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Demand for Energy and Energy Generation: Does Regional Energy Policy Play a Role?

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Abstract

Does regional energy policy play a role in regional energy generation? What does the implication of the current industrialization trend mean for the generation and the supply process across regions? And to what extent does regional energy policy affect energy security (energy supply risks) in regions? This study investigates the effect of regional energy policy on regional generation characteristics in seven regions of the World using regional panel data from 1980 to 2010 a period of 31 years although some years of data are missing. It was found that regional energy policy were been shaped by pollution concerns and that cost reduction needs had strong effects on energy security (energy generation resources supply). The method of estimation used is the quantile regression estimation method which provides robust estimates after controlling for heterscedastic errors and is robust in the presence of outliers in the response measurement. Energy policy has strong implication for access to sustainable supply of energy generation resources however it had little or no effect on energy generation itself. Industrial demand for energy particularly in the developed countries were probably also making developed countries depend on more nuclear and hydro energy generation sources.

Keywords: Kyoto Protocol, Energy Policy, Energy Generation and Generation Sources.

1.0 Introduction

In this section we introduce the topic of discussion. World demand for energy is on the increase particularly with the industrialization drive currently being experienced in emerging economies. For instance from 2016 the United States will no longer be the largest importer of oil from Nigeria since their imports will be overtaken by China[1]. Other issues that bother on consumption patterns such as emissions are also likely to affect regional energy policy.

It is clear that the Kyoto protocol might not be realizable in near future with major energy consuming nations withdrawing from the Doha 2012 round of talks and other circumstance that point to the fact that emissions cut are not likely to be met in the future. Energy generation across regions will be affected by the dwindling availability of fossils as well as drive in improving innovative generative capabilities for cleaner and more sustainable methods of energy production.

Lots of papers e.g. Knox-Hayes, Brown et al (2013), have also tried to address issues of energy demand and supply risk in the generation process. However few have tried to relate specifically the effect of industrial demand for energy on regional specific energy generation and supply. It is also noticeable that industrial energy consumption is on the increase and noticeable industrialization trends in regions mean that this will continue to remain so in the near future[2]. Regions are also highly concerned about cost of each generation source and are likely to continue to diversify their production capabilities to mitigate supply risks Ojeaga, Azuh and Odejimi (2014). For instance the paper Cohen et al 2011 argue for diversification away from fossils due to overdependence stating that one way of risk reduction were probably depending on a variety of energy sources for generational purposes. Cost of generation- can have strong implications for –energy- stakeholders and -policy makers- forcing countries across regions to source for cheaper and sustainable ways to improve generational capabilities EU Green Paper 2001.

The role of regional policy and industrial energy consumption on energy supply and generation remains unclear. The question if countries across regions are actually concerned about industrial demand for energy and the effects

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[1] Nigeria National Petroleum Corporation (NNPC) Oil Projection for Nigeria 2013
[2] (World Bank Statistics 2010)

of regional energy policy on the generation and supply process could offer new insight into how energy stakeholders view the need for providing energy that will meet the increasing demand in countries across regions.

This paper studies the effect of regional policy on energy generation and supply (energy security) across seven regions of the World which include Africa, South East Asia Pacific, Australia, Europe, North America and Latin America. Panel data for regions is used and data is obtained for the period of 1980 to 2010 a period of 31 years although some years of data are missing. The method of estimation used is the quantile regression estimation method which provides robust estimates after controlling for heterscedastic errors in the presence of outliers in the response measurement. The rest of the paper is divided into the scope and objective of study, stylized facts on regional energy policy and generation, literature review, theory and methodological section, sources of data, empirical analysis and results and finally the concluding section.

2.0 Scope and Objective of The Study

In this section we state the scope and objective of the study. The study investigates the effect of regional energy policy (since policy is shaped by energy demand across regions) on energy generation and the energy supply process across regions using a panel of seven regions in the world. It deals extensively on how regional energy policy will shape generation and supply patterns across region noting difference across regions and its implication for the overall supply and generation process across regions. The objectives of the study include;

1. To determine the role of regional energy policy on the energy generation process across regions
2. To examine the extent to which regional energy policy affect energy supply (energy security) across regions.
3. To determine the implications of industrialization trends on energy supply risk mitigation and energy production across regions.

