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Geographical Distribution of Small Physical Exercise Enterprises in the Greater Athens Area

By Gregory T. Papanikos[*]

The determinants of the geographical distribution of private business exercise centers in a large city, such as the wider area of Athens known as Attica, are the subject matter of this paper. The spatial distribution of any business enterprise, particularly those dealing with physical exercise, is of interest for two reasons. First, the spatial distribution of such businesses highlights the unevenness of health-related activities among the wider population living in a large metropolitan city, where geographical location often indicates uneven wealth distribution. This has certain government policy implications if physical exercise is to be considered a public good to be shared equally by all, rich and poor. Second, the spatial distribution of gym businesses shows whether, given wealth and population, there is an over- or undersupply of gym services. If there is an undersupply, there are opportunities for investment in small physical exercise businesses. This empirical study uses the 58 municipalities of Attica and the geographical distribution of 214 physical exercise businesses to show how wealth and population affect the under- or oversupply of physical exercise enterprises. The empirical evidence shows that, as expected, there is a positive effect of both wealth and population. However, the population effect is linear, while the wealth effect is non-linear; an increase in wealth increases the number of gyms in an area but at a decreasing rate. The study also identifies unexplored opportunities for investing in small physical exercise enterprises as well as areas of oversupply.

Keywords: *Gyms, population, wealth, SMEs, fitness centers, exercise, geographical distribution, spatial distribution, entrepreneurs, Athens, Attica*

Introduction

The analysis of the geographical distribution of private business exercise centers in a large city is of interest to society at large, as well as to individual entrepreneurs, usually small entrepreneurs, who want to invest in the business of providing exercise services. At the social level, the spatial distribution of private gyms is an indicator of the unequal distribution of wealth. Wealthy areas have more and better fitness centers than areas with less wealth. This is because wealthy people demand exercise services and can afford to consume them. Physical exercise is a good that has social benefits, such as promoting public health and increasing productivity.[1] The public health aspect can be viewed as a preventive

[*]President, The Athens Institute, Greece. The author has previously taught in many Canadian, Greek and U.K. Universities.

[1]Actually, the whole literature of sports relates significantly to promoting physical exercise among the entire population, especially the youth. This is, for example, the legacy of the

health policy that reduces the cost of providing hospital and pharmaceutical services. The productivity aspect relates to an overall increase in income at both the individual and aggregate levels.

At the business level, particularly for Small and Medium Enterprises (SMEs), the spatial analysis will reveal which areas have more or fewer gym enterprises than needed, as determined by characteristics such as population and wealth. Areas with fewer gyms offer potential investment opportunities.

This study serves both these purposes. The wider area of Athens, called Attica, is used as a case study to demonstrate how this approach can be applied to test the hypothesis of the wealth effect on the number of gyms in a section of the city. Attica is one of the 13 regions of Greece and is divided into sections, which are further divided into municipalities called "dimoi" (δήμοι) in Greek, from which the word "democracy" originates.

In addition to wealth, the demand for fitness services depends on population size. Larger populations have a ceteris paribus positive effect on the demand for fitness services. I have examined this aspect in Papanikos (2015a).

At the business level, the results of this study can be used to divide the different municipalities of Attica into three groups. The first group consists of areas where there is an oversupply of gyms, which therefore do not offer opportunities for new investments. The second group includes areas where there is an undersupply of services, consequently providing an opportunity for new small firms to enter the market. Finally, the last group of municipalities consists of areas where the demand equals the supply of gyms.

A note of caution should be made at the outset. We assume that the gyms are very small firms that approximately supply the same quantity of services. While this is not a very strong assumption, it should nevertheless be mentioned. Measuring the actual output of each fitness service would have been a Herculean task, i.e., almost impossible. There are many reasons for this, but the most important is that most SMEs in Greece do not report their actual revenues to avoid paying taxes. This is a general phenomenon, as I have analyzed in a series of papers (refer to Papanikos 2024, 2015b).

