INDUSTRIAL DEVELOPMEN AND CO2 EMISSIONS IN 6 EUROPEAN COUNTRIES, 1960-2016: FRANCE, GERMANY, ITALY, SPAIN, SWITZERLAND AND UK

GUISAN, Maria-Carmen

Abstract: We analyse industrial and non industrial development of 6 European countries, for the period 1960-2016, with particular emphasis on the period 2000-2016. We critize the excessive austerity restrictions, imposed to several countries by national and European policies, which have led to stagnation and even diminution of industrial production per capita, as in the cases of France, Italy, Spain and the UK for the period 2000-2016. We include the estimation of an econometric model, with a pool of 7 OECD countries, to show the positive impact of industry in non industrial production. Regarding CO2 Emissions it is outstanding the diminution of Total CO2 emissions in this group of six European countries, for the period 1970-2015, thanks to the educational level of population, moderation in population growth and diminution of emissions per capita. Switzerland presents both the highest industrial production per capita and the lowest levels of CO2 Emissions per capita. We wish to emphisaze that it is possible to conceal the increase of industry, and economic development, with environmental policies addressed to diminish total CO2 Emissions.

JEL Codes: L6, P28, Q5, Q51, Q56, O52
Keywords: European Industry, Environment, CO2 total emissions, education and development, population growth

1. Introduction

The six European countries of this study have experienced a sustained development of industry and economic development for the period 1960-2000, but economic policies have failed to guarantee sustainable development of industry for all of them during the period 2000-2016.

These European countries have diminished the total CO2 Emissions for the period 1970-2015, thanks to moderation in population growth and diminution of emissions per capita. Our aim is to conceal industrial development with sustainable environmental quality, and the empirical evidence shows show that it is possible in countries that moderate population growth and support good environmental policies.

In section 2 we analyze the evolution of CO2 emissions in 6 countries of Europe, and we may appreciate a diminution of 475 millions of total CO2 for the period 1970-2015, what amounts for a 18% reduction. This important diminution has been mainly due to the educational level of population which has led to moderate population growth and to diminution of contamination per capita.

The lowest level of contamination per capita, in this group of European countries, correspond to Switzerland, the country with the highest level of industrial production per capita in this group, which shows that it is possible to conceal high levels of industry with moderate levels of emissions.

---

*Maria-Carmen Guisan, Professor of Econometrics, Honorary Professor, Faculty of Economics, University of Santiago de Compostela (Spain), mcarmen.guisan@usc.es and mcarmen.guisan@gmail.com, http://www.usc.es/economet/guisan.htm

In 1990 I had the opportunity to present a lecture on the evolution of CO2 emissions in the World during the period 1880-1990, for the university meeting CUMA90. Data is summarized in table A1 in the Annex. The available data indicated a stability in the annual increase in the ratio between the increase in CO2 concentration in the atmosphere and the increase in population, although there are also other causes of emissions not directly or indirectly linked to human activity. Attention to this topic has increased.

Section 3 analyses de evolution of industry and economic development in those countries. After several decades of improvement, the economic policies of the period 2008-2019 have led to stagnation, or even diminution, of industrial development in several European countries. Those policies have created many problems to the citizens such as the increase of unemployment rates, the lack of labor opportunities for the young population, stagnation of real wages, diminution of resources for financing health assistance or other important goods and services per capita. We include the estimation of an econometric model with a pool of 7 OECD countries which show the important positive impact of industry on non-industrial activities and economic development. We conclude that European citizens wish to conceal diminution of total CO2 emissions with an increase of industrial production, economic development and quality of life. It is their right to get that European institutions help to reach their objetives. The problem is not easy but not impossible.

Section 4 present a summary of the main conclusions not only for the European countries but also for the fair contributions that those countries should develop for international cooperation with other areas of the World in order to conceal economic development and low level of CO2 emissions.

2. CO2 Emissions in 6 European countries, 1970-2015

Table 1 shows the evolution of CO2 emissions per capita and total increase of CO2 in a group of 6 European countries for the period 1970-2015.

Table 1. CO2 Emissions per capita (Tm per inhabitant), Population (million) Total CO2 Emissions (million Tm) and Increase for the period 1970-2015.