3.0 Stylized Facts on Regional Energy Policy and Generation

In this section stylized facts on energy policy and the generation process are presented for regions under study. Graphs, trends and information are extracted from past studies by Ojeaga, Azuh and Odejimi (2014). The Kyoto protocol aims to cut emissions particularly green house gases emission to the barest minimum. Energy security is measured using score values assigned to regions, based on the level of diversification and regional specific infrastructure in renewable energy sources in regions with North America particularly the

Table 1. World total installed generating capacity by region and country, 2010-2040

		Projections						yearly
	2010	2015	2020	2025	2030	2035	2040	% Δs
OECD								
OECD Americas	**1,248**	**1,316**	**1,324**	**1,379**	**1,456**	**1,546**	**1,669**	**1.0**
United States[a]	1,033	1,080	1,068	1,098	1,147	1,206	1,293	0.8
Canada	137	144	152	163	174	185	198	1.2
Mexico/Chile	78	93	104	118	135	155	177	2.8
OECD Europe	**946**	**1,028**	**1,096**	**1,133**	**1,159**	**1,185**	**1,211**	**0.8**
OECD Asia	**441**	**444**	**473**	**489**	**501**	**516**	**524**	**0.6**
Japan	287	275	293	300	304	309	306	0.2
South Korea	85	93	100	107	114	122	130	1.5
Australia/New Zealand	69	76	81	83	83	85	87	0.8
Total OECD	**2,635**	**2,788**	**2,894**	**3,002**	**3,116**	**3,247**	**3,403**	**0.9**
Non-OECD								
Non-OECD Europe and Eurasia	**408**	**421**	**455**	**480**	**508**	**538**	**563**	**1.1**
Russia	229	239	264	282	299	315	325	1.2
Other	179	182	191	198	209	223	239	1.0

Non-OECD Asia	**1,452**	**1,820**	**2,188**	**2,479**	**2,772**	**3,057**	**3,277**	**2.8**
China	988	1,301	1,589	1,804	2,007	2,176	2,265	2.8
India	208	241	285	327	376	440	510	3.0
Other	256	278	314	347	390	441	502	2.3
Middle East	**185**	**197**	**216**	**233**	**247**	**267**	**280**	**1.4**
Africa	**134**	**147**	**164**	**184**	**211**	**244**	**283**	**2.5**
Central and South America	**247**	**279**	**304**	**329**	**362**	**400**	**447**	**2.0**
Brazil	114	137	152	169	191	221	256	2.8
Other	134	142	152	160	171	179	191	1.2
Total Non-OECD	**2,426**	**2,864**	**3,327**	**3,705**	**4,099**	**4,505**	**4,850**	**2.3**
Total World	**5,061**	**5,652**	**6,221**	**6,707**	**7,214**	**7,752**	**8,254**	**1.6**

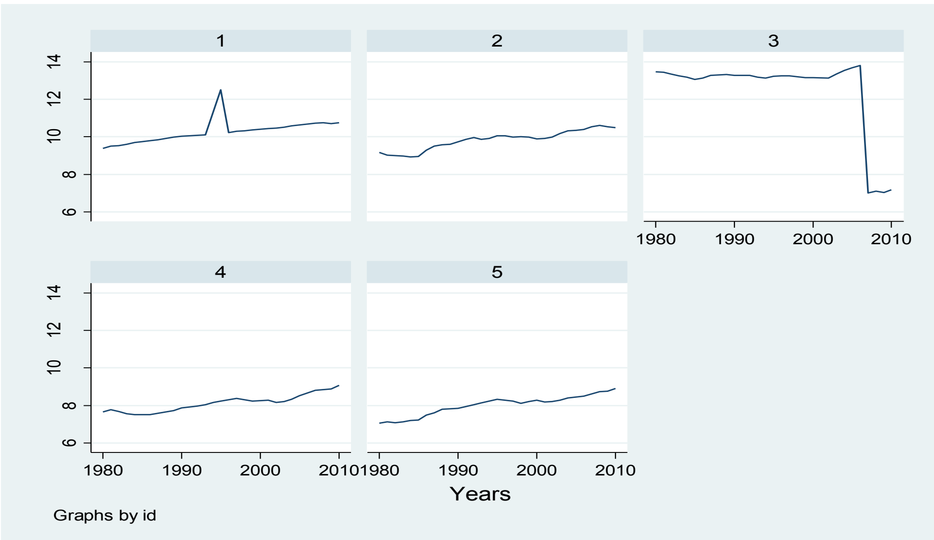
[a]Includes the 50 states and the District of Columbia.

