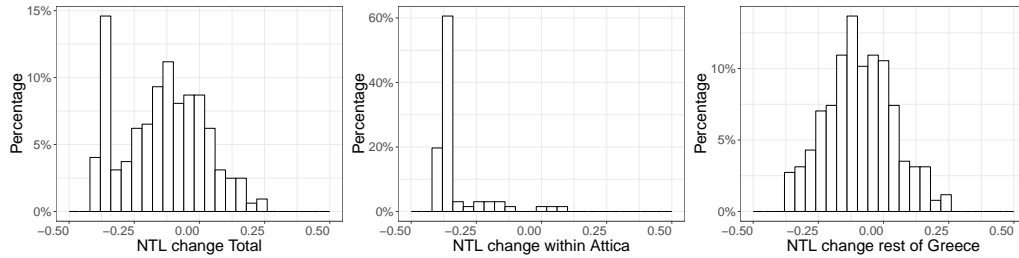


Figure A-4: Histogram Independent Variable: NTL change. Subset to Greece, Attica, Rest of Greece. Measure subtracts the average NTL 2004-2009 from the average NTL 2010-2013. The Attica region is a second level administration tier that includes eight subordinate regional units: North, South, Centras and West Athens, along with West and East Attica, Pireaus and the Islands.

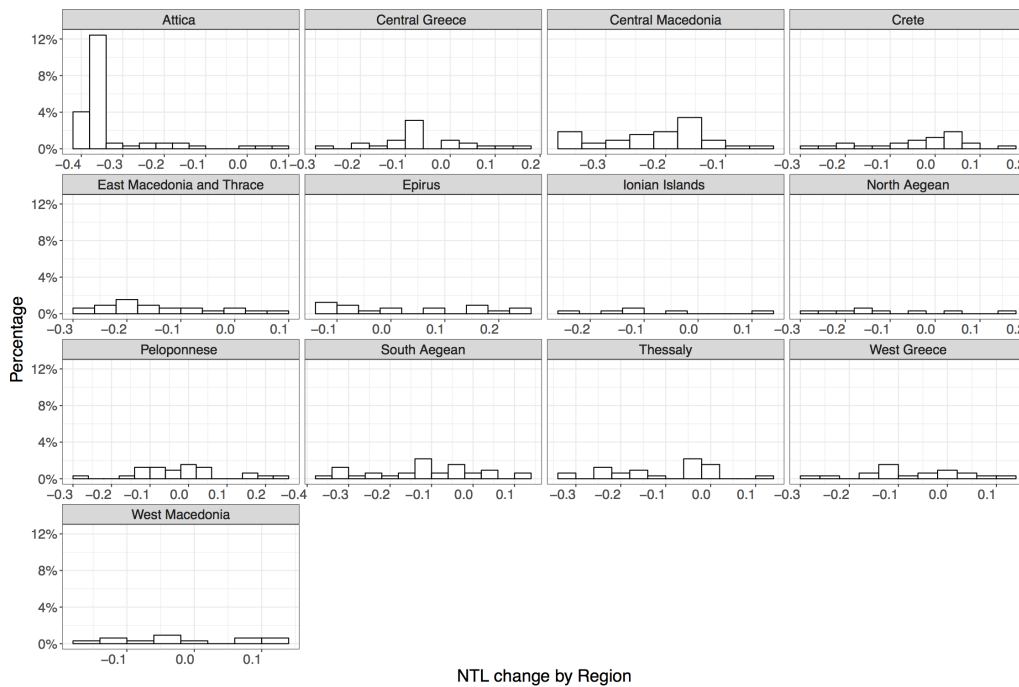


Figure A-5: Histogram Independent Variable: NTL change. Subset by region. Measure subtracts the average NTL 2004-2009 from the average NTL 2010-2013.

#### A.4 Previous Validations of NTL as a Measure of Income & Wealth

Using a *wealth* index from the DHS surveys Michalopoulos and Papaioannou (2013) use buffers around enumeration areas (10 km or 20 km) and find an average correlation of 0.7 with NTL. Weidmann and Schutte (2017) extended the analysis to more countries (39) smaller buffers (2 km and 5km) and find an average correlation of 0.73. Mellander et al. (2015) investigated the relation between *population*, *business density*, and *income* and NTL data in Sweden. Using economic data that is available at a high spatial resolution, their results show that, in most cases, radiance NTL is a slightly better predictor compared to saturated NTL. Radiance calibrated NTL does not have a upper limit. Saturated NTL is bound between values of 0-63. However, saturated NTL still correlates highly with density and total sum of night-time population (0.73,0.53), day-time business (0.72,0.40), and performs somewhat worse for take-home wage income (0.67,0.48). For their Saturated light measure Mellander et al. (2015) rely on the “Average Lights x Pct”. We use the “Average Visible, Stable Lights, & Cloud Free Coverages”. Comparing the two measure for the Swedish case, Mellander et al. (2015, 6) note: “*This data performed very similarly to the Average Light x Pct light data in the analysis, but was somewhat weaker in the relation to industry and people activity, and we therefore excluded this version of the light data from the analysis.*”