This study is organized into six sections, including this introduction. Section two presents the municipalities of Attica (the wider area of Athens) divided into geographical sections, followed by the number of gyms in Attica presented per geographical section. Section three examines more closely the descriptive statistics of the two most important determinants of the number of business physical exercise enterprises in the wider area of Athens, namely the wealth of each municipality and its population. Wealth is measured by the average value of property in each of the municipalities, as property values vary across and within municipalities. Section four develops a simple model of the determinants of the number of SMEs in physical exercise services, which is then tested using cross-sectional data from the 58 municipalities of Athens. The raw data used and their

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Olympic Games, as explained in Papanikos (2020 & 2022). Numerous other studies also link sports to physical exercise and various related issues. Refer, for example, to studies by Naquin et al. (2018), Balatoni et al. (2020), Burke et al. (2014), Djafarova & Thompson (2020), Jedlicka & Predel (2018), and Máté (2018).

sources are given in an appendix at the end of the paper. Section five uses the empirical findings (specifically the residual of the regression estimation) to classify the 58 municipalities of the wider area of Athens into the three types mentioned above. The final section of the paper concludes.

The Gyms of Attica

As shown in Map 1, Greece is divided into 13 regions (municipalities – δήμοι). The region of Attica is further divided into 7 sections (units). It includes islands which from an economic analysis point of view cannot be considered as belonging to the same geographical area. They are included in the region of Attica for public administration reasons. This is why they are excluded from the analysis of this study. Attica in terms of area is the smallest region of Greece but almost half of the population of Greece lives and works in this region.

Map 1. *The 13 Regions of Greece*

Greece is divided into 332 municipalities (δήμοι), of which 58 belong to the area of Attica, excluding the islands. The distribution of the 58 municipalities across the six geographical sections of Attica is displayed in Figure 1. The central section of Athens has eight municipalities, including the city of Athens, which has a disproportionately higher population and density. The western section has the largest number of municipalities (15), followed by the eastern section of Attica (13). The northern section has 12 municipalities. The smallest sections, in terms of the number of municipalities, are Dytiki (Attica) and Piraeus.

This geographical division of the region of Attica has its own merit for the empirical analysis in this study. The sections may have different characteristics that are non-measurable, and the only way to account for such section-related effects is by using a dummy variable. As it turns out, and as discussed later in the empirical section of the paper, the central and eastern sections of Attica have a statistically significant effect on the number of gyms located in these two areas.

Dummy variables to account for the effects of the other sections were not statistically significant.

The key variable of this study is the number of gyms in the region of Attica. The source of the data is provided in the appendix at the end of the paper. In total, there are 214 gyms. Figure 2 shows how these gyms are spatially distributed across the six geographical sections of the region of Attica. The central section of Athens has 42 gyms. Although it is the most populous of the six sections, the West of Attica has the highest number of gyms, with 56, followed by the North with 52. The East has 24 gyms, Piraeus has 18, and Dytiki Attica has 10.