Note: Totals may not equal sum of components due to independent rounding.

Sources: History: Derived from U.S. Energy Information Administration (EIA), International Energy Statistics database (as of November 2012), www.eia.gov/ies. Projections: EIA, Annual Energy Outlook 2013, DOE/EIA-0383(2013) (Washington, DC: April 2013); AEO2013 National Energy Modeling System, run REF2013.D102312A, www.eia.gov/aeo ; and World Energy Projection System Plus (2013).

United States having stronger capabilities towards averting energy interruptions. Total installed world energy capability appears to be on the increase see table 1 above. This is attributable growing domestic demand for energy and industrialization needs particularly in emerging nations. Data from Data Market of Iceland also show that here is also rapid industrialization in Latin America, South East Asia and other emerging African countries starting in the early 2000s, see graphs 3, 4 and 5 respectively in Fig 3, also means that the competition for the world resources is on the increase despite the slowdown in the industrialization development of the highly developed countries in Europe and North America. See graphs 1 and 2 in Fig. 3. Investment in domestic technology in regions is also ongoing with a steady rate of investment in Europe and North America and continuous improvement for Latin America and Africa. Statistics also show that North America particularly the United States and Canada have some of the largest number of Wind generating plants in the World after China

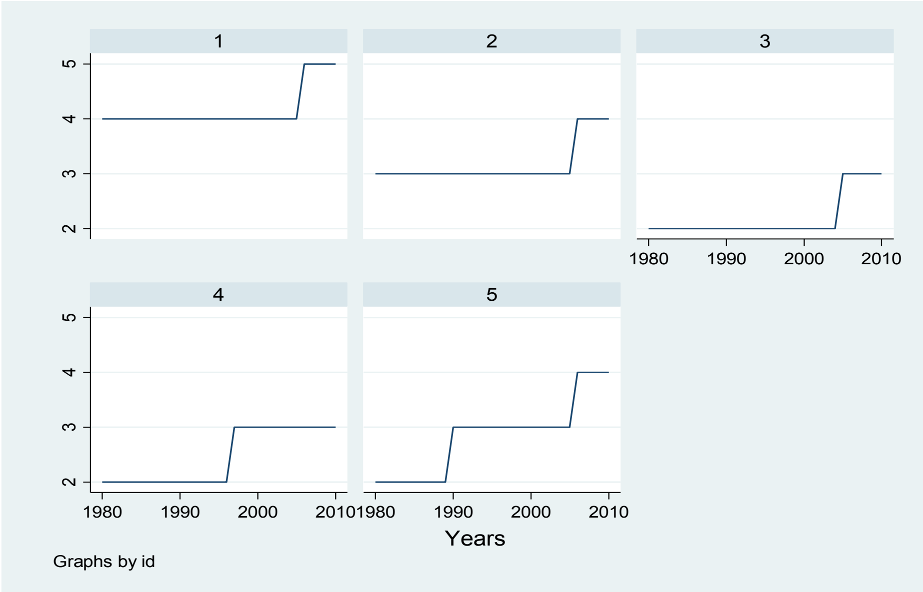
Fig. 1



Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively.

(Renewable Global Status 2006 – 2012 report). Asia is presently experiencing a slowdown from the massive investment of the 1990s in generation technology, but still maintaining steady investment in the development of improved generation sources.

