Bioeconomy and growth in the Balearic Islands (Spain)

Draft

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ABSTRACT
This work is an advanced research whose main objective is to offer a different view of the economic evolution of a tourist province in Spain which has become a leading region in mass tourism: the Balearic Islands. Biophysical data are provided, which complement and even question conventional macroeconomic variables. In this same line of research and through an ecological perspective, the author relates the field of economics with environment. In fact, indicators such as water consumption, the emission of solid urban waste, pollution among others, are directly related to up to ten biophysical and social indicators. These magnitudes help to point out and to warn that, in a context of climate change, measuring the economy in a different way is necessary. The case of the economy of the Balearic Islands is an excellent laboratory on this subject.

KEYWORDS

Bioeconomy, Balearic Islands, thermodynamics, economic growth, ecological economics, consumption of natural resources, tourism.

1. Introduction

The Balearic Islands, in the Mediterranean Sea, Spain: more than sixteen million tourists a year; just over a million inhabitants; the most dynamic labour market in the autonomous communities of Spain (although with precarious occupations); businesses focused on the service sector; ecological saturation and excessive consumption of territory; world leadership in the transnationalisation of investments. This could be a tight synthesis of the contradictions and inconsistencies of the economic growth in the Balearic Islands since the "tourist boom" of 1970s (Balaguer-Cantavella, 2002; Manera, 2014). This economic expansion, however, is a double-edged sword. On the one hand, in a macroeconomic context, many companies specializing in tourism have been evolving up to the point that some of them have expanded their investment strategies into international markets (Apostolopoulos-Loukissas-Leontidou, 2001; Manera-Garau, 2005). On the other hand, the great growth in tourism has caused serious consequences on the insular natural capital, which represents the main asset of the Balearic Islands: environmental externalities are detected in the form of (i) excessive consumption of territory, (ii) water resources, (iii) energy resources and (iv) the creation of urban solid waste. Moreover, these factors are causing demographic implosion (Murray, 2002, 2012, 2013).

Connecting economics with the field of natural sciences is a major challenge for social scientists (Vera-Ivars, 2003). In this sense, linking biology and thermodynamics with economics, and qualifying the excess of mathematical formalism and emphasizing factors of a qualitative nature is a difficult task to carry out (Pearce, 1989; Poon, 1993; Shaw-Williams, 1994; Sindinga, 1999). In the case of the Balearic Islands, the results of various research approaches have been mainly cultivated in the academic sphere. However, in some cases, ideas and reflections have been also transferred to active politics (Alegre-Pou, 2002, 2003; Garau, 2010; Murray, 2013). The aspects that have been under analysis can be grouped into two blocks: the first one affects environmental economics; and the second one is related to ecological economics. Concerning the former block, the applied instruments are neoclassical, that is, they are oriented to aspects such as paying a fee in order to protect and preserve both natural and landscape resources and also to give and determine approximations of their economic value. Regarding the latter block, a nonchrematistic approach with biophysical data (territorial consumption, waste production, pollution, etc.) and without direct translation to prices has been used. At this point, the distinction between price and value is very significant, since indicators like the ecological footprint have become very present in the field of social sciences of the Balearic Islands. These investigations have been barely present in public policies. For this very reason, more and more specific biophysical variables are needed to facilitate decision-making pathways (O'Really, 1986; Mullins, 1991; Mowforth-Munt, 1998). If this were carried out, it would cross the boundaries between investigation and its application in politics. In short, the rise to political economy (Wilkinson, 1989; Twining Ward-Butler, 2002).

The preparation of indicators reacts to this holistic challenge. In this way, the integration of the laws of thermodynamics into economic theory, proposed in 1974 by the Romanian economist Nicholas Georgescu-Roegen, which implies a process towards a consilience between biology, physics and chemistry, is very important to be considered in order to have a better knowledge of the economic process. (Georgescu-Roegen, 1996). Based on the conclusion that economic growth causes disorder in all areas and, obviously, in the environmental environment, Georgescu-Roegen defends extending the range and scope in the analysis of economic processes, including methods and theories from natural sciences (Gormsen, 1997; Agarwal-Ball-Shaw-Williams, 2000; Gössling-Hanssonb-Hörstmeierc-Sagge, 2002; Hall, 2006; Ateljevic-Pritchard-Morgan, 2007). The change is substantial. But it contributes to enrich, technically and conceptually, the analysis of the economy (Crick, 1989; Clancy, 1998). This change moves away from a mechanistic phase, that is, a closed circular flow, to a holistic one, in which the economist and the scientist come into terms and are required to dialogue with other disciplines in order to understand much better what happens in their own (Britton, 1991; Williams-Shaw, 1999). The temporal vector and the mobility of factors are basic characteristics, which provide a depth and greater rigour to the investigation and analysis.

This article will present the first results of a study case that is being developed in a competitive investigation in the Balearic Islands. First, based on the previous ideas, we will present ten indicators that we have selected in order to measure the economy in a different way, as well as the methodology that has been applied together with the descriptive comments according to the results. Finally, some provisional conclusions and a future forecast of the investigation will be offered.