Figure 1. *Municipalities (Δήμοι) per Geographical Section of Attica*

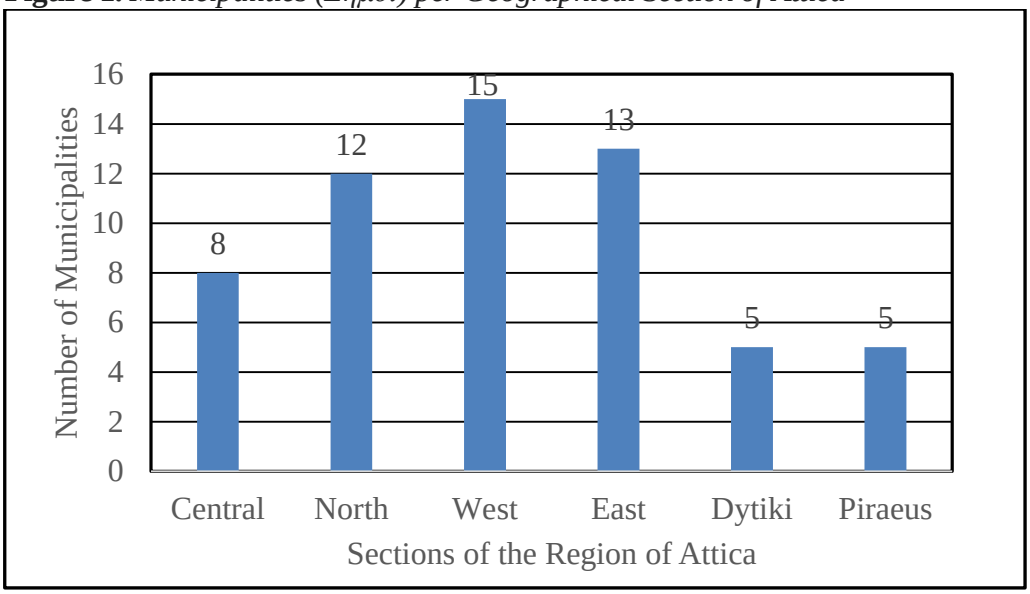
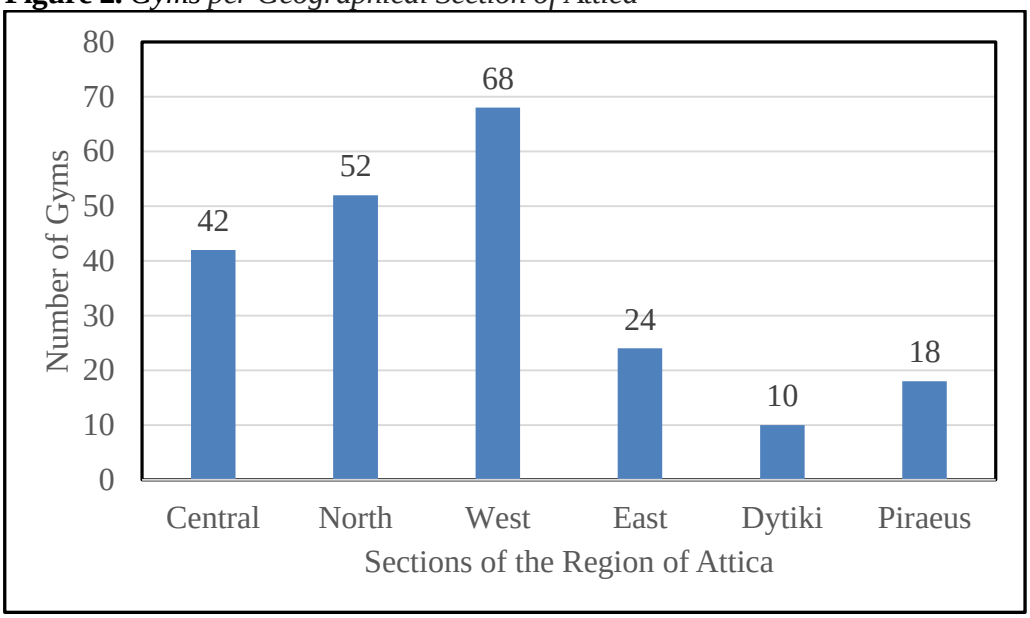


Figure 2. *Gyms per Geographical Section of Attica*



The variations in the number of gyms may be explained by differences in wealth and population. These two factors are examined in the next section and are used in the estimation of a regression equation as explanatory variables in the subsequent section of the paper.

Uneven Distribution of Wealth and Population

The most important variables for the purposes of this study are population and wealth. The raw data and their sources are provided in the appendix of this study. According to the 2021 Greek census data, the population of Greece was 10,482 million. In Attica, there were 3,744 million people, accounting for 36% of the Greek population. The actual number is much larger because many Greeks are registered in their hometowns for the census but live and work in Athens.

Table 1 reports descriptive statistics of population, population density (population divided by area), and property values of the 58 municipalities of Attica. The average population of the 58 municipalities is 56 thousand people, but there are significant variations. The city of Athens has 626 thousand people (the maximum value in the data set), while the smallest municipality, located in the Dytiki section, has 18 thousand people. The standard deviation is 83 thousand people. An important relevant indicator is density, defined as the number of people living in a square kilometer, as shown in the third column of Table 1. This is also an indicator of free space that may exist in an area where people can walk and play. These areas likely have small and large public parks and other amenities for outdoor activities, which might be considered substitutes for private fitness centers.