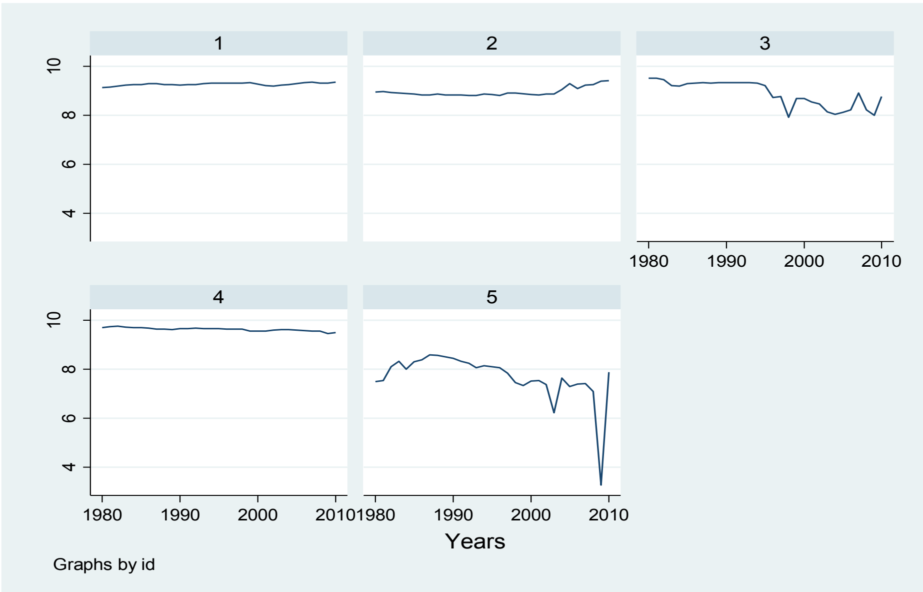
Fig. 2



Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

Statistics show that North America has the most diversified energy sector with the United States having the highest number of wind farms and hydro power stations in the world. Europe is also gradually disengaging from the use of nuclear plants in energy generation and introducing renewable energy technology in the energy generation process although it is still vulnerable to strong dependence on Gas production sources see IEA 2011 report. Hydro production capabilities utilization is still reasonably high for North America, Europe, Africa and Latin America. South East Asia is actually experiencing reduced