COUNTRIES	CO2 PER CAPITA		POPULATION		TOTAL CO2 EMISSIONS		TOTAL CO2 INCREASE
	1970	**2015**	**1970**	**2015**	**1970**	**2015**	**1970-2015**
Germany	13.55	9.64	77.709	81.687	1053	787	-265
France	9.10	5.09	50.772	66.593	462	339	-123
Italy	5.88	5.90	53.822	60.731	316	358	42
Spain	3.73	5.70	33.876	46.445	126	265	138
Switzerland	6.63	4.83	6.267	8.327	41	40	-1
UK	11.99	6.16	55.632	65.129	667	401	-266
Europe 6	**9.59**	**6.66**	**278.078**	**328.912**	**2666**	**2191**	**-475**
World	**4.23**	**4.93**	**3684**	**7341**	**15583**	**36191**	**20608**

Source: own elaboration from data published in EU(2014), EU(2019) and WB Indicators.

This group of 6 countries have diminished the average emissions per capita from 9.59 to 6.66, and thanks to the moderation in population growth, has diminished total CO2 emissions, from 2666 (17% of the World) in 1970 to 2191 (6% of the World) in year 2015). Those European countries are a good example for other areas of the World trying to conceal economic development with diminution of total CO2 emissions.

In table 1 the lowest level corresponds of emissions per capita correspond to Switzerland, country slighty below World average in spite of its great level of industrial development. France, Spain and Italy, show more moderate levels than UK and Germany.

With the moderate levels of population growth of these six European countries, the World would have reached only 4357 million people in year 2015, instead of 7341, and total CO2 emissions would be 21480 instead of 36191.

3. Industrial production and economic development in 6 European countries in comparison with the United States

3.1. Evolution of industrial and non industrial value-added per capita

Table 2 shows the evolution or real Value-Added per capita in this group of 6 European countries in comparison with the United States of Americam for the period 1960-2015. We may notice a positive evolution of the 6 countries for the period 1960-2000 and a diminution in several of them for the period 2000-2015, due to mistaken policies at national and European level, as seen in Guisan and Exposito(2018) and other studies.

Table 2. Industrial real Value-Added per capita (thousand Dollars at 2000 prices) of 6 Euriopean countries and comparison with the United States

	1960	1970	1980	1990	2000	2010	2015	2015-2000	IPI15
France	1.665	2.534	3.167	3.522	**3.809**	3.321	3.334	-475	100.4
Germany	2.114	3.458	4.124	4.909	**5.218**	5.818	6452	1234	110.9
Italy	1.252	2.292	3.086	3.423	**3.926**	3.130	2.892	-1034	92.4
Spain	0.551	1.270	1.803	2.167	**2.707**	2.087	1.976	-731	94.7
Switzerland	3.490	5.064	5.510	6.304	**7.540**	8.280	8.769	1229	105.9
UK	2.920	3.503	3.759	4.412	**4.884**	4.029	3.976	-908	98.7
USA	2.470	3.511	4.234	4.787	**6.282**	5.584	6.187	-95	110.8

Source: Elaborated by M.C.Guisan, from OECD National Accounts, several years, World Bank data of population, and OECD MEI for industrial production index of the period 2012-2015 (IPI15).

The countries with the highest levels of industry per capita are usually those with the highest levels of non industrial production per capita, although it may be some exceptions. The case of Germany is an exception, with lower level of non industrial production per capita than France, in spite of having higher values of industrial value-added per capita. When comparing two countries with different levels of outsourcing of *Services to Industries*,happens that real value-added of those services is assigned to Industry (in the country with less outsourcing) and to Services in the other one. Other causes may be related with countries with high industrial production investing in

Services, or other sectors in foreign markets. Table 3 presents the evolution of non-industrial real-value added of those countries for the period 2010-2015.

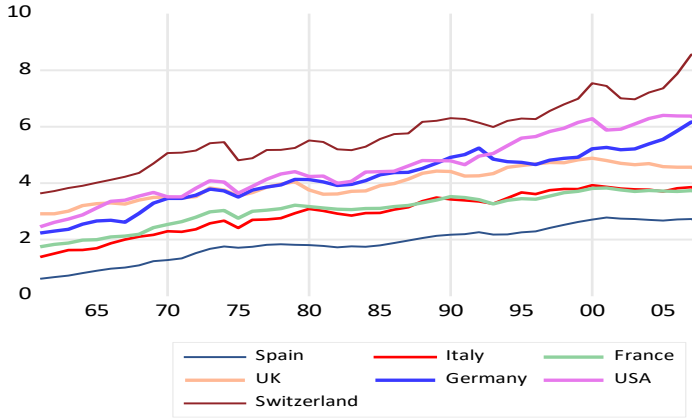
Table 3. Non industrial real value-added per head (thousand US Dollars at 2000 prices)

