

# Regional Inequality of Gross Domestic Product in Greece: 1970-1998

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## 1. Introduction

During the period 1970-1998, various important events marked the economic life of Greece. In the meantime, several economic policy measures were taken and applied to improve the Greek economy. The application of these measures – combined with the current developments – affected the GDP distribution as a total and by production sectors (primary, secondary and tertiary).

The main purpose of this study was to measure and analyze the inequality of GDP regional distribution at a prefecture level during the period 1970-1998. Accordingly, the study was divided into two parts. In the first part, we examined the trend of the total GDP distribution inequality at a prefecture level. In the second part, we analyzed the regional (prefecture level) inequality of GDP distribution by production sectors and examined how each production sector contributed to the total GDP inequality.

## 2. Inequality Indices

In order to measure the inequality of the GDP regional distribution at a prefecture level, we used three inequality indices: Gini coefficient, Atkinson index and Theil index. We chose these three indices for two basic reasons. Firstly, because they are very popular measurements of inequality and therefore, they are the most used indices in the literature. Secondly, because they meet the three basic properties that one would like an inequality index to satisfy:

(1) Mean or scale independence. That is, the index remains invariant if everyone's income (GDP in the present case) is changed by the same proportion.

(2) Population size independence. That is, the index remains invariant if the population at each income (GDP) level is changed by the same proportion.

## Abstract

The main purpose of this paper was to measure and analyze the inequality of GDP regional distribution at a prefecture level for the period 1970-1998. To this end, we used three inequality measurements: Gini coefficient, Atkinson index and Theil index. Furthermore, by analyzing the extended Gini coefficient in its basic components, we examined how the three basic production sectors contributed to the formation of the inequality level.

## Résumé

*L'objectif de ce travail est de mesurer et d'analyser l'inégalité de la distribution du PIB à l'échelle d'une préfecture dans la période 1970-1998. A cet effet, nous avons utilisé trois mesures de l'inégalité : le coefficient de Gini, l'indice d'Atkinson et l'indice de Theil. En plus, en examinant le coefficient de Gini dans ses composantes fondamentales, nous avons évalué dans quelle mesure les trois secteurs de production de base contribuent à la formation du niveau d'inégalité.*

(3) The Pigou-Dalton condition. That is, any transfer from a richer to a poorer person of the population, that does not reverse their relative ranks, reduces the value of the index. (In the present case, any GDP transfer from a "rich" prefecture to a "poorer" one).

The (standard) Gini coefficient can be computed (by) using the formula (1) (Lerman and Yitzhaki

(1984, 1985), Garner (1993), Lazaridis (2000)):

$$G_0 = \frac{2Cov[y_0, F(y_0)]}{\mu} \quad 0 \leq G_0 \leq 1 \quad (1)$$

where  $G_0$  represents the Gini coefficient,  $y_0$  the GDP per prefecture,  $F(y_0)$  the cumulative distribution of GDP and  $\mu$  the GDP arithmetic mean.

The Atkinson index is computed by the formula (2) (Atkinson (1970), Barrett et al. (2000)):

$$I_{(y)}^\alpha = 1 - \frac{1}{\mu} \left[ \frac{1}{n} \sum_{i=1}^n y_i^{1-\alpha} \right]^{\frac{1}{1-\alpha}}, \quad \alpha \geq 0, \alpha \neq 1 \quad (2)$$

For  $\alpha=1$ , the Atkinson index is computed by the formula (3):

$$I_{(y)} = 1 - \prod_{i=1}^n \left( \frac{y_i}{\mu} \right)^{\frac{1}{n}} \quad (3)$$

where, in both formulas  $0 \leq I^\alpha(y) \leq 1$ ,  $I^\alpha(y)$  represents the Atkinson index,  $y_i$  the GDP per prefecture,  $\mu$  the GDP arithmetic mean,  $n$  the number of the prefectures and  $\alpha$  is the "inequality aversion" parameter with larger values of  $\alpha$  corresponding to greater inequality aversion. Finally, the Theil index is defined as (Deaton (1997)):

$$T = \frac{1}{n} - \sum_{i=1}^n \frac{y_i}{\mu} \log \frac{y_i}{\mu} \quad 0 \leq T \leq 1 \quad (4)$$

where,  $T$  represents the Theil index,  $y_i$  the GDP per pre-

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fecture,  $\mu$  the GDP arithmetic mean and  $n$  the number of the prefectures.