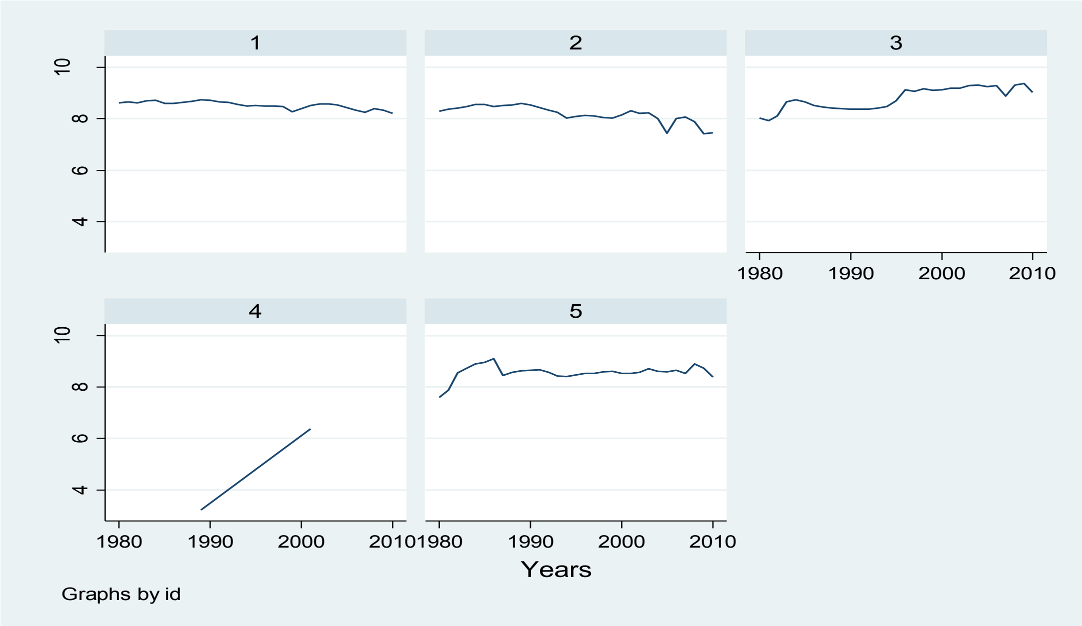
Fig. 3



Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

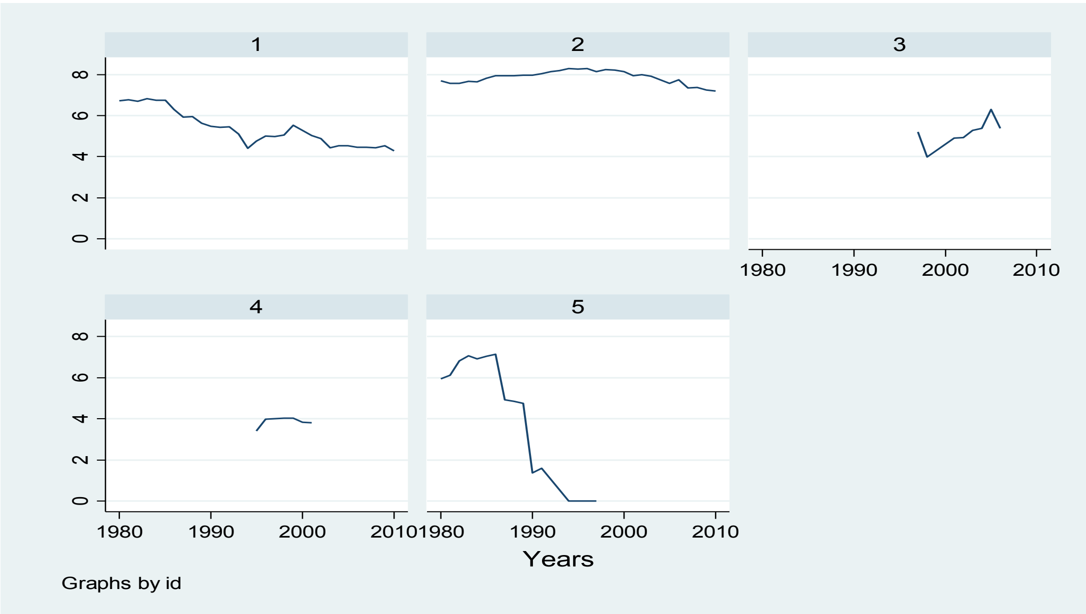
dependence on hydro generation due to probably poor natural sources for developing hydro generation plant capabilities. The use of coal in energy generation is also on the increase for all regions except North America and Europe where a decline in their use are noticeable. This is probably due to the advent of alternative means of generation that are cleaner making these highly developed regions to lack further incentives to continue developing more of such plants for future energy use. Dependence on nuclear generating

Fig 4



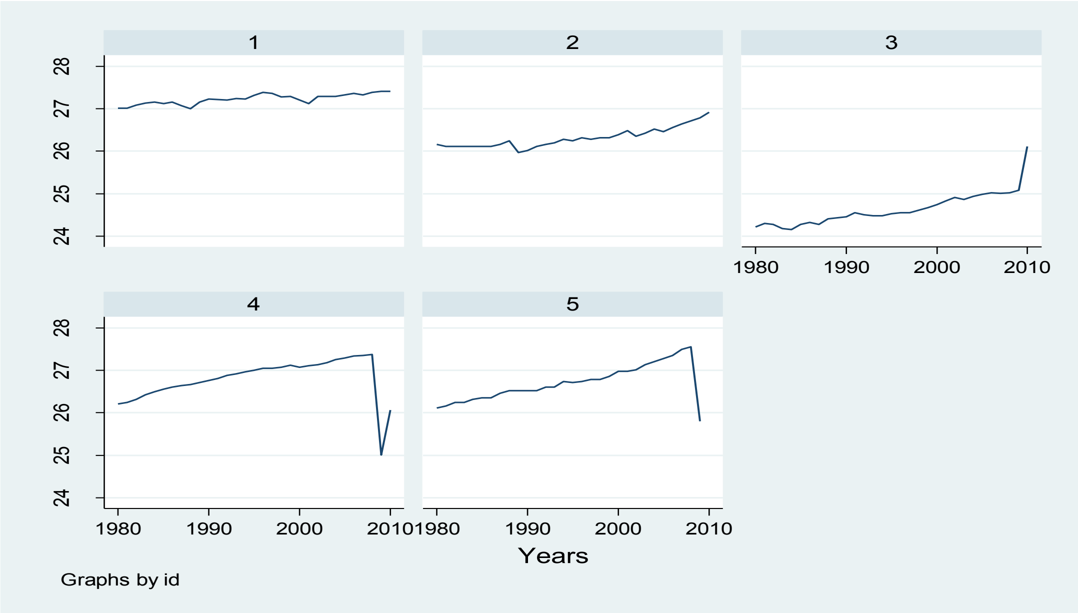
Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

