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# Economic growth and trend changes in wildlife hunting

Yukichika KAWATA [1)]

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**ABSTRACT**

Petty-Clark's law suggests that as the economy of a country develops, its proportion of primary industries declines while those of its secondary and tertiary industries increase. Traditionally, hunting has played a crucial role in a country's food supply; however, currently, it is increasingly viewed as a leisure activity. This paper empirically examines whether Petty-Clark's law holds in case of hunting in European countries. The results reveal that the proportion of hunters across countries increases when the per capita GDP is between 5,000 and 15,000 USD. Once the per capita GDP crosses the 15,000 USD mark, two major trends are detected: the number of hunters continues to increase in some countries but decreases in some other countries. Finally, the number of hunters in a country stabilizes when its per capita GDP reaches around 25,000 to 30,000 USD.

**Key words:** hunting, economic growth. Petty-Clark's law

**IZVLEČEK**

**GOSPODARSKA RAST IN SPREMEMBE PRI LOVU DIVJADI**

Po Petty-Clarkovem zakonu se z razvojem gospodarstva manjša relativni delež primarne gospodarske dejavnosti, medtem ko se veča sekundarni in terciarni. V zgodovini je imel lov odločilno vlogo pri zagotavljanju prehrane prebivalstva, toda v novejšem času gledamo na lov čedalje bolj kot na aktivnost v prostem času. V tem članku je empirična raziskava če Petty-Clarkov zakon velja v primeru lova v evropskih državah. Ugotovljeno je, da se število lovcev veča v povezavi z večanjem bruto domačega proizvoda (BDP) na prebivalca v državi, v razponu 5.000 do 15.000 USD. Ko pa BDP na prebivalca preseže vrednost 15.000 USD, sta odkrita dva glavna trenda. V nekaterih državah se število lovcev še nadalje povečuje, v nekaterih drugih pa se zmanjšuje. Število lovcev postane stabilno ko BDP doseže okoli 25.000 do 30.000 USD.

**Ključne besede:** lov, ekonomska rast, Petty-Clarkov zakon

## 1 INTRODUCTION

Man has been hunting wild animals since prehistoric times. Since hunting began, human beings have both exploited and co-existed with wild animals, and this holds true even in the present day. Therefore, a decline in the hunting of wild animals by humans will naturally change the relationship between the two—the wild animal population may drastically increase and cause various serious imbalances in the ecosystem. The impact of an increase in the wild animal population on the ecosystem can be especially problematic when there is a decrease in the hunting of ungulates whose predators are now extinct. This is because the growth rate of ungulates is generally high, and at times, they graze so extensively on the vegetation in their region that it leads to a drastic decline in the same.

Although recent times have witnessed a decline in the hunting of wild animals in some countries, it remains prevalent in others. The reasons behind this prevalence could be one or more of the following: the tradition and culture of hunting that exist in these countries and which have been maintained over time, the continuing

[1] Department of Animal and Food Hygiene, Obihiro University of Agriculture and Veterinary Medicine, Inada-cho, Obihiro, Hokkaido 080-8555, Japan, Ph.D., ykawata@obihiro.ac.jp

use of game meats in the traditional cuisine in these countries, or a shift in the role of hunting from a means of procuring food to a leisure activity. The hunting of wild animals may have declined in the countries where the above reasons do not hold good. If the movement against hunting gets stronger, there may be a decline in hunting activities (for example, Bambi syndrome is one such examples wherein people, especially those living in the city, advocate not to kill bambi, without considering the importance of deer population control; Banta, 2002; Takatsuki, 2006). In addition, we should note that the same change may bring about different results depending on the methods of hunting, tastes and/or difference in attitude of the inhabitants of the regions or countries. For example, an income increase in a certain region may result in a decline in the region's hunting activities because of the increased availability of staple foods. On the other hand, in another region, an income increase may result in an increase in hunting because it will enable the region's inhabitants to purchase advanced and expensive hunting gear—a factor that contributes to hunting effectiveness.

As mentioned above, the rise and decline in hunting depends on various factors, which suggests that Petty-Clark's law will not necessarily hold in the case of hunting. Petty-Clark's law is one of the most well-known empirical rules to suggest that as an economy develops, its proportion of primary industries declines while those of its secondary and tertiary industries increase. However, although hunting is considered to be a primary industry, it may not decline as an economy develops. The purpose of this paper is to analyse the current situation in Europe with regard to animal hunting. Data pertaining to Europe's GDP, hunting activities, and forests will be used in the analysis.