Country	2010	2015
France	20.528	21.167
Germany	18.934	20.021
Italy	15.569	15.329
Spain	13.039	13.465
Switzerland	29.464	29.961
UK	23.348	24.449
USA	32.276	34.494

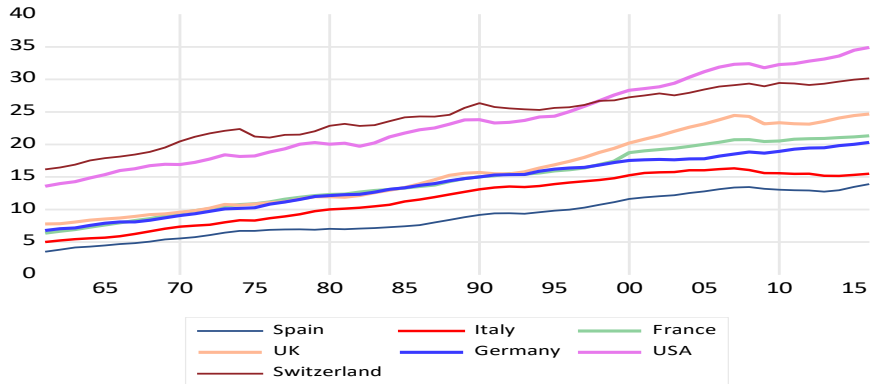
Source: Elaborated by M.C. Guisan from OECD and World Bank Statistics.

Graphs 1 and 2 show, respectively, the evolution of real value-added of Industry and Non Industrial sectors, for the period 1960-2016, with data expessed in Dollars at 2000 prices and exchange rates.

Graph1. Real value-added of Industry per capita in 7 OECD countries, 1960-2016



Graph 2. Real value-added of non industrial sectors in 7 OECD countries, 1960-2016



Source of graphs 1 and 2: Elaborated by M.C. Guisan form OECD Statistics (several years).

In these graphs it is outstanding that national and European economic policies have not provided enough support to foster economic development in Spain, Italy, France and the United Kingdom for the period 2000-20116. The voice of experts economists and other advisers, should be listen to by European institutions and national governments, and social initiativas, from firms, lementation of better policies but it is not easy that politicians and bureaucrats of the institutions listen to the good advices.

3.2. Econometric model measuring the positive impact of industry on non industrial sectors: pool of 7 countries for 1961-2016.

Table 4 persents the estimation of a mixed dynamic model, with a pool of the 7 OECDn countries (France, Germany, Italy, Spain, Switzerland, UK and USA) for the period 1961-2015, where QHNI00 is a function of its lagged value and the increase of QH00

Table 4. Mixed dynamic model for the impac of QHI on QHNI in 7 countries

Dependent Variable: QHNI00? Method: Pooled Least Squares. Sample: 1961 2016 Included observations: 56. Cross-sections included: 7 Total pool (balanced) observations: 392				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.216615	0.042825	5.058138	0.0000
QHNI00?(-1)	1.000416	0.002553	391.8331	0.0000
D(QHI00?)	0.854624	0.068399	12.49473	0.0000
Fixed Effects (Cross)				
AX--C	-0.044236			
E--C	-0.050517			
F--C	0.023930			
IT--C	-0.053994			
SI--C	-0.042220			
UK--C	0.065402			
U--C	0.101636			
	Effects Specification			
Cross-section fixed (dummy variables)				
R-squared	0.998981	Mean dependent var		16.11695
Adjusted R-squared	0.998960	S.D. dependent var		7.088835
S.E. of regression	0.228660	Akaike info criterion		-0.090468
Sum squared resid	20.02533	Schwarz criterion		0.000709
Log likelihood	26.73180	Hannan-Quinn criter.		-0.054333
F-statistic	46925.92	Durbin-Watson stat		1.277061
Prob(F-statistic)	0.000000			

Note: this estimation by Ordinary Least Squates (OLS) shows some degree of autocorrelation. The estimation by Generalized Least Squares (GLS), with correction of autocorrelation provide the following estimations for the coefficients: 0.9990 for QHNI00(-1) and 0.7555 for D(QHI).