Fig. 5



Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

Fig. 6

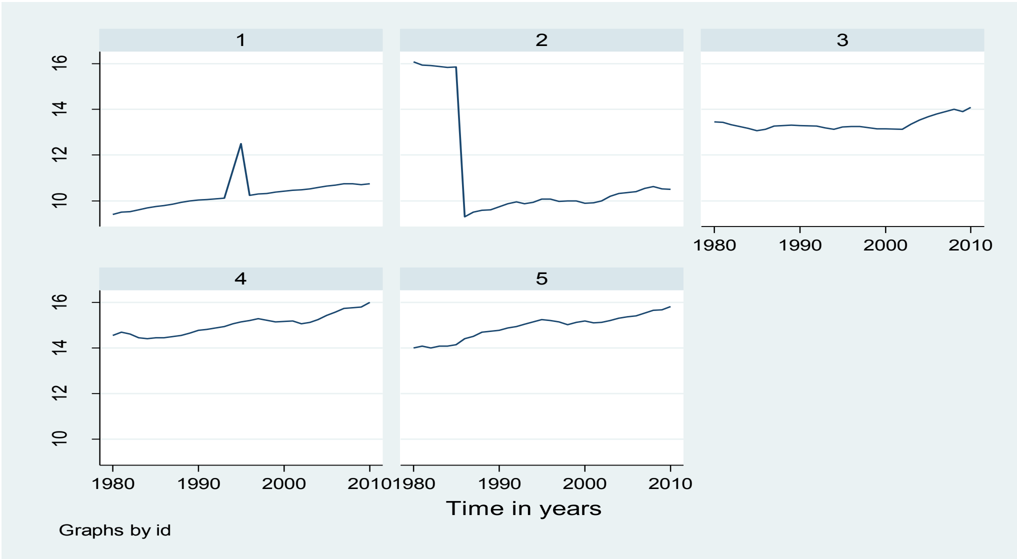


Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

Fig. 7

Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

Fig. 8

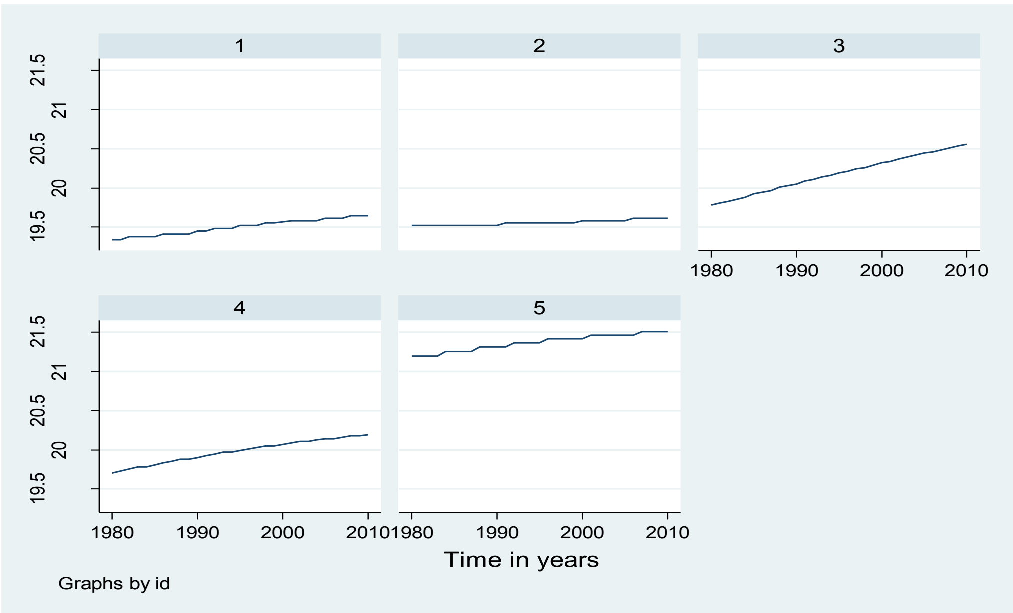


Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

plants is also on the decrease in all regions except in Africa where only minimal increases were recorded; this is attributable to complexities associated with nuclear waste disposal, cost of maintenance and development and finally the high risk associated with operating such plants, making regions not to have sufficient incentive to develop such generating capacities. Reliance on gas production sources are also on the increase for all regions except for Africa, this is attributable to the relative ease of development of gas plants and access to gas supplies to power such plants.