Table 1. *Summary Statistics of Property Values and Population*

	Population (N) (000s)	**Density** (000s/km^2)	**Property Values (V)** (€/m^2)
Mean	65	6.44	1268
Median	49	6.12	1173
Standard Deviation	83	5.74	432
Range	626	20.77	2283
Minimum	18	0.04	664
Maximum	643	20.82	2948
Sum	3744		
Count	58	58	58

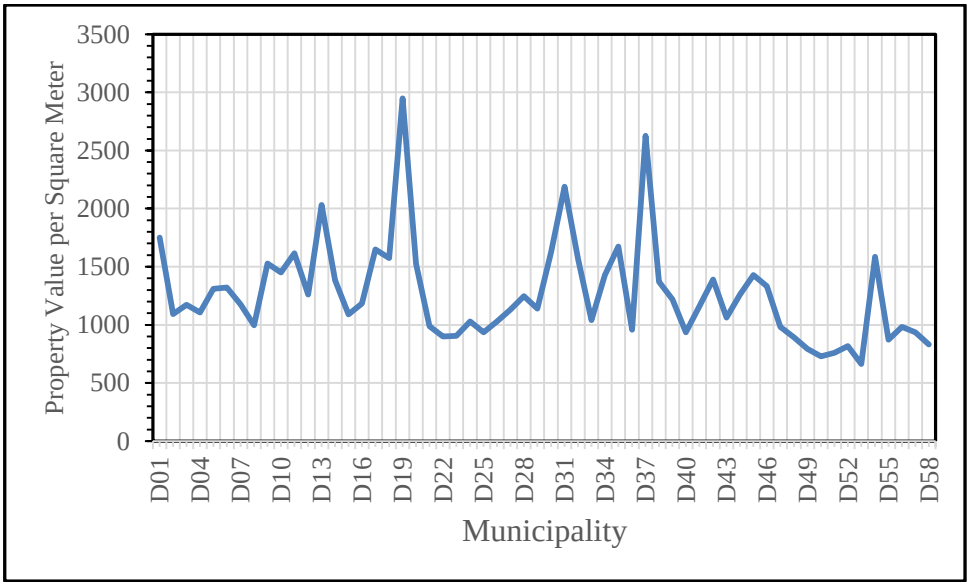
The last column of Table 1 provides the summary statistics of property values in each municipality. The data are reported by the government for administrative purposes such as property taxes. Although it is not the market price, it can be considered that the variations between the values reported by government officials are similar to those determined in the market.

A second issue is that each municipality does not have only one value for property. Within a municipality, there are multiple values. The table reports the

average property values for each municipality. These average values are used as an explanatory measure of wealth.

The standard deviation of this measure, calculated for the 58 average property values, indicates wealth distribution among municipalities. The maximum, minimum, and range also illustrate the uneven distribution of wealth. Figure 3 shows this distribution for the entire range of 58 values.

Figure 3. *Distribution of Property Values*



It is obvious that wealth is not equally distributed. Four municipalities have an average property value of more than 2000 euros per square meter. Eighteen municipalities have a property value of less than 1000 euros. The remaining 36 municipalities have an average property value between 1000 and 2000 euros.

It should be noted that property values reflect other characteristics of the residents of these municipalities. Property value is a good approximation of the level of education and, consequently, people's awareness of the benefits of regular exercise in a gym.

The next section uses the two variables of population and property values in an empirical regression model to test whether these variables determine the number of gyms in each municipality of the region of Attica.

Estimation of the Population and Wealth Effects

The empirical model of the simple regression is given by the following general mathematical function:

(1) $G = F(N, V, \mathbf{D})$

Where:

F: Functional form, e.g., linear, polynomial, logarithmic, etc.
G: Number of gyms in the wider area of Athens
V: Wealth of the area of the gym
N: Number of people (population) living in the municipality of the gym
D: A vector of other variables, mainly dummy variables to account for various characteristics of the area, such as the section of the wider area of Athens, public transportation, etc.

For empirical purposes, the above equation can take many functional forms, but the one chosen to report here is a second-degree polynomial. Thus, the equation that is estimated is the following:

$$G = a_0 + a_1N + a_2N^2 + a_3V + a_4V^2 + z\mathbf{D} + u \quad (2)$$

Where a's and z's are parameters to be estimated and u is the disturbance term of the regression which becomes the error term of the estimated equation. As shown in the next section, this error term is very important in determining the oversupply or undersupply of gyms in various administrative units (municipalities) of the wider area of Athens.