## A.5 Potential Problems of NTL data in the Greek Case

Unlike GDP measures, the NTL measure we use (Version 4 DMSP-OLS night-time lights Composites) has an upper bound. This characteristic, often also referred to as sensor saturation or “top-coding” (Henderson, Storeygard and Weil, 2012; Weidmann and Schutte, 2017), describes the fact that the scale of our measure ends at a value of 63. Therefore, it is possible that municipalities are coded 63, but their true value could be any value above this threshold. If this is the case, we would underestimate economic losses for those municipalities (our main independent variable). Therefore, we investigate the extent of the problem in our data, but conclude that is not a problem for the study design. The problem of top-coding should be most pronounced in urban areas because those usually show the highest illumination. To overcome this problem, researchers rely on radiance calibrated night-time lights. However, this measure is not available for our study period. To explore the issue of top-coding, we plot all municipalities that scored 60 or above in 2004 and follow their development over the time (until 2013) (see figures A-6 and A-7). First, almost all municipalities that score 60 or above are located in the Attica region which is not surprising since it is the biggest urban center in our sample. Second, there is substantial within-year and between-year variation in the measure. This suggests that the measure picks up meaningful variation also within urban centers over time. It could still be the case that some municipalities scoring 63 in the pre-crisis years are undervalued. However, the within-year distributions at the upper end of the distributions does not change in a meaningful way from pre crisis to crisis years. In both cases, there is a set of municipalities that are uniformly clustered at the upper end of the distribution. Since the crisis measures are not suspect to saturation, we can be confident that this distribution is measured correctly. Furthermore, in our empirical analysis we check if our inference holds when we exclude Athens.

Another potential limitation is that DMSP-OLS NTL time-series ends in 2013, a year and a half prior to the EU referendum. While we would like to include data for 2014, our measurement of the crisis economy relies on an average over a four year period. Even if we would observe some deviation in 2014, it is unlikely that it would substantively change the average.

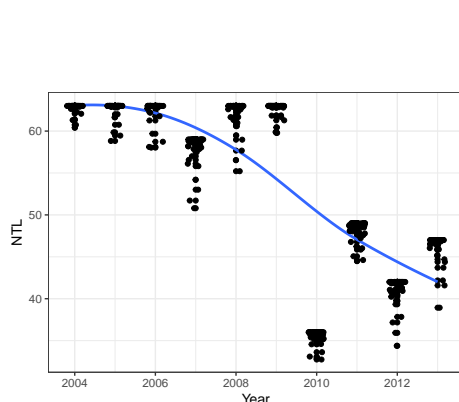


Figure A-6: Development of NTL measure ( $> 60$  in 2004) over time.

Municipality		
• Agia Paraskevi	• Ilio	• Neapoli-Sykies
• Agia Varvara	• Ilioupoli	• Nikala-Agios Ioannis Rentis
• Agioi Anargyroi-Kamatero	• Irakleio	• Palaia
• Agios Dimitrios	• Kaisariani	• Palaio Faliro
• Aigaleo	• Kalamaria	• Pallini
• Alimos	• Kallithea	• Papagou-Cholargos
• Ampelokipoi-Menemeni	• Keratsini-Drapetsona	• Pavlos Melas
• Athens	• Kifisia	• Perama
• Chaidari	• Kordelio-Evosmos	• Peristeri
• Chalandri	• Korydallos	• Petroupoli
• Dafni-Ymittos	• Lykovrysi-Pefki	• Piraeus
• Elliniko-Argyroupoli	• Marousi	• Thessaloniki
• Filadelfeia-Chalkidona	• Metamorfosi	• Vrilissia
• Filothei-Psychiko	• Moschato-Tavros	• Vyronas
• Galatsi	• Nea Ionia	• Zografou
• Glyfada	• Nea Smyrni	

Figure A-7: List of all municipalities that scored above 60 in 2004.