Accordingly to the macro-econometric approach developed by Guisan(2013), Guisan and Exposito(2018) and other studies, we find that there is a positive effect of industrial production on services and other non industrial activities, and thus an important contribution of industry to employment, income per capita and development. For that

reason we have estimated, with a sample of the 6 European countries of this studies and data of the United States, for the period 1961-2015, the following model:

QHNI = f (QHNI(-1), D(QHI), C, Dummy variables for country differences)

Where QHI00 and QHNI00 are, respectively, the values of real value added of Industria and Non industrial sectors, in Dollars at 2000 prices and exchange rates, for each country and year.

The average effect of an increase of one unit in QHI was an increase of 0.85 in QHNI. Although may be some small differences among countries or periods, the important question is that this relationship shows cointegration, satisfies causality tests and shows a signifcan positive effect of industry on non industrial production. The goodness of fit is very high with a % of S.E. of regression as low as 1.41% (%SE = 0.228660*100/16.11695).

Table 5 presents the resuls of the estimation in 3 subperiods together with the whole sample. The estimated coefficient of the lagged value of the dependent variable was close to unity (varied between 0.9964 and 1.0310) and the coefficient of the annual increase of QHI varied between 0.4014, for the period 1994-2006 and 1.1982 for the period 1961-1993, with a value of 0.6436 for the period 2007-2016. All the parameters where significant and there was not autocorrelation for the subperiods.

Table 5. Estimation in 3 subperiods and total: pool of 7 OECD countries

Period	Coef. of QHNI00 (-1)	Coef. Of D(QHI00)	Adjusted R^2	%SE
1961-1993	0.9964	1.1982	0.9989	1.46
1994-2006	1.0098	0.4014	0.9989	1.02
2007-2016	1.0310	0.6436	0.9985	1.16
1961-2016	1.0004	0.8546	0.9990	1.41

Surce: Own elaboration

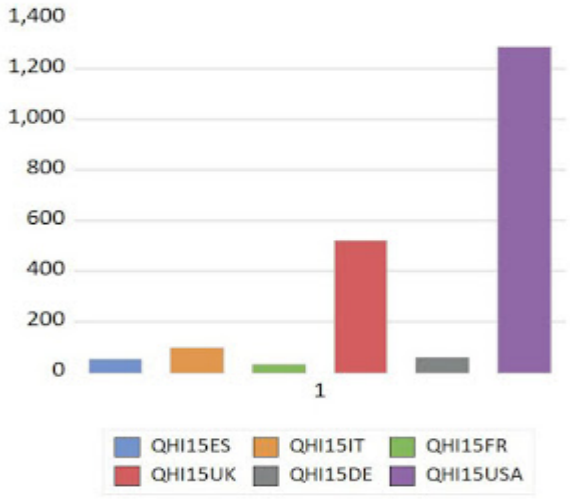
Individual coefficients for 6 OECD countries where estimated by Guisan(2011) for the period 1961-2005 and the relationship between QHNI and QHI, by means of a mixed dynamic model, satisfied cointegration tests and analysis of causality in all the countries.

Now we are interested in the evolution of the period 2005-2018, because during this period appeared several problems in European economic policies that have had as consequence stagnation, or even diminution in several productive sectors of several countries of this study.

3.3. Industrial production by sector in 7 OECD countries in year 2015

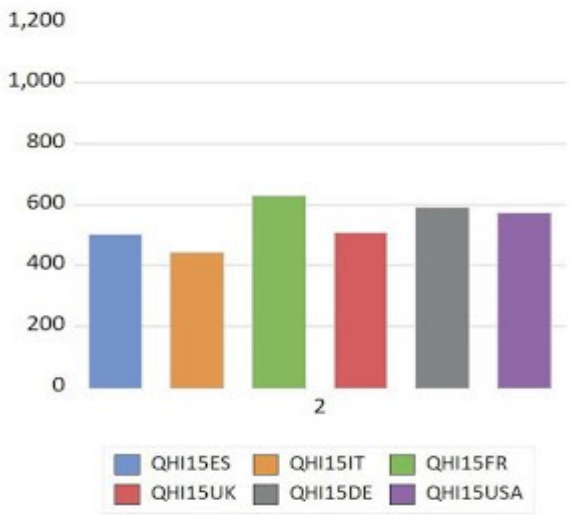
For a most complete knowledge of the industrial sector we present a comparative view of real value-added in 10 industrial sectors in this group of 7 countries.Graphs 3.1 to 3.10 present a comparison of Real Value-added of Industrial Production, in year 2015, expressed in Euros at constant prices of year 2010, elaborated by Guisan(2019) from OECD STAN statistics. Data of real value-adde per capita in year 2015 is expressed as QHI15 of country i (i=es, it, fr, uk, de, usa) for Spain, Italy, France, United Kindom, Germany and the United States. The table of data is included in Annex 2.