### 3. Inequality of GDP regional distribution

In view of examining the trend of GDP distribution inequality at a prefecture level, we used the Regional Accounts data for the period 1970-1994 (million drachmas, current rates), such as data from the Tables of Production Gross Value for the period 1995-1998 (million drachmas, current rates), that are available at the National Statistical Service of Greece. The total number of prefectures in Greece is 51.

Applying the formulas (1), (2), (3) and (4) we calculated the values of the three inequality indices: Gini, Atkinson (for  $\alpha=0.5$ ,  $\alpha=1$  and  $\alpha=2$ ) and Theil. Their values are given in Table 1. Table 1 indicates that the Gini coefficient of the country total GDP ranges between 0,570 (1971) and 0,637 (1976-77). The values of the Atkinson index range between 0,310 (1971) and 0,385 (1976) for  $\alpha=0.5$ , between 0,453 (1971) and 0,537 (1976) for  $\alpha=1$  and between 0,608 (1971) and 0,680 (1976) for  $\alpha=2$ . The Theil index ranges between 0,397 (1971) and 0,510 (1970).

We investigated the inequality trends as determined by the results of our calculations of the three indices and compared these trends as illustrated by Figure 1.

Figure 1 illustrates the values trend for each index over the period 1970-1998. Based on these results, we ascertained that the three indices displayed a similar inequality trend. Generally, we observed that inequality during the first 12 years of the period examined did not follow a systematic trend. Since the early eighties, a continuous increase in inequality has been observed, with slight fluctuations. The result is a significant increase in GDP unequal distribution over 14 years (1983-1996).

In order to confirm the statistical tendency to the increase in GDP distribution inequality from the early eighties on, we estimated, through the simple regression method, the linear trend of the values for each index used.

Table 1. *Inequality indices of GDP distribution*

Year	Gini ( $G_j$ )	Atkinson ( $I_j$ )			Theil ( $T$ )
		$\alpha = 0,5$	$\alpha = 1$	$\alpha = 2$	
1970	0,632	0,379	0,527	0,664	0,510
1971	0,570	0,310	0,453	0,608	0,396
1972	0,590	0,330	0,477	0,627	0,428
1973	0,605	0,344	0,494	0,644	0,447
1974	0,636	0,378	0,531	0,674	0,502
1975	0,637	0,380	0,534	0,676	0,506
1976	0,637	0,385	0,537	0,680	0,487
1977	0,637	0,380	0,534	0,678	0,506
1978	0,631	0,374	0,528	0,674	0,495
1979	0,633	0,375	0,530	0,676	0,498
1980	0,622	0,360	0,517	0,673	0,469
1981	0,598	0,336	0,487	0,642	0,432
1982	0,598	0,335	0,486	0,639	0,432
1983	0,610	0,346	0,498	0,647	0,449
1984	0,604	0,342	0,493	0,644	0,443
1985	0,604	0,339	0,494	0,651	0,434
1986	0,602	0,340	0,492	0,646	0,438
1987	0,606	0,343	0,496	0,650	0,442
1988	0,604	0,341	0,493	0,649	0,438
1989	0,612	0,347	0,504	0,662	0,445
1990	0,614	0,350	0,506	0,663	0,449
1991	0,610	0,345	0,502	0,662	0,441
1992	0,616	0,353	0,512	0,671	0,454
1993	0,621	0,359	0,517	0,675	0,463
1994	0,619	0,356	0,515	0,676	0,457
1995	0,631	0,366	0,523	0,672	0,474
1996	0,629	0,362	0,520	0,670	0,463
1997	0,617	0,352	0,503	0,642	0,452
1998	0,619	0,354	0,506	0,645	0,456

Table 2 includes the regression results for each index. These results prove the inequality augmentative tendency provided that  $b$  is statistically important for all three indices.