The motivations behind this investigation are as follows. First, it will enable us to ascertain whether Petty-Clark's law is applicable to hunting. Second, a rise or decline in hunting activity within a region may substantially influence the population size of game animals in the region, which, in turn, has a significant impact on the region. An examination of the reasons underlying rises and declines in hunting activity may enable us to determine a mechanism for influencing demand for game hunting, which could be helpful for game management.

The structure of this paper is as follows. In section 1, we provide a brief review of related existing researches; we also present a theory-based argument that Petty-Clark's law does not necessarily hold in the case of hunting. In section 2, to empirically show that Petty-Clark's law does not necessarily hold in the case of hunting, we use empirical data to graphically examine the relationships between per capita GDP and the number of hunters and between per capita GDP and the proportion of hunters across countries. In section 3, we discuss the reasons why Petty-Clark's law holds true in some cases but not in others. On the basis of our findings in sections 1 and 2, we expect the following result: the income elasticity of demand for the hunting of wild animals is greater than 1 in northern and eastern European countries, while it is less than 1 in middle, western, and southern European countries. The reasons for the difference in the income elasticity of demand can be attributed to the following points, all of which are related to differences in latitude: (1) differences in the body size of game animals, (2) differences in hygienic conditions, and (3) differences in forest areas and the abundance of game populations. In section 3, we examine these three points in detail and apply the ordinary least squares method and correlation analysis to statistically investigate the third point. The last section concludes the paper.

## 2 BACKGROUND

### 2.1. Previous researches

In this paper, we examine the relationship between hunting and economic development. The relationships between industry and economic development have been examined in several fields of economics. Some of the most well-known relationships are as follows: (1) the relationship between economic development and inequality in income distribution, known as the Kuznets curve; (2) the relationship between economic development and environmental quality, known as the environmental Kuznets curve; and (3) the relationship between economic development and a change in industrial structure, known as Petty-Clark's law. The idea behind Petty-Clark's law had first appeared in *Political Arithmetick* which was written by W. Petty in 1690. This fact was revealed in *The Conditions of Economic Progress* by C. Clark (1940) and confirmed by S.S. Kuznets in *Modern Economic Growth* (1966). The Kuznets curve was developed by Kuznets (1955), and it states that inequality of income distribution tends to rise in the early stages of economic development but then diminishes gradually; this relationship is often referred to as an inverted U-curve. Research on the environmental Kuznets curve was undertaken after the 1990s. It states that the quality of the environment

worsens in the early stages of economic development but then begins to improve gradually.

This paper examines the proposition that although hunting is a primary industry, Petty-Clark's law does not necessarily hold in the case of hunting. In general, the production of goods in the primary industry tends to show an inverted U-curve; however, we empirically demonstrate that this is not true in the case of hunting. We also show that this result is theoretically sound. To the best of our knowledge, there is no existing study that has examined this topic.

One of the reasons that Petty-Clark's law does not always hold in the case of hunting is that there are several types of hunting, and the type of hunting prevalent in a region depends on its level of economic development. Chardonnet et al. (2002) and Loveridge et al. (2006) classify hunting as subsistence hunting, commercial hunting, and sport hunting. Among these, only subsistence hunting is classifiable as a primary industry. As the level of economic development increases, subsistence hunting might decline and/or commercial hunting and sport hunting might increase. These changes may be influenced by regional differences in the body size of game animals, hygienic conditions, forest areas, or strength of protest campaigns. We will discuss these issues later.

### 2.2. Theoretical background

In this section, we theoretically examine the situations in which hunting activity declines as the economy develops. We trace this phenomenon in the context of hunting based on Egaitsu (2008). The following equation—obtained by modifying an equation of income elasticity of demand—holds true in the abovementioned context.

ratio of change in demand = income elasticity of demand x ratio of change in income (1)

Let us rewrite this relationship in the context of hunting. Suppose the ratio of change in the demand for wild animals, income elasticity of demand for wild animals, and GDP growth rate are denoted by $WD_R$, $r]_w$, and $GDP_R$, respectively. Here, we substitute the ratio of change in income with GDP growth rate. Thus, we have the following equation.