Graph 3.1. D05T09: Mining and quarrying [B]



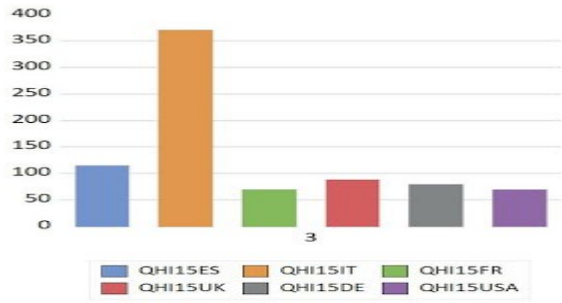
Sector 1: Mining includes oil production. The values are below 200 Euros per capita in Germany, France, Italy and Spain, and more than 400 in UK and more than 1200 in USA. EU countries and higher than 1200 in the United States.

Graph 3.2. D10T12: Food products, beverages and tobacco



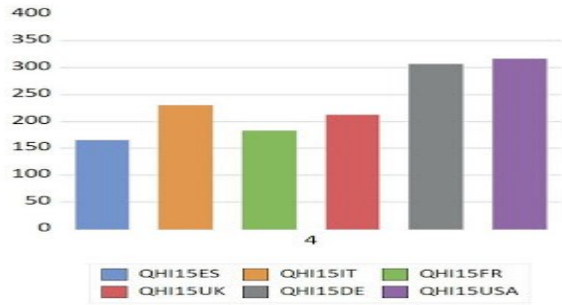
Sector 2: the values are very alike in the 6 countries, with the highest value in France.

Graph 3.3. D13T15: Textiles, wearing apparel, leather and related prodcuts



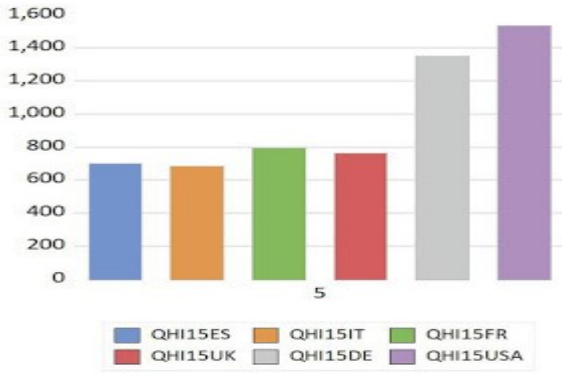
Sector 3: the most outstanding value corresponds to Italy, with nearly 400 Euros per capita, while the other countries have values lower than 150.

Graph 3.4. D16T18: Wood and paper products, and printing



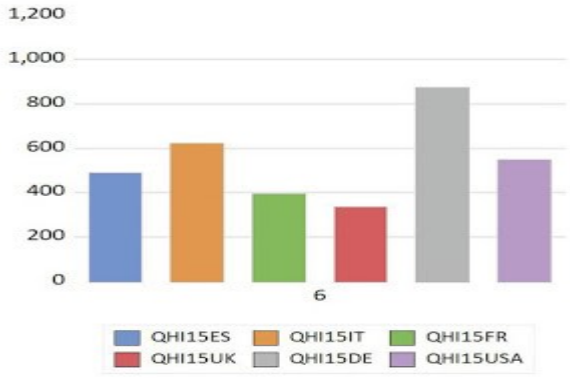
Sector 4: The highest values of sector 4 correspond to the USA and Germany and the lowest to Spain and France.