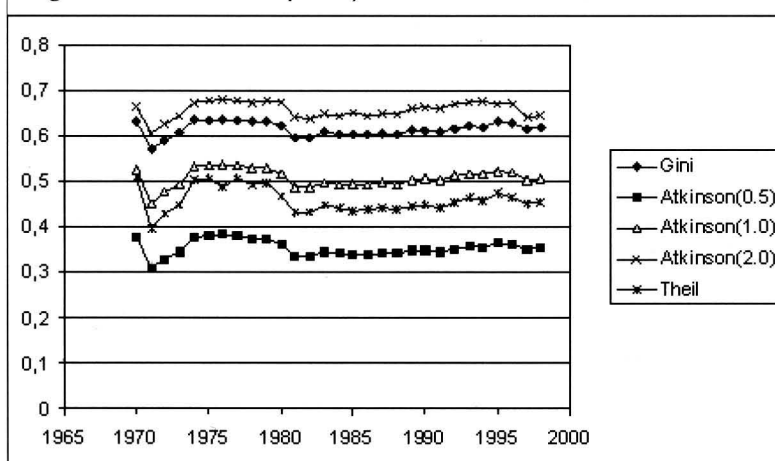
### 4. Decomposition of inequality by production sector

The country total GDP can be analyzed by sectors of production. The production sectors are three: the primary, the secondary and the tertiary, with the tertiary sector providing today 70% of the total GDP.

To examine how each production sector contributes to the inequality of the total GDP distribution, we analyzed the (extended) Gini coefficient, which, according to the covariance properties can be decomposed as follows (Lerman and Yitzhaki (1984), Yitzhaki (1990)):

$$G_0 = \frac{2Cov[y_k, F(y_0)]}{\mu} = \sum_{k=1}^K R_k S_k G_k \quad (5)$$

Fig. 1 *Indices of inequality*



Index	a	b	r <sup>2</sup>
Gini	1748,56 (44,97)	393,05 (6,20)	0,762
Atkinson (α=0,5)	1842,30 (74,72)	421,48 (5,97)	0,748
Atkinson (α=1)	1814,27 (82,31)	347,26 (7,95)	0,841
Atkinson (α=2)	1771,40 (67,21)	330,48 (8,28)	0,851
Theil	1862,28 (63,13)	283,08 (4,31)	0,608

The value of t statistic is given in brackets

where,  $S_k$  represents the GDP share of sector k as against the total GDP, that is:

$$S_k = \frac{\bar{y}_k}{\bar{y}_0} \tag{6}$$

$R_k$  represents the relative correlation between  $y_k$  (GDP of sector k) and  $y_0$  (total GDP), that is:

$$R_k = \frac{Cov[y_k, F(y_0)]}{Cov[y_k, F(y_k)]} \tag{7}$$

and  $G_k$  is the Gini coefficient for (the) sector k, that is:

$$G_k = \frac{2Cov[y_k, F(y_k)]}{\mu_k} \tag{8}$$

Furthermore, by assuming one percentage change e in the GDP of each prefecture for each production sector, due to an external factor, the sector's marginal effect relative to the (overall) Gini coefficient can be expressed as:

$$\frac{\partial G_0 / \partial e}{G_0} = \frac{R_k S_k G_k}{G_0} - S_k \tag{9}$$

## 5. Results

The results concerning the Gini inequality measure for each sector as well as the impact of a marginal change in the GDP of each sector, for the period 1970-1998, are given in Tab. 3. Furthermore, Fig. 2 describes the trends of the overall Gini coefficient values and of the Gini's coefficient values for each production sector.