2. Ten indicators: measuring the economy differently

Ten important indicators have been processed for the period 2000-2015. The series is brief, but it embraces a period of economic expansion followed by the outbreak of the Great Recession in 2007-2008:

1. Water consumption (in cubic hectometres),
2. Energy consumption (in equivalent tons of oil),
3. Production of urban solid waste (RSU, in tons),
4. CO2 emissions (in kilotons),
5. Gini Index,
6. GDP deflated at 2010 values,
7. GDP per capita deflated to values of 2010,
8. Wages,
9. Price of work and labour cost,
10. Demographic evolution.

An essential outcome is revealing in the evolution of these data: two clear stages are detected in the period analysed (2000-2015). A first one that ranges the period from 2000 to 2007, and a second one that starts from the Great Recession and ends up in 2015. This distinction, although simple and expected, is important because it entails not only different behaviours in some variables, but also different readings of the impact of growth on biophysical constants. One conclusion arises: economic growth causes disorder—situations, therefore, entropic from the environmental point of view—; but such an affirmation, which may seem obvious, hides at the same time different characteristics depending on the analysed specific stage.

The ten variables–and their reciprocal relation–are characterised, always taking into account demographic evolution, by the following:

- They do not present unachievable methodological difficulties for data collection and subsequent calculation, so that they can be perfectly assumed as panel discussion by policy makers;
- Chrematistic variables (GDP, GDP per capita) are intermingled with biophysical ones (production of RSU, energy and water consumption), illustrative of the externalities that growth causes;
- They do not put aside the social aspect of the process of growth since they incorporate data on inequality (Gini index) and consumption capacities (through wage indicators);
- They help identify the ecological externalities of economic growth;
- They provide a different reading of the growth process since they specify and systematize dispersed variables that do not usually appear in the regular diagnoses of public administrations.

One is aware that other variables can be incorporated into this exercise; what is required, though, is that they fulfil at least minimum five characteristics which have been specified above.

Figures and graphics highlight the following:

1. The deflating GDP at 2010 values increases by 18 percent; on the contrary, GDP per capita is reduced by 15 points (it goes from an index of 100 to 85). This occurs due to a very relevant growth of the population, 39 percent. Hence, the Balearic Islands, continue to have the so-called demographic "effect call" that increases the production of wealth and vice versa. Nevertheless, this is clearly insufficient to recover the per capita income, in constant values.

2. The biophysical data have some behaviours that, in some cases, surprise. The consumption of water and energy have increased by 9 percent and 6 percent respectively; while the production of RSU has risen by 14 percent, and the CO2 emissions have been reduced 7 points. Here is an apparent dysfunction:

    - The generation of RSU has a greater and closer connection with the GDP. In fact, the correlation between both variables reaches 75 percent, and in the case of the GDP per capita (at constant values) is non-existent (it even has negative value, -0.13 percent). The connection between RSU and population is not high (39 percent), suggesting that the correlation between both variables does not consider the total population (that is, the residents plus the floating population). It is logical that more population supposes more production of RSU; hence, incorporating the tourists would increase the degree of integration between the two figures (RSU and total population).
    - Energy consumption shows a clear growth between 2000 and 2008, while it decreases from 2009 to 2015. The correlation with CO2 emissions is high (77 percent) and weaker but still significant with the production of RSU (67 percent). Similarly, the comparison between energy consumption and the constant GDP represents 71 percent. The explanation is plausible: The Balearic Islands, between 2000 and 2008, grew economically (between 1 and 4.4 percent), and witnessed negative rates between 2009 and 2013 (from -0.30 to -4 percent), to

return to increase in 2014. The economy remained steady until 2016, with positive rates in GDP. This growth profile is directly related to natural and energy resources: CO_2 emissions increased until 2008 and shrank from 2009. The same is identified, although more attenuated, with the RSU. This helps to explain:

–That the energy intensity of the economy increased a lot from 2000 to 2005, but it declined due to the impact of the crisis;

–That CO_2 emissions grew until 2005 and began a process of contraction that lasted until 2013. A new growth is observed between 2014 and 2015, parallel to the recovery of the Balearic macroeconomy;

–The intensity of RSU on constant GDP grew until 2004 and fell sharply from 2005 to 2010. It is evident then a new growth until 2015;

–The energy consumption per inhabitant was stable until 2008 and decreased from that year on.

• Water consumption is very regular, and its correlation with energy consumption is significant (66 percent), as well as with CO_2 emissions (52 percent) and MSW production (53 percent). The correlation of these indicators seems obvious: economic growth drives consumption of resources (water, energy) and generates waste, thus, the correlation coefficients are higher than 50 percent among all these variables.

• Inequality, measured with the Gini index, has increased since 2008 (with a coefficient of 27,4, after being reduced two points since 2004). The index stabilized in 2016 with a coefficient of 31,7 points. Correlations with energy consumption, the production of RSU and CO_2 emissions are relevant, over 50 percent, which implies that the increase of these variables do not contribute to an effective reduction of inequality.

It is important to bear in mind that the GDP growth (-14 percent between 2000 and 2015) is above the growth rates of the biophysical indicators presented, with the sole exception of the production of RSU.

The calculations of the linear regression between the four biophysical indicators and the deflated GDP per capita contribute new considerations which complement the previous ones:

• Between the period 2000-2007, the slopes of the linear regression are negative, as are the correlation coefficients. The lines are positive in all cases between the year of 2008 and 2015, with the only exception of water consumption in relation to the deflated GDP per capita, which remains stable.