Graph 3.5. D19T23: Chemical, rubber, plastics, fuel products and other non-metallic mineral products



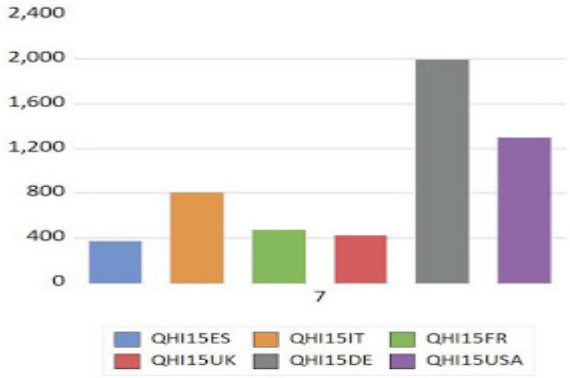
Sector 5: There is a great difference between the values of the USA and Germany and those of the other 4 countries.

Graph 3.6. D24T25: Basic metals and fabricated metal products



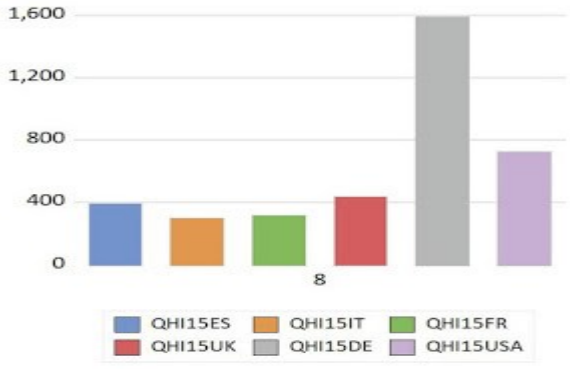
Sector 6: the highest values correspond to Germany and Italy

Graph 3.7. D26T28: Machinery and equipment



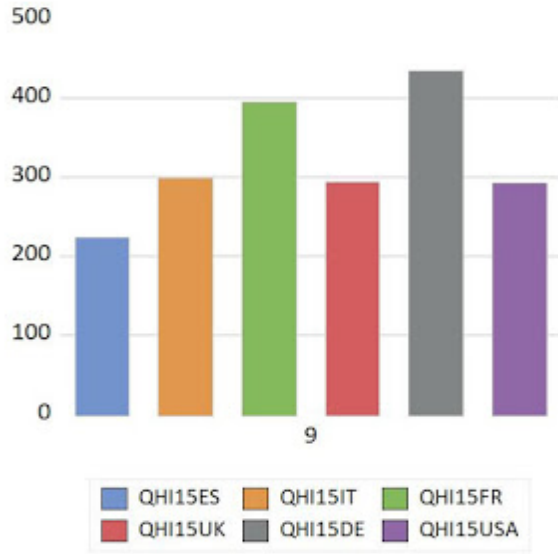
Sector 7: High values of Germany (nearly 2000) and the USA.

8. D29T30: Transport equipment



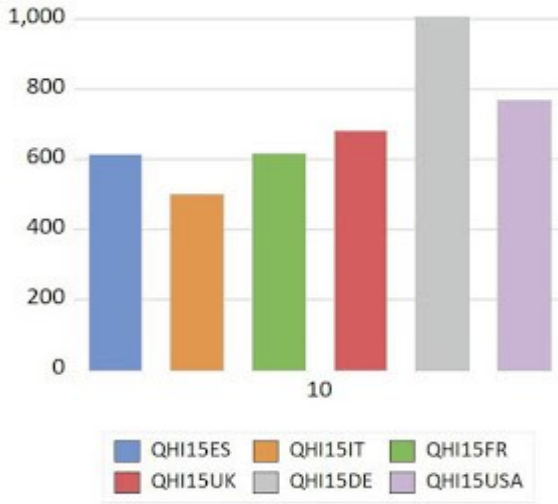
Sector 8: The most outstanding country in the graph is Germany, with nearly 1600 Euros per capita.

9, D31T33: Furniture; other manufacturing; repair and installation of machinery and equipment



Sector 9: Germany and France present the highest values among these 6 countries.

10. D35T39: Electricity, gas and water supply; sewerage, waste management and remediation activities [D-E



Sector 10: The most outstanding country is Germany, followed by the USA.

We include figures and commenst about industry in Annex 2

5. Conclusions

We may summarize some of the main conclusions from this study:

1) Total CO2 Total Emissions have decreased, for the period 1970-2015, in the group of six European countries of this study (France, Germany, Italy, Spain, Switzerland and the United Kingdom) mainly due to their moderation in population growth and the diminution of CO2 Emissions per capita. European countries should increase international cooperation addressed to moderate CO2 Total Emissions at World level, mainly through support to Education and good policies of economic development in developing countries.