According to our results, the sector that displays the highest inequality level is the tertiary sector (the Gini coefficient ranges between 0,648 (1997-98) and 0,753 (1974)). The secondary sector follows (with the Gini coefficient ranging between 0,498 (1971) and 0,715 (1974)), and finally, the primary sector exhibits the lowest inequality level (the Gini coefficient ranges between 0,342 (1998) and 0,441 (1994)).

All three sectors present a high relative correlation coefficient  $R_k$  with the total GDP (columns 3, 7, 11 of Table 3). The tertiary sector contributed most to the total inequality ( $S_k$ ) with a percentage of 70% (1998), the secondary sector follows with 23% (1998) and finally, the primary sector gives the lowest contribution of 4% (1998).

Furthermore, columns 5, 9, and 13 of Tab. 3, that include the marginal effect ( $I_k - S_k$ ) of each sector on the total inequality, suggest that the primary sector has a negative marginal effect, while the secondary and the tertiary sectors have a positive marginal effect. Consequently, if the GDP of the primary sector increases – provided that the GDP of the two other sectors remains unchanged – the total inequality will decrease. Conversely, if the GDP of the secondary or the tertiary sector increases – provided that the GDP of the two other sectors remains unchanged – the total GDP distribution inequality will increase.

## 6. Concluding remarks

Based on the results of this study, we may conclude that the inequality of the total GDP regional distribution has significantly increased, especially since the beginning of the '80s. Moreover, the trend of the unequal distribution of the secondary sector is also on the increase, while in the tertiary sector, inequality decreases. The inequality trend of the primary sector has continuously increased, with slight fluctuations, from the early eighties until 1994, whilst a significant decrease has been recorded in the last four years of the period examined. We ascertained that the accession of Greece to the European Union was characterized by an important increase in GDP, and at the same time by a more unequal distribution of GDP at a regional level, even though many of the financial inflows from the EU were aimed at decreasing regional inequality.