• Between 2000 and 2007, the growth of the deflated GDP per capita provoked contractions in the consumption of energy, water, CO_2 emissions and in the production of RSU. These data would suggest two aspects: on the one hand, the improvement in technological efficiency; on the other, the change in consumption patterns. However, the index of energy consumption exceeds that of the total deflated GDP: this can be seen between 2000 and 2011. One might observe that economic growth is lower, compared to energy consumption. The verification of this is more evident between 2001 and 2006, a phase characterised by a strong economic expansion, which needs however, greater expansions of the energy consumed (the rates are higher than those of GDP, as detailed in table 8). The Great Recession means the fall of the GDP, which, since 2012 is higher than the energy consumption. In terms of CO_2 emissions and the production of RSU, their curves are above the GDP curve between the period of 2000 and 2005. From 2006, the RSU indicator is below the evolution of GDP. This does not happen with the emissions, whose evolution exceeds that of GDP. The Great Recession infers, also here, changes: the emissions are contracted while the production of RSU increases.

• From the Great Recession, the regression slopes turned positive: the upward or downward variations in the deflated GDP per capita imply similar movements in the biophysical indicators -with the exception, as has already been said, of water consumption. This suggests that during the severe economic crisis, and after significant declines in GDP, the capacity for economic growth is more directly related to the fundamental consumption of energy vectors.

In short, between 2000 and 2007, the evolution of biophysical indicators exceeds that of GDP, which suggests that the economic growth of the Balearic Islands requires a high consumption of energy, water and CO2 emissions. In fact, the reduction in GDP implies the contraction of these variables. Some specifications should be noted:

• From the Great Recession, the energy consumption per capita is retracted, as well as the production of RSU but unlike the former, it does it slightly. CO2 emissions per inhabitant fall from 2004-2005 until 2013. That would suggest, as noted above, that the incorporation of the population to this model causes that population either controls its consumption more efficiently or, perhaps, there has been improvements in technological efficiency.

• This last aspect is marked with the calculated intensities. The energy intensity of the economy falls since 2005, after an expansive period between 2000 and 2005. The reduction is evident until 2015. In relation to the RSU, the intensity trend tends to be low throughout the period: the collapse is more evident between 2000 and 2010, while the intensity expands from 2011, specifically when there is a clear growth in GDP.

• The average growth rate of water consumption, energy, CO2 emissions and RSU production remains at positive levels—although oscillating—between 2000 and 2007. The Great Recession provokes negative rates that change their trend until 2014 with the recovery of the economy.

3. Final thoughts

The changes that are experiencing the tertiary economies in the process of economic globalisation are very fast (Farrell-Twining-Ward, 2004; Podhorodecka, 2018). At this point, there exist some challenges that affect the Balearic economy. The dynamic competitiveness of productive systems consists not only in the ability to adapt to changes but also to do it as quick as possible (Morley, 1992; Papatheodorou-Song, 2005; Maroto-Cuadrado, 2009; Rodrik, 2015). Indeed, the speed with which local actors process and execute information, which can be enhanced through cooperation between the different productive units, is crucial. The agility with which this information is systematised is related, among other factors, to three essential ideas. Firstly, the productive resources of the companies, according to their critical mass or size (tangible plus intangible). Secondly, both human capital and the implementation of regional and local innovation systems could favour new possibilities that would have more efficient productive combinations in order to respond to changes that are in demand. Finally, the active role that the public sector would have to assume in order to develop synergies with the private capital, which until very recently, has been prone to investments (Segreto-Manera-Pohl, 2009). These are indeed difficult challenges, but they are considered by all the regional mature economies. Tourism as a system is consolidated itself as an integral system for the economy in general (Turner-Ash, 1991; Manera-Navinés, 2018). In this sense, working on alternative indicators, which take into account the negative externalities of this integral system, will be a determining factor in improving the adoption of public policies. This has been the central objective of this article, which means the basis for future research with a clear horizon: to create a synthetic indicator of environmental sustainability, which will help to better understand the ecological impacts of tourism activity.

Table 1. Basic biophysical indicators of the Balearic economy

ars	Gini Index	Consumption Water Cubics Hect.	Energy consumption Equiv.tones of oil	CO2 Emissions KT	Urban Solid Waste Tones	Nominal GDP €
000		89	2.551.745	8.994	677.834	16.492.806
001		95	2.660.509	9.284	709.421	17.789.707
002		98	2.639.664	9.505	716.262	18.780.108
003		99	2.789.619	10.779	707.067	19.692.948
004	29	98	2.871.532	10.401	744.971	20.983.851
005	30	99	3.023.086	10.513	717.797	22.602.678
006	28	101	3.106.753	10.724	748.735	24.429.529
007	30	100	3.135.572	10.773	776.387	26.144.862
008	27	96	3.078.856	10.897	778.760	27.193.863
009	32	98	2.951.670	10.565	744.750	26.153.141
010	33	96	2.919.635	10.516	713.393	26.194.558
011	34	98	2.833.539	10.040	725.839	26.030.098
012	33	97	2.742.233	9.515	705.206	25.646.507
013	32	95	2.675.049	8.577	701.894	25.507.987
014	33	96	2.769.375	8.187	726.820	26.262.492
015	33	97	2.711.007	8.402	772.497	27.228.681
016	32					28.460.988