$$WDR = {}_{r\ W} XGDPR \quad (2)$$

Next, we consider an equation that describes the ratio of wild animal-related products in the GDP. Suppose the wild animal-related production value, ratio of wild animal-related products in the GDP, and GDP are denoted by $WP$, $WP$, and $GDP$, respectively. We then have the following equation.

$$WP = WP_r \times GDP \quad (3)$$

Let us denote the variations in $WP$, $WP$, and $GDP$ by $wp$, $wp_R$, and $gdp$, respectively. Then, the ratio of change in Eq. (3) can be denoted as follows.

$$\frac{{}^{w}PR}{WP} \_ \frac{{}^{w}P}{WP} \quad \frac{gdp}{GDP} \quad \frac{{}^{w}P_R \bullet gdp}{WP \bullet GDP} \quad (4)$$

We substitute $\frac{gdp}{GDP}$ with $GDP$ because $\frac{gdp}{GDP}$ is the ratio of change in the $GDP$. We ignore $\frac{{}^{w}PR \cdot g^{d}P}{WP \bullet GDP}$ because of its small value. We further substitute the ratio of change in the wild animal-related production value $\frac{wp}{WP}$ with the ratio of change in demand for wild animals WD. Then, by substituting Eq. (2) into Eq. (4), we obtain the following result.

$$^{m} = Vlw - 1 ] \times GDPR \quad (5)$$

where $m = \frac{WP_R}{WP}$. It follows from Eq. (5) that if the income elasticity of demand for wild animals $rj_w$ is less than 1, the ratio of the wild animal-related product value in the GDP will decrease. This is the application of the Petty-Clark law for wild animal products based on Egaitsu (2008).

Several inter-related factors are indicative of the demand for wild animals, and we can select one or more of these factors to examine the said demand. Two major factors are (1) the hunting of wild animals as a primary source of food and (2) hunting for game meat or trophy hunting as a leisure activity. As stated in the introduction section of this paper, an increase of income in a particular region might reduce the demand for game meat in that region. In this case, since $r]_w < 1$, m will decrease. On the other hand, in another region, an increase in income might promote hunting as a leisure activity and lead to an increase in the hunting of wild animals. In the above case, since $r > 1$, m will increase.

As seen above, we cannot predict increases or decreases in m on the basis of theoretical analysis; rather, an empirical examination is required to make such a prediction. Moreover, empirical results are influenced by factors such as the purpose of hunting and the use of products derived from the hunted animals. In the following sections, we examine these topics in detail, particularly from an economic perspective.

In our analysis, the ratio of the change in $WP_R$ (the left-hand side of eq. (5)) is substituted with the 'number of hunters' and the 'hunters' proportion in the population' in sections 1.1 and 1.2, respectively. This is because it is difficult to use the ratio of the change in $WP_R$ because different (sub)species of game animals are hunted in different countries and valued at different standards. In addition, poaching activities degrade the accuracy of these data. The 'number of hunters' and the 'hunters' proportion in the population' may reflect hunting (including poaching) statistics more realistically, and can also be used as standardized data.

## 3 RELATIONSHIP BETWEEN PER CAPITA GDP AND HUNTING

### 3.1. Increases or decreases in the number of hunters

In this subsection, we examine the influence of increases in the per capita GDP of various countries on changes in the number of hunters in the countries. For this purpose, we use per capita GDP data for 2007 obtained from the 'World Economic Outlook' (WEO), which is an annual report published by the International Monetary Fund (Table 1). For data pertaining to changes in the number of hunters in various countries, we utilized Table III of Chardonnet et al. (2002, p. 27) and categorized the data by assigning the following values: increased (2), stable or slightly increased (1), stable (0), slightly decreased (-1), decreased (-2), and drastically decreased (-3). Chardonnet et al. (2002) provides data for 20 countries.

The results are illustrated in Figure 1. Chardonnet et al. (2002) states that the number of hunters decreased in the Latin countries of southern Europe but increased in the Scandinavian countries. We further have the following results. In the western and southern European countries, the population trend of hunters averages to less than -1, which suggests a decrease in the number of hunters. In the eastern and northern European countries, the average is greater than 1, which suggests an increase in the number of hunters. In the middle European countries, it is between -1 and 1, which suggests that the number of hunters has stabilized. In addition, the middle European countries generally tend to have high incomes as compared to the other European countries. This suggests that as the income of a country increases, the fluctuations in the number of hunters in the country reduces, and the number tends to stabilize.