Fig. 2 Gini Coefficients

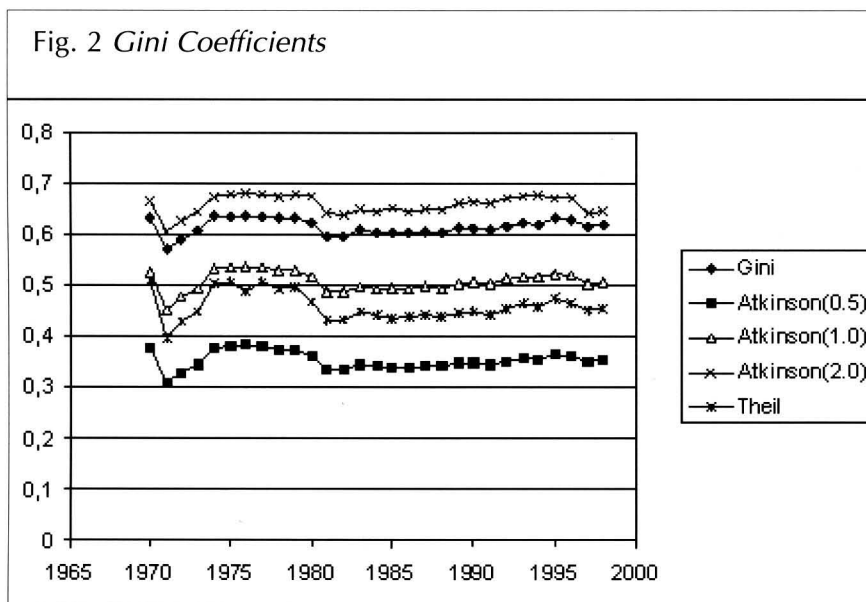


Table 3. *Inequality of regional distribution by sector*

Year	Primary Sector				Secondary Sector				Tertiary Sector				Total
	$G_k$	$R_k$	$S_k$	$I_k-S_k$	$G_k$	$R_k$	$S_k$	$I_k-S_k$	$G_k$	$R_k$	$S_k$	$I_k-S_k$	
1970	0,360	0,917	0,188	-0,090	0,701	0,986	0,322	0,031	0,717	0,988	0,490	0,059	0,632
1971	0,360	0,954	0,186	-0,075	0,498	0,987	0,328	-0,045	0,721	0,986	0,486	0,120	0,570
1972	0,361	0,938	0,192	-0,082	0,562	0,986	0,330	-0,020	0,725	0,987	0,478	0,102	0,590
1973	0,363	0,927	0,210	-0,093	0,628	0,984	0,338	0,008	0,728	0,987	0,452	0,085	0,605
1974	0,367	0,906	0,204	-0,097	0,713	0,977	0,313	0,030	0,733	0,988	0,483	0,067	0,636
1975	0,370	0,897	0,193	-0,092	0,710	0,979	0,309	0,028	0,728	0,989	0,498	0,065	0,637
1976	0,374	0,895	0,192	-0,091	0,706	0,980	0,313	0,028	0,723	0,989	0,495	0,063	0,637
1977	0,378	0,882	0,172	-0,082	0,697	0,983	0,320	0,024	0,718	0,989	0,508	0,058	0,637
1978	0,384	0,886	0,179	-0,083	0,691	0,983	0,315	0,024	0,713	0,988	0,506	0,059	0,631
1979	0,389	0,873	0,163	-0,076	0,686	0,985	0,331	0,022	0,709	0,988	0,506	0,053	0,633
1980	0,375	0,888	0,182	-0,084	0,672	0,979	0,319	0,019	0,712	0,988	0,499	0,066	0,622
1981	0,367	0,846	0,183	-0,088	0,655	0,975	0,315	0,021	0,686	0,988	0,502	0,067	0,598
1982	0,345	0,890	0,189	-0,092	0,660	0,976	0,298	0,023	0,685	0,990	0,513	0,069	0,598
1983	0,391	0,859	0,175	-0,079	0,654	0,972	0,306	0,013	0,693	0,990	0,519	0,065	0,610
1984	0,378	0,858	0,181	-0,084	0,665	0,974	0,301	0,022	0,687	0,984	0,518	0,062	0,604
1985	0,400	0,812	0,178	-0,082	0,669	0,970	0,301	0,022	0,685	0,983	0,521	0,060	0,604
1986	0,358	0,819	0,166	-0,085	0,666	0,972	0,307	0,023	0,683	0,986	0,527	0,062	0,602
1987	0,362	0,822	0,162	-0,082	0,669	0,971	0,294	0,021	0,684	0,986	0,544	0,061	0,606
1988	0,369	0,838	0,168	-0,082	0,666	0,971	0,290	0,020	0,683	0,986	0,542	0,062	0,604
1989	0,406	0,851	0,168	-0,073	0,675	0,965	0,286	0,019	0,683	0,985	0,546	0,054	0,612
1990	0,409	0,833	0,150	-0,066	0,669	0,964	0,286	0,014	0,680	0,986	0,564	0,052	0,614
1991	0,416	0,850	0,169	-0,071	0,670	0,966	0,274	0,017	0,679	0,986	0,557	0,054	0,610
1992	0,426	0,842	0,152	-0,063	0,674	0,961	0,268	0,014	0,679	0,985	0,580	0,050	0,616
1993	0,433	0,838	0,141	-0,059	0,677	0,964	0,264	0,014	0,678	0,985	0,595	0,045	0,621
1994	0,441	0,844	0,153	-0,061	0,679	0,960	0,255	0,014	0,678	0,985	0,592	0,047	0,619
1995	0,377	0,837	0,099	-0,049	0,703	0,963	0,224	0,016	0,669	0,989	0,677	0,033	0,631
1996	0,371	0,844	0,091	-0,046	0,701	0,961	0,223	0,016	0,662	0,991	0,686	0,030	0,629
1997	0,347	0,780	0,085	-0,048	0,697	0,953	0,210	0,016	0,648	0,996	0,705	0,032	0,617
1998	0,342	0,770	0,082	-0,047	0,702	0,950	0,216	0,017	0,648	0,996	0,702	0,030	0,619

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