ars	GDP/Cap. €	Population	GDP Index Volum	GDP per capita deflated € constants 2010	Wages Index	Price of work Index	Laboral cost €
000	20.030	823.400	89	28.163			
001	21.256	836.900	91	28.326			19.855
002	21.684	866.100	91	27.486			20.716
003	21.914	898.600	92	26.778			21.904
004	22.710	924.000	94	26.514			23.254
005	23.677	954.600	97	26.531			24.322
006	24.746	987.200	100	26.455			25.161
007	25.502	1.025.200	103	26.356			26.149
008	25.717	1.057.400	105	25.893		100	28.013
009	24.260	1.078.100	100	24.387	98	102	29.069
010	24.084	1.087.600	100	24.084	99	102	29.109
011	23.762	1.095.500	100	23.850	101	98	29.302
012	23.224	1.104.300	98	23.282	100	100	28.615
013	22.924	1.112.700	96	22.675	101	99	28.359
014	23.439	1.120.500	99	23.074	102	103	28.754
015	24.102	1.129.700	101	23.409	102		28.994
016	24.870	1.144.400	105	23.978	104		

SOURCE: personal development. All sources are of public access. Gini Index: IBESTAT (Balearic Institute of Statistics); water consumption: Regional Minister of Environment, Agriculture and Fisheries; energy consumption and CO2 emissions: Regional Minister of Territory, Energy and Mobility; USW: Island Councils; GDP, GDP per capita and labor price: INE (National Institute of Spanish Statistics; labour cost: IBESTAT.

Table 2. Reduction of indicators to index numbers

Years	Consumption Water	Energy consumption	CO2 Emissions	Urban Solid Waste	Nominal GDP k€	GDP/Cap. €	Population	GDP Index Volum	GDP per capita deflated
2000	100	100	100	100	100	100	100	100	100
2001	106	104	103	105	108	106	102	102	101
2002	110	103	106	106	114	108	105	103	98
2003	111	109	120	104	119	109	109	104	95
2004	110	113	116	110	127	113	112	106	94
2005	111	118	117	106	137	118	116	109	94
2006	114	122	119	110	148	124	120	113	94
2007	113	123	120	115	159	127	125	117	94
2008	107	121	121	115	165	128	128	118	92
2009	110	116	117	110	159	121	131	113	87
2010	107	114	117	105	159	120	132	113	86
2011	110	111	112	107	158	119	133	113	85
2012	109	107	106	104	156	116	134	111	83
2013	107	105	95	104	155	114	135	109	81
2014	108	109	91	107	159	117	136	111	82
2015	109	106	93	114	165	120	137	114	83
2016					173	124	139	118	85

SOURCE: See table 1.

Table 3. Correlation Matrices

	Gini	Water's	Energy's	CO2	USW	Nominal GDP	GDP/ capita	Population	GDP Index	GDP/cap. deflated	Wages	Price work
ini	1,00											
'ater's consump.	-0,41	1,00										
nergy's consump.	-0,76	0,67	1,00									
O2 Emissions	-0,63	0,52	0,77	1,00								
SW	-0,51	0,53	0,68	0,33	1,00							
ominal GDP	0,34	0,38	0,52	0,07	0,60	1,00						
DP/per capita	-0,48	0,59	0,84	0,44	0,81	0,88	1,00					
opulation	0,69	0,23	0,27	-0,16	0,39	0,96	0,72	1,00				
DP Index volum	-0,12	0,44	0,72	0,28	0,75	0,95	0,96	0,83	1,00			
DP/cap.deflated	-0,84	-0,10	0,00	0,35	-0,13	-0,82	-0,47	-0,94	-0,60	1,00		
'ages	0,18	-0,13	-0,72	-0,82	0,28	0,69	0,23	0,93	0,46	-0,31	1,00	
ice of work	-0,02	0,01	0,26	0,01	0,13	0,23	0,13	-0,01	0,11	0,07	-0,35	1,00
aboral cost	0,69	-0,17	0,20	-0,17	0,26	0,96	0,66	0,98	0,80	-0,90	-0,12	0,21

URCE: See table 1.

Table 4. Indicators growth rate

	Water's	Energy's	CO2	WSU	Nominal	GDP	Population	GDP	GDP
Years	consumption	consumption	Emissions		GDP	per capita		Index	deflated
2000									
2001	6,41	4,26	3,23	4,66	7,86	6,12	1,64	2,23	0,58
2002	3,1	-0,78	2,38	0,96	5,57	2,01	3,49	0,41	-2,97
2003	1,6	5,68	13,41	-1,28	4,86	1,06	3,75	1,09	-2,58
2004	-1,36	2,94	-3,51	5,36	6,56	3,63	2,83	1,81	-0,99
2005	1,31	5,28	1,08	-3,65	7,71	4,26	3,31	3,38	0,07
2006	2,13	2,77	2,01	4,31	8,08	4,51	3,42	3,11	-0,29
2007	-0,72	0,93	0,45	3,69	7,02	3,06	3,85	3,46	-0,37
2008	-4,91	-1,81	1,15	0,31	4,01	0,84	3,14	1,33	-1,76
2009	2,69	-4,13	-3,04	-4,37	-3,83	-5,67	1,96	-3,98	-5,82
2010	-2,53	-1,09	-0,47	-4,21	0,16	-0,73	0,88	-0,36	-1,24
2011	2,15	-2,95	-4,53	1,74	-0,63	-1,34	0,73	-0,26	-0,97
2012	-0,66	-3,22	-5,22	-2,84	-1,47	-2,26	0,8	-1,59	-2,38
2013	-1,98	-2,45	-9,86	-0,47	-0,54	-1,29	0,76	-1,87	-2,61
2014	1,11	3,53	-4,55	3,55	2,96	2,25	0,7	2,47	1,76
2015	0,97	-2,11	2,64	6,28	3,68	2,83	0,82	2,29	1,45
2015/2000	9,18	6,24	-6,58	13,97	65,09	20,33	37,2	14,04	-16,88

SOURCE: See table 1.