2) Industrial development may be compatible with quality of environment, when there are policies addressed to that aim. The case of Switzerland is outstanding in this regards, because it is the country of the group with the lowest level of CO2 Emissions per capita in spite of being the country of the highest levels of industrial production per capita.

3) The European economic policies should avoid diminution or stagnation in countries with moderate level of industrialization, because industry may have very good effects on development and employment of several production sectors, particularly in Services.

4) European countries may be an example, and a support for sustainable development in other areas of the World. International cooperation should be addressed to increase the educational level of population, given that accordingly to Guisan, Aguayo and Exposito(2001) and other studies, it is one of the most important factors in order to avoid excessive average fertility rates in countries with excessive increases of Population and of Total CO2 Emissions. Accordingly to Guisan and Exposito(2020) more than 83% of the World increase of total CO2 Emissions, for the period 1970-2015 was due to high levels of population growth. To conceal development and environment, population growth should be moderate and European countries can be an example for other areas.

5) The econometric relationship between non industrial and industrial production presents high goodness of fit, significant parameters and a positive impact of industry on non industrial sectors and economic development.

References

EU(2014). Emission Database for Global Atmospheric Research (EDGAR), release version 4.2. http://edgar.jrc.ec.europe.eu

EU(2019). CO2 Emissions 1990-2017. EDGAR, http://edgar.jrc.ec.europe.eu

Guisan, M.C., (2011). Causality and Cointegration between Consumption and GDP in 25 OECD countries: Limitations of Cointegration Approach. A*pplied Econometrics and International Development* Vol. 1-1.

Guisan, M.C. (2012). Industry, Foreign Trade and Employment in EU Countries; Comparison of France, Germany, Italy, Spain and the UK with the United States, A*pplied Econometrics and International Development* Vol. 11-2.

Guisan, M.C. (2013). Macro-Econometric Models of Supply and Demand: Industry, Trade and Wages in 6 Countries, 1960-2012. A*pplied Econometrics and International Development* Vol. 13-2.

Guisan, M.C. (2015). Selected Readings On Econometrics Methodology, 2001-2010: Causality, Measure Of Variables, Dynamic Models And Economic Approaches To Growth And Development, A*pplied Econometrics and International Development* Vol. 15-2.

Guisan, Aguayo and Exposito(2001) Economic growth and cycles: Cross-country models of Education, Industry and Fertility and International Comparisons, A*pplied Econometrics and International Development* Vol. 1-1.

Guisan and Exposito(2018). Economic Development Problems And Crisis In The European Union, 2005-2015 *Applied Econometrics and International Development* Vol. 18-1.

Guisan, M.C., Exposito, P. (2020). CO2 Total Emissions In The World, 1970-2015: Relationship With Economic Development And Population Growth, *Applied Econometrics and International Development* Vol. 20-1.

Hoover, K. and Hanson, L.A. (2019). Wildfires Statistics. In Focus. Congressional Research Service, https://fas.org/sgp/crs/misc/IF10244.pdfwi

OECD. National Accounts Statistics. Several years.

OECD. STAN structural statistics of industry. Several years

UN(1987). Nuestro future común. Comisión Mundial para el medio ambiente.

UN(2020). World population and other statisticss
https://population.un.org/wpp/Publications/Files/WPP2019_PressRelease_ES.pdf

WB(2020). World Development Indicators.

White, R.M. (1990). El gran debate sobre el clima. Investigación y Ciencia (Spanish edition of Research America, September of 1990).

Annex on line at the journal Website: http://www.usc.es/economet/eaat.htm

Annex 1. Increase of CO2 concentration in the atmosphere and population growth, data for the period 1880-2019

In year 1990, M.C. Guisan presented the following tables at the Congress CUMA90, held at the university of Santiago de Compostela. The interesting tables where elaborated by the author, from the interested figures published by White(1990) and international statistics. Now we include here table A1 updated with information for the period 1990-2019.