The polynomial functional form encapsulates several hypotheses that can be tested, which cannot be addressed by other forms such as the logarithmic form, for example. The logarithmic form assumes constant elasticity, which may not hold true. In the polynomial case, elasticity can vary according to the levels of the explanatory variables. In this scenario, the elasticity is given by:

$$E_{GN} = (a_1 + 2a_2N)(N/G) \quad (3)$$

$$E_{GV} = (a_3 + 2a_4V)(V/G) \quad (4)$$

The marginal impact of population and property values is given by:

$$M_{GN} = a_1 + 2a_2N \quad (5)$$

$$M_{GV} = a_3 + 2a_3N \quad (6)$$

The elasticity and the marginal effect vary with the explanatory variables, which is crucial for obtaining accurate effects at the municipality level, considering specific wealth and population characteristics.

Table 2 reports the regression results of the parameter estimates for equation (2) above. The table includes only the statistically significant dummy variables. Specifically, the dummy variables for Central and East were found to be

statistically significant. The presence of a metro station in each municipality turned out to be marginally statistically significant.

Overall, Table 2 presents three estimated equations. The first regression includes the population variable (linear and squared), the property value variable (linear and squared), and three dummy variables: Central, East, and metro. The dummy variables Central and East take the value of one if the gym is located in the central or east section respectively, and zero otherwise. Similarly, the metro variable takes the value of one if there is a metro station close by, and zero otherwise. Two variables were found to be not statistically significant: population squared and metro. The non-significance of population squared suggests that the effect of population on the number of gyms is linear, indicating that as population increases, there is a proportional increase in the number of gyms.

In the second regression, the squared of population is dropped. Now, the variable metro is statistically significant at the 8.24% level of significance. The effect of metro is negative. One possible interpretation could be that people in this municipality have the option to use the metro to access gyms located farther away from their area. However, this explanation may not suffice because people from outside the municipality also find it convenient to travel and use gym services. Another explanation could be that the cost of renting property to establish a gym is higher in municipalities served by a metro compared to those without, which might weaken the effect. These two explanations together suggest that the effect of metro is not as strong as the other variables.

Table 2. *Regression Results* (Dependent variable: Number of gyms per municipality in the wider area of Athens)

	1	2	3
Constant	-4.25 (1.38)	-4.44 0.002	-4.00 (1.52)
Population (N)	0.035 (0.012)	0.042 (0.002)	0.04 (0.002)
Population (squared)	1.09E-05 (1.79E-05)	---	---
Property Value	0.008 (0.002)	0.008 (0.002)	0.0066 (0.002)
Property Value (squared)	-1.95E-06 (5.46E-07)	-1.90E-06 (5.20E-07)	-1.55E-06 (5.81E-07)
Central	-2.03 (0.59)	-1.95 (0.59)	-1.57 (0.66)
East	-1.92 (0.4)	-1.84 (0.42)	-1.4 (0.39)
Metro	-0.82 (0.57)	-0.90 (0.50)	---
R-squared	0.8441	0.8427	0.8350
R-squared (Adj.)	0.8223	0.8242	0.8192
F-statistic	38.68	45.54	52.64
Observations	58	58	58

Notes: In brackets, HAC standard errors.

The last regression equation excludes the metro variable. This regression estimation is used throughout the remainder of this section and the following sections of the paper. All variables are statistically significant, at least at the 2% level of significance, as indicated by the t-statistic.

Overall, the variations in explanatory variables explain at least 81.92% of the variance in the number of gyms among the 58 municipalities of Attica. For cross-sectional data, this coefficient of determination is quite high, but it should be noted that this is not a sample of gyms; it includes all gyms listed in the wider area of Athens (Attica). The F-statistic is also statistically significant, indicating that all estimated coefficients as a group have a significant effect on the dependent variable, i.e., the number of gyms.