### 3.2. Hunters' proportion of the population

In this subsection, we examine the influence of increases in per capita GDP on the proportion of hunters across countries. For the data of per capita GDP, we used 2007 WEO data. For data on the proportion of hunters across countries, we utilized the values of their *proportion of the population* in various countries given in Table III of Chardonnet et al. (2002, p. 27).

The results of the above analysis are shown in Figure 2. The proportion of hunters in a nation is low when the nation's per capita GDP is low. When the per capita GDP reaches a certain level, the proportion of hunters varies from nation to nation. To clarify this, we have

[1] Department of Animal and Food Hygiene, Obihiro University of Agriculture and Veterinary Medicine, Inada-cho, Obihiro, Hokkaido 080-8555, Japan, Ph.D., ykawata@obihiro.ac.jp

used arrows in Figure 2 to indicate the changing direction in the number of hunters. Figure 2 shows that the proportion of hunters across nations demonstrates an upward trend when the per capita GDP is between 5,000 and 15,000 USD. However, once the per capita GDP crosses 15,000 USD, the countries exhibit two main trends: the number of hunters continues to increase in some countries but decreases in some other countries. Finally, the number of hunters appears to stabilize when the per capita GDP reaches around 25,000 to 30,000 USD.

**Table 1.** Data used in the analysis

| Country | Per capita GDP of 2002 | The proportion of hunters across countries | Number of hunters | Forest area | Latitude |
|---|---|---|---|---|---|
| Austria | 25,801 | 0.0139 | 0 | 47.0% | 47.52 |
| Belgium | 24,397 | 0.0029 | 0 | | 50.50 |
| Denmark | 32,493 | 0.0345 | 1 | | 56.26 |
| Finland | 26,145 | 0.0588 | 2 | 72.0% | 61.92 |
| France | 24,449 | 0.0286 | -2 | 27.9% | 46.23 |
| Germany | 24,523 | 0.0040 | 1 | 30.7% | 51.17 |
| Greece | 15,486 | 0.0286 | -3 | 27.9% | 39.07 |
| Hungary | 6,548 | 0.0049 | 2 | 19.9% | 47.16 |
| Ireland | 31,394 | 0.0333 | 0 | | 53.41 |
| Italia | 21,318 | 0.0167 | -2 | 34.0% | 41.87 |
| Luxembourg | 50,970 | 0.0063 | 0 | | 49.82 |
| Netherlands | 27,207 | 0.0022 | 0 | | 52.13 |
| Norway | 42,526 | 0.0400 | 0 | 28.9% | 60.47 |
| Poland | 5,185 | 0.0026 | 2 | 29.7% | 51.92 |
| Portugal | 12,349 | 0.0250 | 0 | | 39.40 |
| Slovenia | 12,079 | 0.0119 | 0 | 55.0% | 46.15 |
| Spain | 16,693 | 0.0256 | -2 | | 40.46 |
| Sweden | 27,326 | 0.0370 | 2 | 65.9% | 60.13 |
| Switzerland | 38,659 | 0.0043 | 0 | 30.3% | 46.82 |
| United Kingdom | 26,719 | 0.0172 | 0 | | 55.38 |
| Source | [1] | [2] | [3] | [4] | [5] |

[1] IMF (2007) World Economic Outlook.
[2] 'Proportion in the population' in Table III (p. 27) of Chardonnet et al. (2002).
[3] The 'trends' in Table III (p. 27) in Chardonnet et al. (2002) are transformed to the following values: increased (2), stable or slightly increased (1), stable (0), slightly decreased (-1), decreased (-2), and drastically decreased (-3).
[4] Values in the 'Forest and Woodland' section of von Arx et al. (2004).
[5] Based on search results (country names were used for search) at the following website: http: //www.benricho. org/chimei/ get_LatLon/.

In the northern and eastern European countries, as an overall trend, the proportion of hunters across countries continues to increase and thereafter stabilizes at high GDP levels. In the middle, southern, and western European countries, the proportion of hunters across countries increases for a certain amount of time, but subsequently diminishes and stabilizes at low GDP levels.