Table A1.CO2 concentration (ppm), and ratio between increases of ppm and World Popultation

Year	CO2 concentration ppm (1)	Population (million) (2)	Δ per decade CO2 ppm	Δ per decade Population	Ratio: (3)/(4)	CO2 Emission Per capita
1880	290	1490				
1950	307	2500	2.4	101	0.0168	
1960	315	3027	8	527	0.0152	
1970	325	3678	10	651	0.0154	4.23
1980	338	4414	13	736	0.0177	4.43
1990	352	5270	14	856	0.0164	4.27
2019	**415**	7700	22	838	**0.0263**	4.91

Source: Guisan, M.C.(2020), update of table presented at CUMA90, with data from White(1990), UN and other statistical sources. Data of ppm in year 2019 from AEMET, published by Europa Press on 14th May 2019. Note: "Δ per decade" indicates increase for 10 years.

The increase of CO2 ppm in the atmosphere, for the period 1990-201,9 has been too high, as well as the increase of the ratio (3)/(4). These increases seem to indicate that during the period 1990-2019 have been other important factors, besides population growth, with impact on CO2 total emissions, contributing to an increase of emissions per capita and to the increase of CO2 ppm.

Increase of wildfires and the strong increases on emissions by international aviation and international shipping, have contributed to this increase, as pointed out in Guisan and Exposito(2020). Wildfires in many areas of the World have been strongly increased since year 2000. International shipping has experienced a high increase, multiplying by a factor of 5 since 1970, and thus it has increased much more than population.

Annex 2. Structure of industry in 6 European countries

Table A2 shows the figures from the OECD STAN statistics of industrial sectors in the 7 OECD countries of this study. Data for some sectors might be undervalued in the case of the UK, because the total value of real value-added of Industry is lower than expected accordingly to OECD National accounts. As in the indicated below the table our provisional estimation for the UK should be 4645 instead of 3597.

Table A2. Real value-added per capita in year 2015 (Euros per inhabitant at 2010 prices)

		France	Germany	Italy	Spain	Switzerland	UK	USA
QH1E	Mining	29	56	96	49	68	439	1076
QH2E	Food	628	590	443	501	923	430	478
QH3E	Textil	70	80	371	115	101	74	58
QH4E	Wood	183	307	230	165	545	180	266
QH5E	Chemical	794	1348	685	699	4344	646	1286
QH6E	Metal	394	874	622	490	890	285	459
QH7E	Machinery	468	1992	808	372	3455	359	1086
QH8E	Transport	317	1589	301	392	238	371	606
QH9E	Furniture	394	435	299	223	521	249	244
QH10E	Electricity	618	1006	501	615	811	577	643
	Industrial	**3895**	**8277**	**4355**	**3621**	**11897**	**3597***	**6195**
Non Industrial Sectors	Agriculture	518	195	481	562	369	219	455
	Construcrtion	1461	1258	1049	1347	2743	1589	1449
	Services	22584	21063	17348	15583	40765	22747	29677
Total	Total1 STAN €10	28458	30792	23233	21113	55775	28153	37757
	Total 2 $10	36902	42691	33162	31800	54453	38491	52005
	Total 2 €10	27861	32232	25037	24009	41112	29061	39264

*Note: the value of Industry (sum of the 10 first rows) in the UK seems undervalued in this source, in comparison with table 2 from OECD Industrial Index. Our provisional estimation would be 4645 instead of 3597. Sources: Elaborated from OCDE STAN statistics, for real value-added, and population from WB and UN. Total1 is the sum in Euros of year 2010. Total2, in Euros and in Dollars of year 2010, is the value calculated by the author from OCDE National Accounts.Table A3 presents de percentage of industry in total Value-Added, from STAN estatistics in comparison with OECD Factbook.

Table A3. % of real Value-Added of Industriy from OECD factbook (years2010-2014) and STAN (year 2015)

	2010	2011	2012	2013	2014	2015
France	13.54	13.74	13.80	13.86	13.76	13.69
Germany	25.86	26.18	26.31	25.84	25.73	26.88
Italy	18.73	18.61	18.47	18.49	18.55	18.74
Spain	17.17	17.45	17.20	17.11	16.99	17.15
Suiza	21.24	21.46	20.98	20.86	20.91	21.33
UK	14.81	14.88	14.89	15.40	14.74	12.78
USA	16.50	16.83	16.72	16.59		16.41

Source: For years 2010-2014 OCDE Factbook. For year 2015 calculated from table A2.
Note: the percentage of Industry in the UK for year 2015 seems undervalued in STAN.