As mentioned earlier, population has a linear effect on the number of gyms, while population squared is not statistically significant. In this case, the population elasticity of gyms drops to the following:

$$E_{GN} = (a_1)(N/G) \quad (7)$$

Evaluating this at the average values of N (64.55) and G (3.69), then the elasticity is equal to:

$$E_{GN} = (0.0406)*(3.69/64.55) = 0.0023$$

This implies that a 10% increase in the population of a municipality will increase the number of gyms by 0.023%.

The effect of property values is non-linear. A rise in property values increases the number of gyms but at a decreasing rate. Evaluating the elasticity at the mean values of G (3.69) and V (1268).

$$E_{GV} = (0.0066 + 3.10E\text{-}06*1268.43)*(344) = 3.62$$

This implies that a 10% increase in property values of a municipality will increase the number of gyms by 3.62%.

All three dummy variables have a negative effect. On average, municipalities that are located in the Central and East sections of the Region of Attica have fewer gyms than the rest of the Attica sections.

Opportunities to Invest in Private Gyms

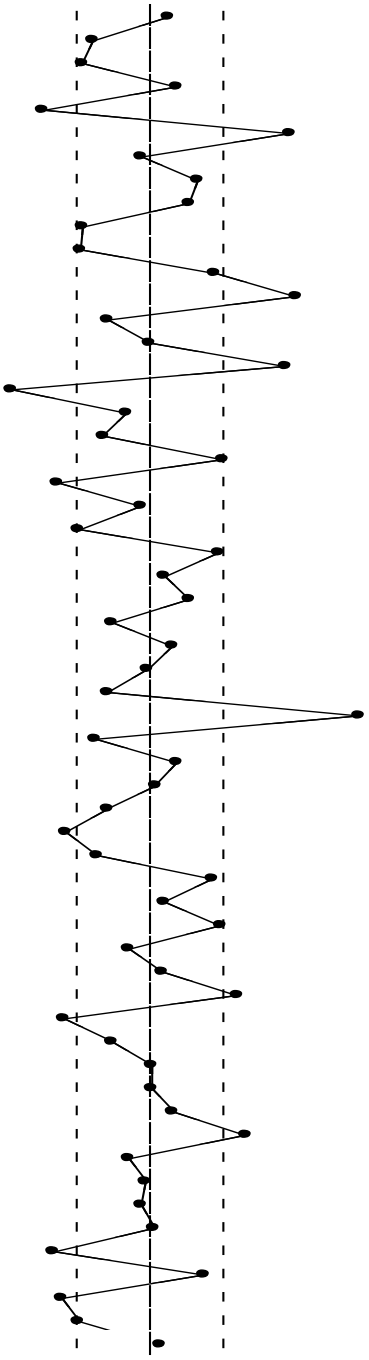
The evidence presented in the previous section can be used to identify municipalities in Attika that have fewer gyms than predicted by the estimation. The residuals follow a normal distribution. The Jarque-Bera test rejects the hypothesis of non-normality.

Table 3 presents the actual, fitted, and residual values from the regression of the third model in Table 2. A negative (positive) difference between the fitted and

actual values indicates an undersupply (oversupply) of gyms in that specific municipality.