## 4 DISCUSSION ON THE REASONS FOR OUR RESULTS

The theoretical and empirical results presented in sections 1 and 2 suggest that in the northern and eastern European countries, the income elasticity of demand for wild animals $r$ is greater than 1 and the ratio of change in wild animal-related production m is increasing while in the middle, western, and southern European countries, $r < 1$ and m is decreasing. The reasons for these results may be as follows. (1) The northern and eastern European countries are located in relatively cool areas, and the wild animals in their forests have relatively larger body sizes than those in other European countries. (2) The post-hunt treatment of game animals is relatively easy with respect to the maintenance of hygienic safety. (3) The forest area in these countries is large such that there are abundant populations of game animals in the forests. In the following subsections, we examine each of these three points.

### 3.1. Differences in the body size of game animals

First, Bergmann's law—which states that the body sizes of homeothermic animals of the same species tend to be larger as latitude increases— supports the presence of relatively large animals in cool areas. Further, the purpose of hunting in a country has changed depending on its economic conditions, among other factors (Chardonnet et al., 2004; Loveridge et al., 2006). Irrespective of the purpose of hunting, hunters tend to seek larger game animals. Once the purpose of hunting changes from the acquisition of food to the pursuit of a leisure activity, those who live in areas where there is an abundance of larger game animals can easily begin considering hunting as a leisure activity, and such hunters will abound in these areas. On the other hand, hunters who live in areas where only small game animals are present have no choice but to hunt the small animals when they have limited economic means; however, when economic development takes place in these areas, some of the hunters might begin travelling to other areas where they can hunt larger game animals. However, the decline in the number of hunters may be greater in the areas with small game animals as compared to that in areas with large game animals. From this economic perspective, these phenomena can be explained as follows. The decrease in the number of hunters is greater in these areas because they obtain smaller benefits from hunting (e.g. because of the small size of the game animals). The hunters living in the areas with small game animals may travel to other areas; however, this translates into additional travel and accommodation costs and reduces the net benefits that accrue from hunting, resulting in an overall reduction in the number of hunters in the area.

### 3.2. Differences in hygienic conditions

It is a matter of common sense that in comparison with areas with a hot climate, areas with a cool climate are more conducive to the hygienic and safe treatment of the carcasses of game animals. The cool climate also helps the carcasses remain fresh for a longer period of time. The hunting of ungulates is often scheduled for the winter months, and in countries whose general climate is cool, the winters are cooler than those of warmer countries. A cooler winter climate leads to the maintenance of a low body temperature in carcasses, which results in a higher quality of game meat. In the warmer countries, on the other hand, it is necessary to carry the carcasses to a slaughterhouse as soon as possible in order to increase hygienic safety and maintain a quality of meat; otherwise, the meat may become rotten or unsafe to eat. However, hunters might not always find a slaughterhouse near the hunting site. Thus, it is clear that from the perspective of the efficient use of hunted game animals, warmer countries have certain disadvantages as compared to the cooler ones.

### 3.3. Difference in forest and woodland cover

Given the natural abundance of game animals in forests, it is expected that countries with greater forest areas will have more abundant populations of game animals. However, the forest area of a country may decrease in direct proportion to its economic development. In this subsection, we examine these relationships using the *Forest and Woodland Cover* data provided in von Arx et al. (2004) and data from the studies already mentioned.

A correlation analysis revealed that there was a statistically significant correlation at the 5% level—with $r = 0.58$ (n = 12, two-tailed test)—between the proportion of hunters across countries and the forest areas in the countries. On the other hand, we could not detect a statistically significant correlation even at the 10% level ($r = 0.24$, n = 11, two-tailed test) between per capita GDP and forest area. We also employed the ordinary least squares method with the proportion of hunters across countries as the explained variable and forest area and per capita GDP as the explanatory variables. The regression equation is as follows (t-values in parentheses)

$$\underset{}{Y} = \underset{(-0.92)}{-0.012} + \underset{(0.91)}{3.800 \times 10^{-7}}\, GDP + \underset{(2.36)}{0.067} FOREST$$

We found that forest area was statistically significant at the 5% level but the per capita GDP was not significant even at the 10% level with the adjusted $R^2 = 0.37$.