Figure 1. Regression between water's consumption and GDP per capita

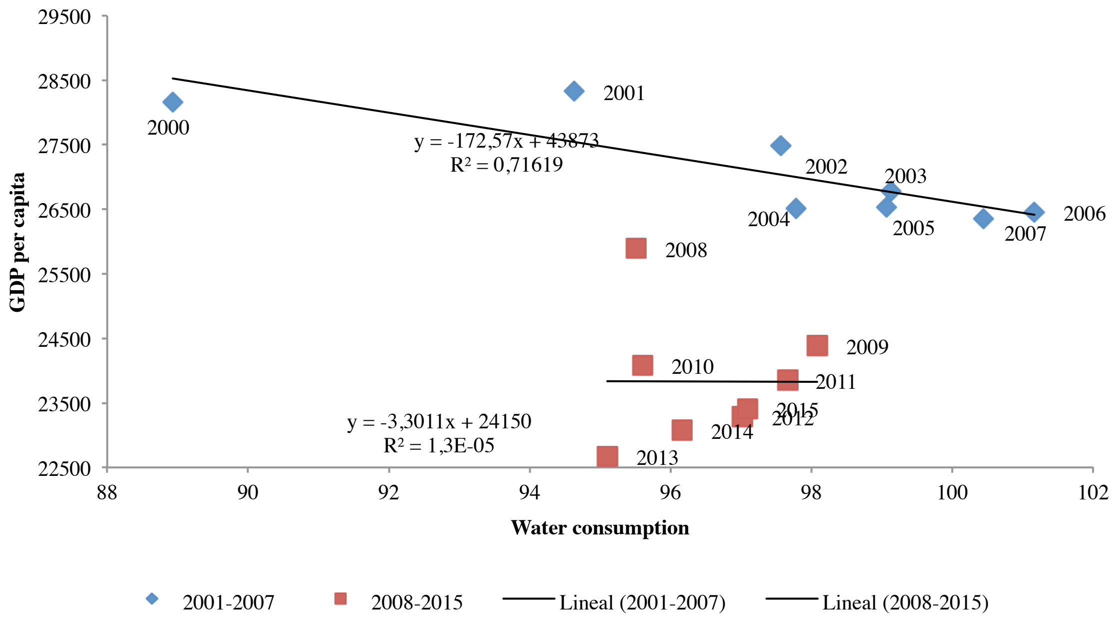


Figure 2. Regression between energy consumption and GDP per capita

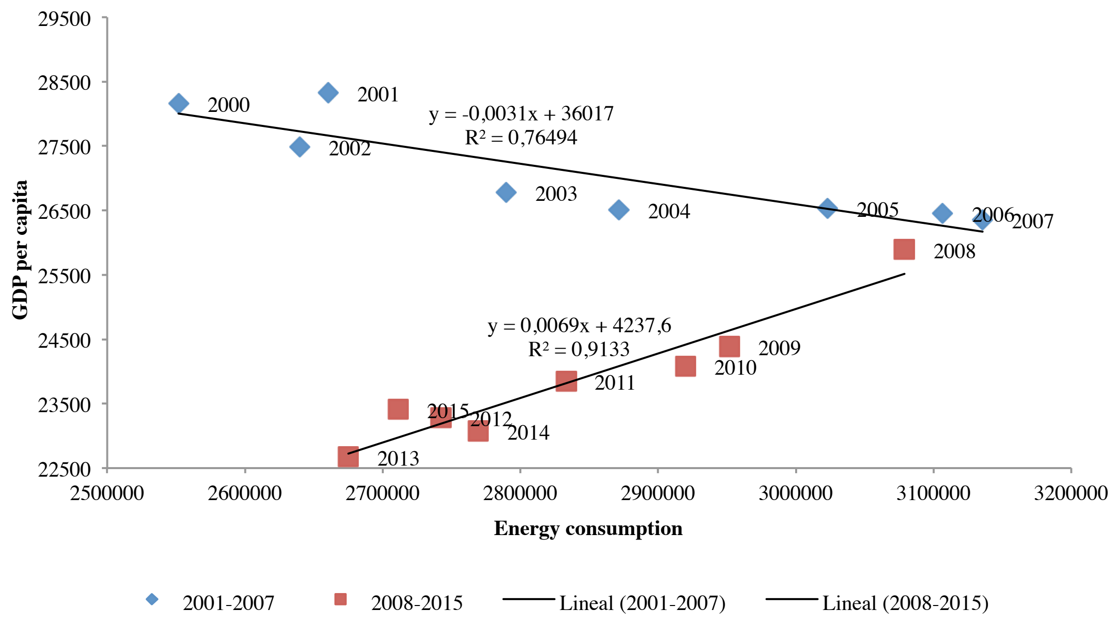


Figure 3. Regression between USW and GDP per capita