## A.6 Party Classification

The governing coalition was comprised by the Coalition of the Radical Left (SYRIZA) and the Independent Greeks (ANEL). For the euro-sceptic parties, we sum percentages for the Communist Party (KKE) and Golden Dawn (XA) from the parliamentary parties and add to these support for the Popular Orthodox Rally (LAOS) and ANTARSYA, two parties that did not gain any seats but made a strong showing in the 2015 elections, the latter especially in Athens. We rely on Chapel Hill Expert Survey data (2014) to gauge the position of these parties in the European Integration dimension (for the newly formed ANTARSYA we rely on direct reading of the party's manifesto material in the 25th January election). We note a caveat here. According to the 2014 Chapel Hill data both SYRIZA and ANEL could be classified as much Eurosceptic as some of the parties included in the above category. However, immediately prior to the 2015 January election at least SYRIZA adopted a clear pro-EU stance at least as regards membership in the political, economic and monetary unions that Greece was part of (EU and Euro area). Also, part of the pact between ANEL and SYRIZA was an understanding that there was no mandate for exit of the euro area as is clearly advocated by the parties now included in the Eurosceptic category. All models presented below have been estimated using alternative categorizations (e.g including ANEL in the Eurosceptic category) and results remain the same. The flip side of this is to use data on the opposition parties (New Democracy, Panhellenic Socialist Party and The River) to test for party cues effects. Again, we test for this as well and results remain unchanged. This is partly due to the fact that expectations regarding the effect of Euroscepticism or the governing coalition on the vote was the same at least as far as the direction of the effect is concerned.

## A.7 Attica vs Rest of Greece

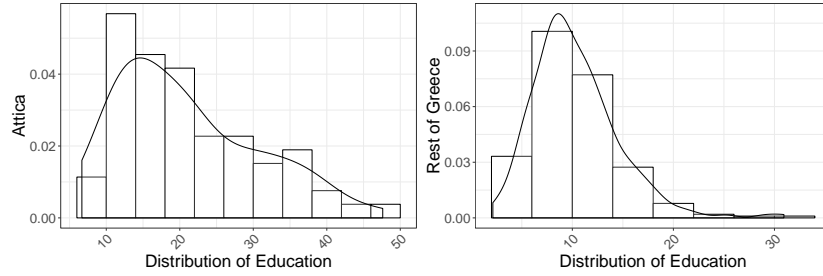


Figure A-8: Distribution of Education in Attica and Rest of Greece.

	Model 1	Model 2
NTL Change	1.23 (5.75)	-10.20*** (2.19)
Outside	-2.07 (1.84)	-8.68*** (1.54)
Education	-0.33*** (0.05)	-0.62*** (0.06)
Government support	0.74*** (0.04)	0.71*** (0.03)
Eurosceptic party support	0.54*** (0.08)	0.40*** (0.07)
Population	-0.74** (0.22)	-0.89*** (0.21)
NTL Change*outside	-14.81* (5.75)	
Education*outside		0.67*** (0.08)
(Intercept)	37.08*** (2.75)	44.69*** (2.64)
R <sup>2</sup>	0.68	0.73
Num. obs.	322	322

\*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

Table 1: Interaction Models

## A.8 Descriptives

Table 2: Coding, Name and Source of Variables Included in the models. SYRIZA: Coalition of the Radical Left, ANEL: Independent Greeks, KKE: Communist Party of Greece, LAOS: Popular Orthodox Rally, XA: Golden Dawn, ANTARSYA: Anti-capitalist Leftist Alliance

Variable	Name	Source
Share of votes to reject the Referendum (July 2015)	No Vote	Greek Ministry of Interior
Change in Night Light: Average(2010-2013)-Average(2004-2009)	NTL change	AidDATA, National Oceanic and Atmospheric Administration (NOAA), Version 4 DMSP-OLS night-time lights
Sum of SYRIZA and ANEL percentages in January 2015 election	Government Support	Greek Ministry of Interior
Sum of KKE, LAOS, XA and ANTARSYA percentages in January 2015 election	Eurosceptic Party Support	Greek Ministry of Interior
Percentage with tertiary Education or above	Education	Census of Population
Logarithm of municipalities population	Population	Census of Population
Logarithm of number of businesses by municipality 2005	Business Register	Hellenic Statistical Authority via Geodata.gov.gr

Table 3

Statistic	N	Mean	St. Dev.	Min	Max
No Vote	322	60.865	7.554	28.160	79.510
NTL Change	322	-0.140	0.158	-0.418	0.259
Education	322	12.514	7.224	2.136	47.612
Government support	322	39.623	7.505	14.760	70.430
Eurosceptic Party Support	322	11.739	3.718	0.000	34.490
Population	322	9.685	1.372	5.024	13.406

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