Table 3. *Regression Residuals*

obs	Actual	Fitted	Residual	Residual Plot
1	28.0000	27.5567	0.44332	
2	1.00000	2.28702	-1.28702	
3	1.00000	2.50823	-1.50823	
4	1.00000	0.37310	0.62690	
5	1.00000	3.43438	-2.43438	
6	7.00000	3.75100	3.24900	
7	1.00000	1.18816	-0.18816	
8	2.00000	0.90144	1.09856	
9	6.00000	5.08406	0.91594	
10	3.00000	4.51474	-1.51474	
11	2.00000	3.58358	-1.58358	
12	5.00000	3.53181	1.46819	
13	9.00000	5.62957	3.37043	
14	3.00000	3.94377	-0.94377	
15	3.00000	3.01442	-0.01442	
16	7.00000	3.88441	3.11559	
17	1.00000	4.17609	-3.17609	
18	4.00000	4.54748	-0.54748	
19	2.00000	3.06397	-1.06397	
20	7.00000	5.30026	1.69974	
21	4.00000	6.08584	-2.08584	
22	1.00000	1.21629	-0.21629	
23	2.00000	3.60478	-1.60478	
24	5.00000	3.39333	1.60667	
25	5.00000	4.68205	0.31795	
26	5.00000	4.05439	0.94561	
27	3.00000	3.87045	-0.87045	
28	6.00000	5.47295	0.52705	
29	4.00000	4.03115	-0.03115	
30	4.00000	4.95287	-0.95287	
31	12.0000	7.19322	4.80678	
32	3.00000	4.24403	-1.24403	
33	3.00000	2.32875	0.67125	
34	6.00000	5.81808	0.18192	
35	5.00000	5.93510	-0.93510	
36	2.00000	3.94980	-1.94980	
37	2.00000	3.18264	-1.18264	
38	4.00000	2.54848	1.45152	
39	2.00000	1.63366	0.36634	
40	2.00000	0.36229	1.63771	
41	1.00000	1.46453	-0.46453	
42	2.00000	1.72560	0.27440	
43	3.00000	0.98381	2.01619	
44	1.00000	2.96518	-1.96518	
45	1.00000	1.84723	-0.84723	
46	2.00000	1.93212	0.06788	
47	1.00000	0.96071	0.03929	
48	1.00000	0.44396	0.55604	
49	4.00000	1.77461	2.22539	
50	1.00000	1.51564	-0.51564	
51	1.00000	1.09187	-0.09187	
52	2.00000	2.21921	-0.21921	
53	2.00000	1.89115	0.10885	
54	7.00000	9.24781	-2.24781	
55	5.00000	3.73901	1.26099	
56	1.00000	3.00783	-2.00783	
57	3.00000	4.59872	-1.59872	
58	2.00000	1.75674	0.24326	



The first observation corresponds to what is called the city of Athens, which has the highest population. The actual number of gyms is 28. The number estimated by the regression is 27.6, and rounding to the closest integer gives a

fitted number of 28. Thus, in the city of Athens, the existing number of gyms is optimal, as there is neither oversupply nor undersupply.

The second municipality, as seen in the table in the appendix, is called Vironas (Βύρωνας), located very close to the City of Athens. According to the estimations, this municipality could support 2 gyms, but there is only one. If we define undersupply as a difference between fitted and actual numbers greater than two, indicating a need for at least two more gyms, then Table 3 shows that there are 6 municipalities where there was an undersupply of gyms. This represents 10% of the total. Similarly, there is a 10% oversupply of gyms, which is not surprising given that the error terms are normally distributed. The remaining municipalities can be considered to have an optimal number of gyms.

Conclusions

The main findings of this study can be summarized as follows. First, the vast majority of the 58 municipalities in Attica (about 80%) have an appropriate number of private gyms, considering the variation in population and property values (wealth). There is significant variability in both population and wealth, which is reflected in the number of private gyms present in each municipality.

However, approximately 10% of municipalities show potential for profitable investment in new gyms. Conversely, another 10% exhibit an apparent oversupply of private gyms. It is important to interpret this evidence cautiously because there may be other local characteristics that could explain deviations from what the data suggests as the optimal number of gyms.

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Appendix A1. *Raw Data and Sources (only the statistically significant variables)*