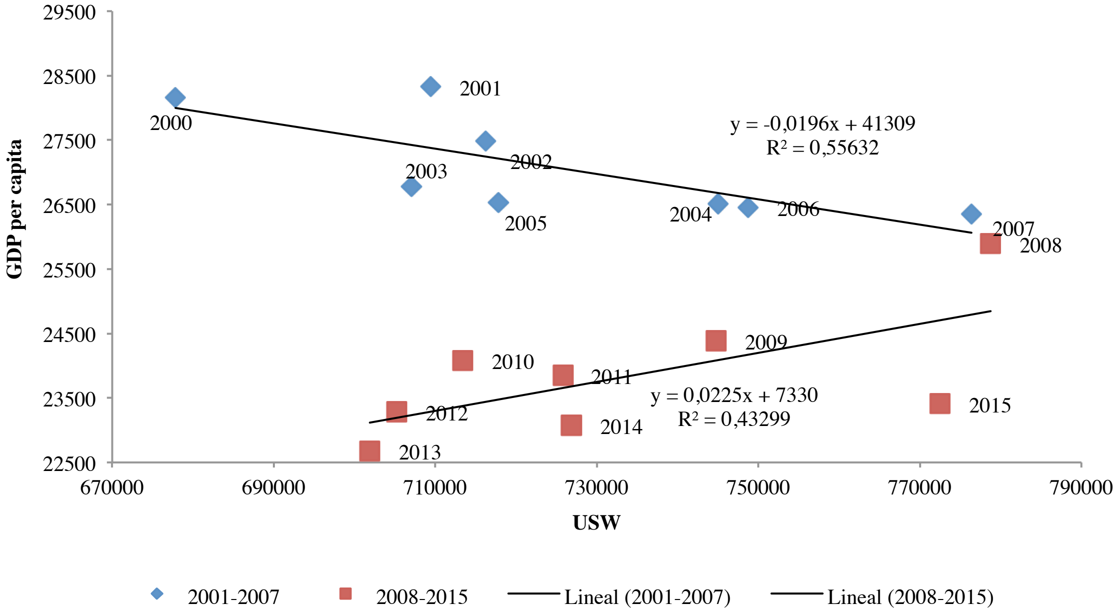


Figure 4. Regression between CO2 emissions and GDP per capita

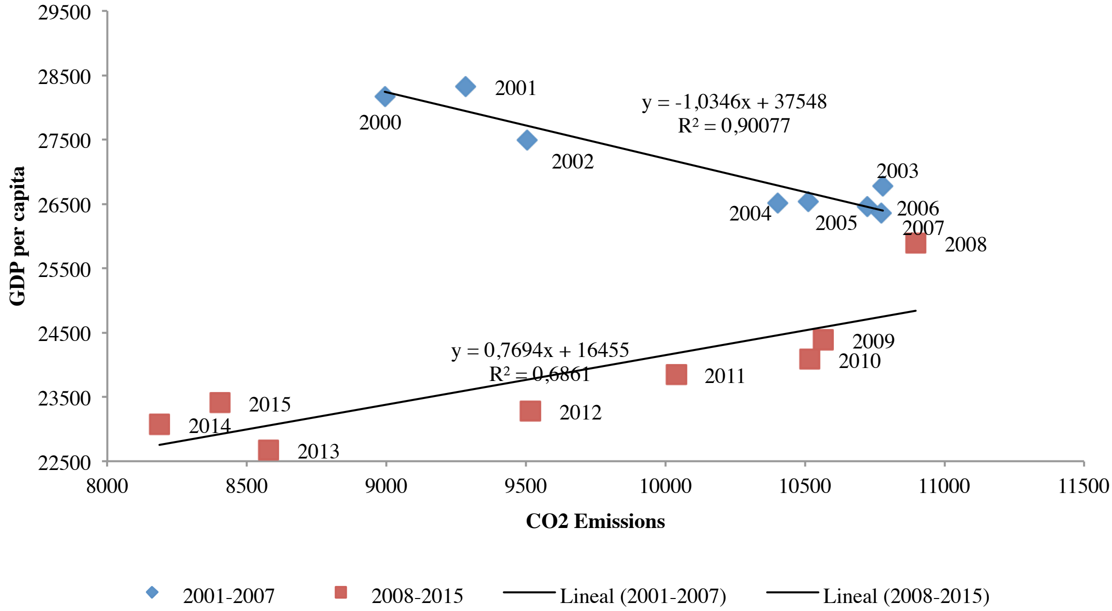


Figure 5. Gini Index

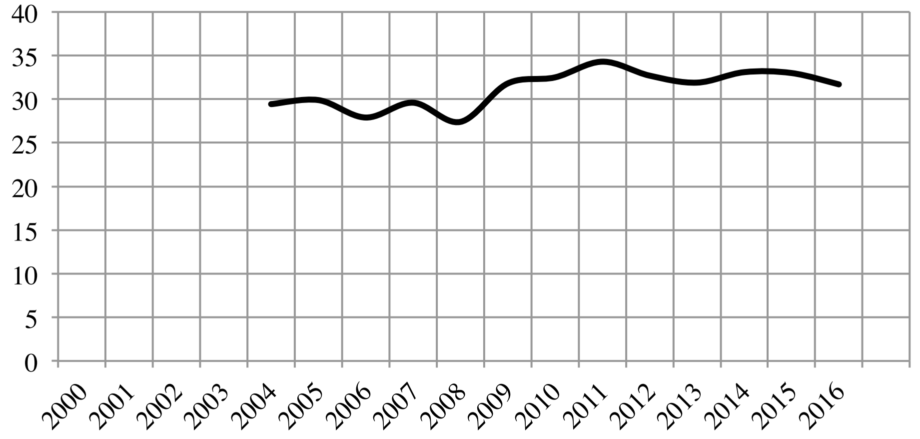


Figure 6. Water and GDP deflated

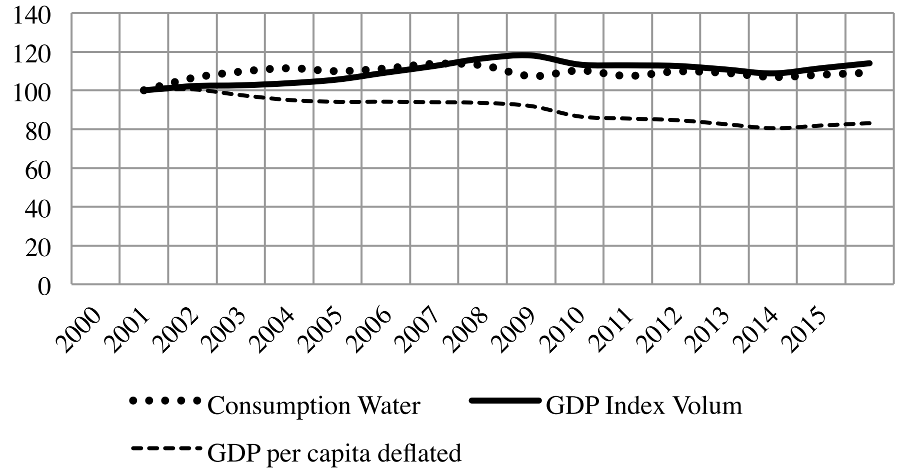