The lack of a statistically significant relationship between forest area and per capita GDP in our results might be explained by the small sample size and the fact that the forest area of a country is dependant on various other factors. In addition, the historical background of the use of the forests may also have been one of the factors for the above finding. On the other hand, we found that there was a statistically significant relationship between the proportion of hunters across countries and forest area. This finding supports our inference that the population size of the wild animals and hunters in a region is directly proportion to the forest area in the region.

Countries located at a high latitudes have larger forest areas. The correlation analysis shows that this hypothesis is statistically significant at the 10% level ($r = 0.54$, $n = 12$, two-tailed test). From the above-mentioned results, we can infer that as the latitude of a country increases, the forest area also increases, resulting in higher game animal populations and a higher proportion of hunters in the country as compared to other countries. However, as stated above, we could not detect any significant relationship between per capita GDP and forest area from our data.

## 5 CONCLUSIONS

It is well known that as the economy of a country develops, the proportion of its primary industries declines while those of its secondary and tertiary industries increase. This paper focuses on hunting, which is a primary industry, and empirically examines whether Petty-Clark's law holds in case of hunting in European countries. The results reveal that the proportion of hunters across countries increases when the per capita GDP is between 5,000 and 15,000 USD. Once the per capita GDP crosses the 15,000 USD mark, two major trends are detected: the number of hunters continues to increase in some countries but decreases in some other countries. Finally, the number of hunters in a country stabilizes when its per capita GDP reaches around 25,000 to 30,000 USD. However, the proportion of hunters in the population may differ across countries in which the number of hunters has stabilized, as illustrated in Fig. 2. In the northern and eastern European countries, as an overall trend, the proportion of hunters across countries stabilizes at high GDP levels. In the middle, southern, and western European countries, the proportion of hunters across countries stabilizes at low GDP levels.