Dimos	Dimos	G	N	V	Central	East	Metro
Αθηναίων	D1	28	643.45	1750	1	0	1
Βύρωνος	D2	1	59.13	1092	1	0	0
Γαλατσίου	D3	1	57.91	1171	1	0	0
Δάφνης - Υμηττού	D4	1	33.89	1106	1	0	1
Ζωγράφου	D5	1	69.87	1310	1	0	0
Ηλιουπόλεως	D6	7	76.73	1320	1	0	0
Καισαριανής	D7	1	26.27	1175	1	0	0
Νέας Φιλαδέλφειας - Νέας Χαλκηδόνος	D8	2	34.96	995	1	0	0
Αμαρουσίου	D9	6	71.83	1527	0	0	1
Αγίας Παρασκευής	D10	3	62.15	1450	0	0	1
Βριλησσίων	D11	2	32.42	1617	0	0	1
Ηρακλείου	D12	5	50.49	1261	0	0	1
Κηφισιάς	D13	9	72.88	2032	0	0	1
Λυκόβρυσης-Πεύκης	D14	3	31.00	1383	0	0	0
Μεταμορφώσεως	D15	3	30.17	1090	0	0	0
Νέας Ιωνίας	D16	7	64.61	1183	0	0	1
Παπάγου-Χολαργού	D17	1	45.27	1650	0	0	1
Πεντέλης	D18	4	35.61	1575	0	0	0
Φιλοθέης-Ψυχικού	D19	2	27.64	2948	0	0	0
Χαλανδρίου	D20	7	77.10	1524	0	0	1
Περιστερίου	D21	4	133.63	988	0	0	1
Αγίας Βαρβάρας	D22	1	26.76	900	0	0	1
Αγίων Αναργύρων - Καματερού	D23	2	61.46	906	0	0	0
Αιγάλεω	D24	5	65.83	1030	0	0	1
Ιλίου	D25	5	84.00	936	0	0	0
Πετρουπόλεως	D26	5	60.15	1030	0	0	0
Χαϊδαρίου	D27	3	47.05	1131	0	0	0
Καλλιθέας	D28	6	97.62	1246	0	0	1
Αγίου Δημητρίου	D29	4	71.66	1138	0	0	1
Αλίμου	D30	4	43.17	1627	0	0	0
Γλυφάδας	D31	12	89.60	2189	0	0	0
Ελληνικού-Αργυρούπολης	D32	3	50.03	1569	0	0	1
Μοσχάτου-Ταύρου	D33	3	39.66	1040	0	0	1
Νέας Σμύρνης	D34	6	72.85	1429	0	0	0
Παλαιού Φαλήρου	D35	5	64.86	1673	0	0	0
Αχαρνών	D36	2	108.17	958	0	1	0

Βάρης - Βούλας - Βουλιαγμένης	D37	2	52.55	2626	0	1	0
Διονύσου	D38	4	42.38	1370	0	1	0
Κρωπίας	D39	2	30.82	1219	0	1	0
Λαυρεωτικής	D40	2	25.20	936	0	1	0
Μαραθώνος	D41	1	31.33	1160	0	1	0
Μαρκόπουλου Μεσογαίας	D42	2	21.72	1389	0	1	0
Παιανίας	D43	3	28.04	1063	0	1	0
Παλλήνης	D44	1	59.46	1260	0	1	0
Ραφήνας-Πικερμίου	D45	1	22.33	1429	0	1	0
Σαρωνικού	D46	2	30.05	1333	0	1	0
Σπάτων-Αρτέμιδος	D47	1	34.92	982	0	1	0
Ωρωπού	D48	1	31.81	890	0	1	0
Ελευσίνας	D49	4	30.15	793	0	0	0
Ασπροπύργου	D50	1	31.38	729	0	0	0
Μάνδρας-Ειδυλλίας	D51	1	17.82	759	0	0	0
Μεγαρέων	D52	2	38.03	817	0	0	0
Φυλής	D53	2	48.16	664	0	0	0
Πειραιώς	D54	7	168.15	1584	0	0	1
Κερατσινίου - Δραπετσώνας	D55	5	89.54	872	0	0	1
Κορυδαλλού	D56	1	61.25	981	0	0	1
Νίκαιας - Αγίου Ιωάννη Ρέντη	D57	3	103.49	935	0	0	1
Περάματος	D58	2	25.63	830	0	0	0

Where:

G: The number of gyms. Two sources of data were used. First, gyms in Attica are listed in https://www.vrisko.gr/dir/gymnastiria/ which is a website that promotes the services of the fitness centers. They are listed for free. The second source is the official website of the Union of Owners of Gyms in Attica (https://siga.gr/). There is a third source from official government archives (Region of Attica) but it is outdated. From the two the first was considered as more reliable. For example, the second list showed municipalities of Attica with zero gyms when there were some. The reason is that the second list includes only those who are members of the union.

N: population from the Greek census of 2021.

V: The wealth of each of the 58 municipalities was calculated as the average value of the properties of each one as this is determined by the government for property taxes.

Central: Takes the value of one if the municipality is located in the central section of Attica and zero otherwise.

East: Takes the value of one if the municipality is located in the east section of Attica and zero otherwise.

Metro: Takes the value of one if the municipality is located close to a metro station and zero otherwise.