Figure 7. Energy's consumption and GDP per capita deflated

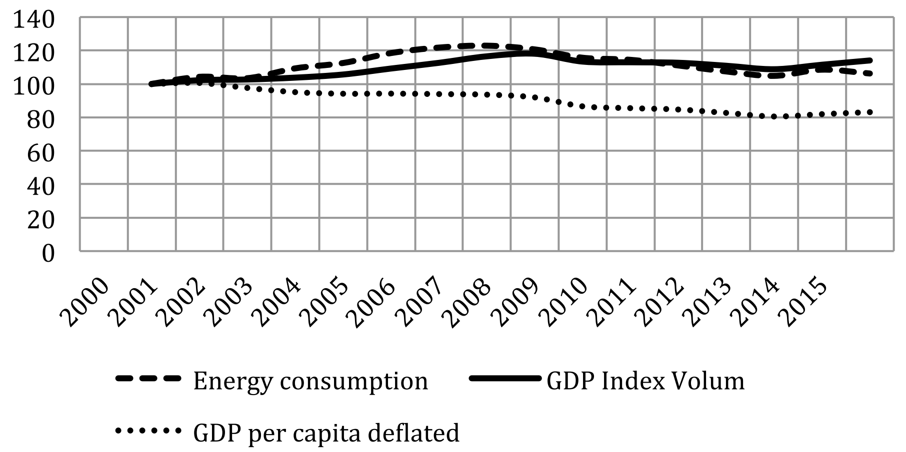


Figure 8. Emissions, USW, GDP and GDP per capita

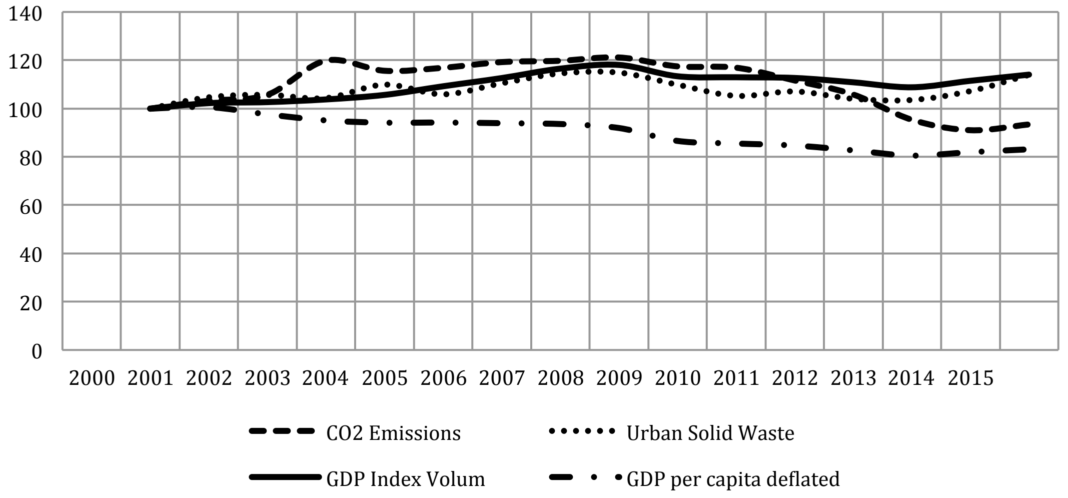


Figure 9. Population and GDP

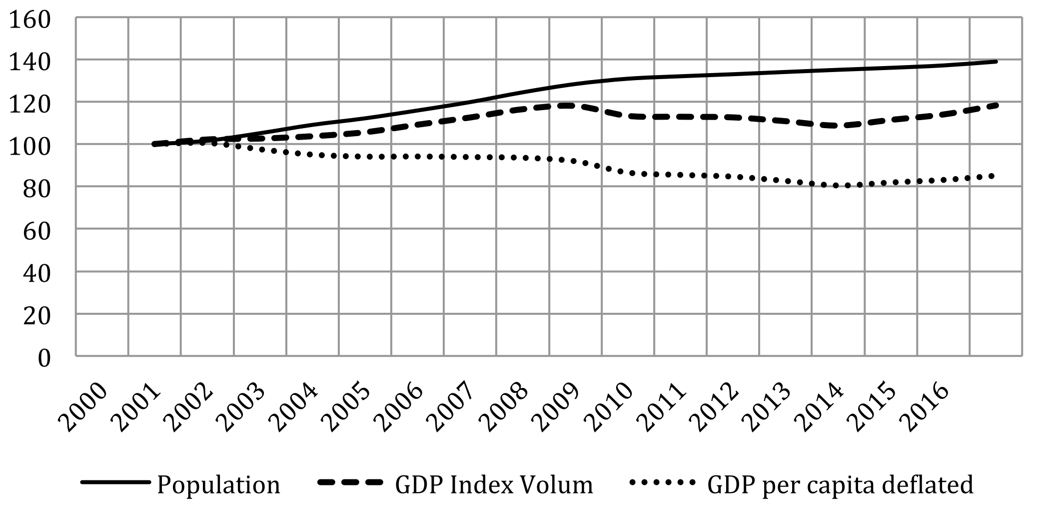


Figure 10. Energy intensity of the Balearic economy