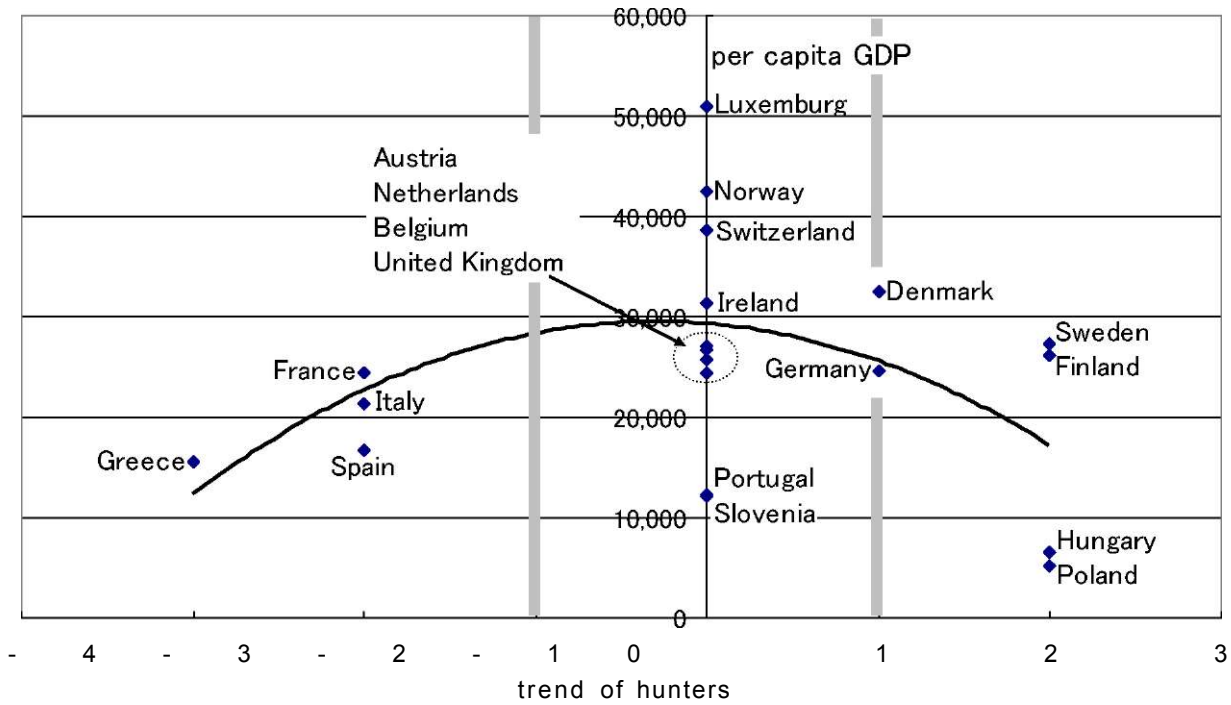


**Fig. 1.** Relationship between GDP and hunting trends

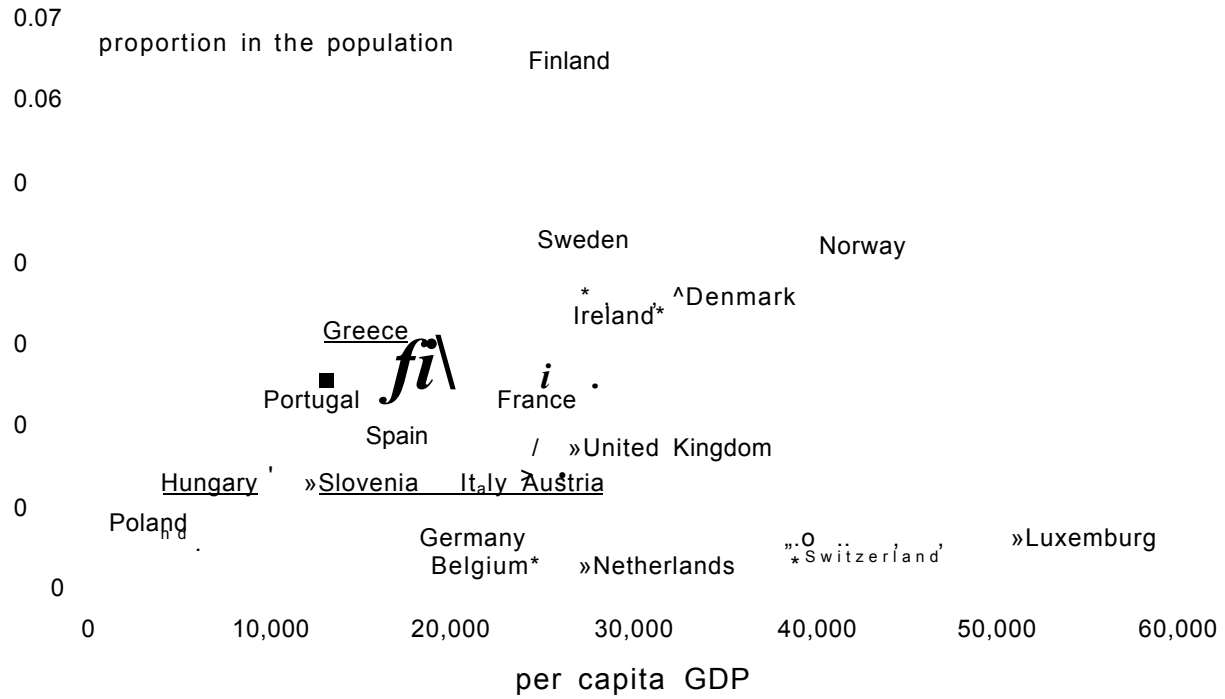


**Fig. 2.** Relationship between GDP and hunters

The reason for these results is that apart from being part of the primary industry of an economy, hunting also involves the aspect of leisure. Hunting as a leisure activity is more frequently observed in the following areas: areas where large-sized game animals are present, areas where the population sizes are large, and areas where the climate is sufficient cool to allow for relatively easy and hygienic treatment of carcasses. Our data show that the proportion of hunters is higher in the areas satisfying the above conditions.

It is natural that hunting activities decline in proportion to the development of industries. However, if the population of ungulates drastically increases in an area where hunting has declined, there is a significant possibility that the increase will lead to serious damage of the regional vegetation and/or agriculture, which would pose a substantive problem to the human population. Our results imply that the proportion of hunters in a country begins to stabilize when the per capita GDP reaches 25,000-35,000 USD.

An issue that has not been examined in this paper is whether—in countries where the proportion of hunters has stabilized at these per capita levels—the proportion of hunters is sufficient to manage the ungulate population and prevent damage to regional vegetation and/or agriculture. In addition, in the presence of strong movements against hunting activities, the number of hunters will decrease and stabilize at a low level, which may worsen the condition of the ungulates and their habitat. Future studies on these issues are required to understand them better.

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