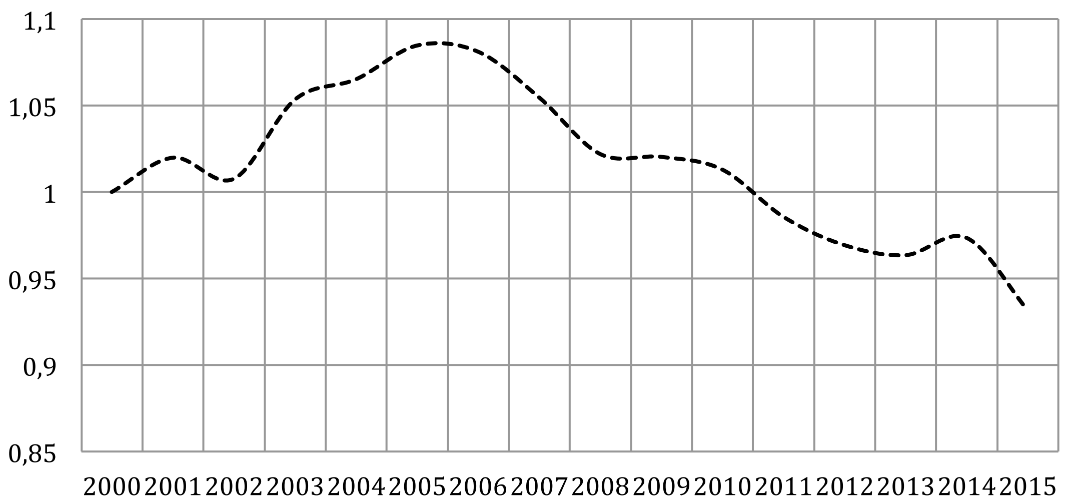
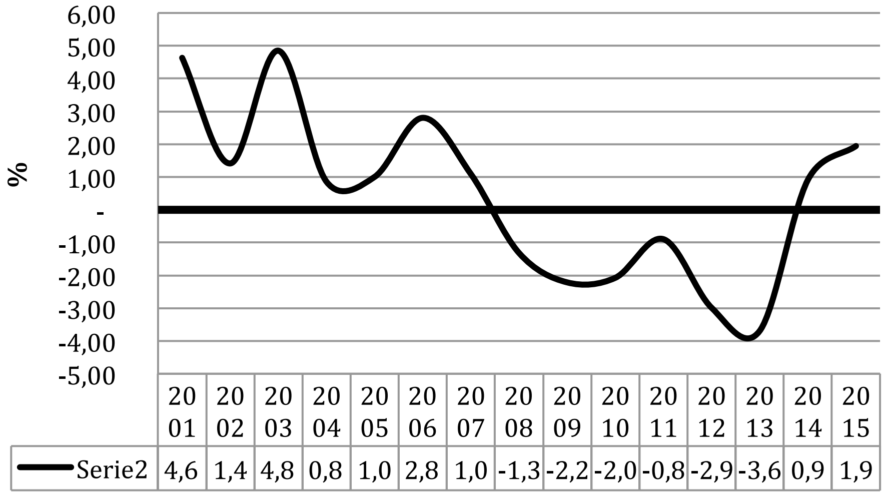


Figure 11. Average growth rate: water consumption+energy consumption+CO2 emissions+USW



SOURCE: for all figures, see table 1.

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