The use of gas plants in Africa has not experienced commensurate increase compared to other regions due to issues of poor technology and the cost implications of developing such plants since such technologies are often obtained overseas. Energy use in general across regions is on the increase making regions to be vulnerable. Population growth and industrial development in regions continue to exert strain on current generation infrastructure making countries in regions to be constantly engaged in development of more plants and use of cheaper and alternative methods in the generation process. (See Ojeaga, Azuh and Odejimi (2014) for further discussion)

Fig. 9



Note: The graphs above show trends for North America, Europe, Africa, Latin America and South East Asia respectively

3.1 Literature Review

In this section we review some literature related to the topic under study. Ojeaga et al (2014), state that availability of energy resources and access to interruptible energy generation supply is likely to hit Europe most owing to extreme cold winter temperatures and dependence on gas supply from Russia and other external sources.

They reiterate that while energy supply conditions in North America seem to be improving slightly in the 2000s with President Obama's recent approval in 2011/2012 of more drilling rights particularly on the US soil. Facts show that about 19% of the world electricity production comes from renewable energy sources with hydro electricity production alone accounting for about 16% of world electricity production (see International Energy Agency Report 2011).

The IEA Report 2011, mentions environmental constraints, industrialization rate, domestic consumption characteristics and regional specific investment in domestic technology as possible determinants of energy availability across regions.

Lots of literatures also continue to argue for diversification away from fossils due to overdependence (Cohen et al 2011), stating that diversification can lead to sustained supply and mitigate future risk of energy shortage attributable to cost related factors that affect gas supply availability.

Awerbach and Berger (2003) state that the cost in this case determines returns, and that cost are in fact the inverse function of returns, therefore optimizing portfolio cost is not likely to affect results making cost to have no effect on the generating mix.

Coq and Palseva (2004) and Newman (2004, 2007). State that increase in demand are not likely to affect energy security on the short-run since consuming countries are likely to shift to new exporters.

Jansen and Beurskens (2004) also study the impact of portfolio diversity on cost for energy importing countries and state that consumer countries should hold portfolios free of cost risk associated with the hikes in fossil fuel prices.

Knox-Hayes, Brown et al (2013) also attempt to study the effect of cross country energy policy effects on energy security from country specific perspective, to energy vulnerability aversion, they find that energy security is actually been affected by country specific domestic consumption and reliance on specific sources for energy generation.

Investment in domestic technology in regions is also ongoing with a steady rate of investment in Europe and North America and continuous improvement for Latin America and Africa. North America particularly the United States and Canada have some of the largest number of Wind generating plants in the World after China (Renewable Global Status 2006 – 2012 report).

Awerbauch, Stirling, Jansen and Beurskens (2004), define energy security in terms of portfolio diversity and green house gases (GHG) reduction concerns. Ojeaga, Azuh, Odejimi (2014), also state that Kyoto protocol will shape energy policy strategically but has been met with still resistances by the major fossil consumers.

Finally, they measure energy security using country specific signatory and participation in the Kyoto Accord and meeting proceedings, starting from 1998 when the first inter government panels were set up to 2010 when commitment towards emission reduction and implementation plans were emphasized, using score values of 1 to 3 depending on regional level of implementation and finally using consumption patterns in the pre Kyoto protocol years.

4.0 Theory and Methodology

Past theories show that having strong energy mix could substantially reduce supply risk in the energy generation process suggesting that cost is not likely to have any effect on the generating mix, Awerbach and Berger (2003).

Others also suggest that demand increases will not affect energy cost on the short run since consuming countries will seek new exporters Coq and Palseva (2004) and Newman (2004, 2007). Knox-Hayes, Brown et al (2013) explains otherwise stating specifically that energy security (risk of supply disruption) is currently be affected by increasing consumption in countries using a panel of several countries.

In this study we present a case where energy security in countries will depend on several factors, particularly how countries across regions, strategically deploy their scarce resources, to avert supply disruptions. We also consider factors that will affect the generation process since cases of rapid industrialization and improvement in domestic innovation could have cost implications for countries across regions. Factors that also drive dependence on specific generation sources in countries across regions are also examined to ascertain the reasons why particular sources of energy generation are likely to be vital to averting supply disruptions.

Therefore three different model specifications are examined; the first is that energy security will depend on energy policy (POL) in countries across regions, Country and regional size (REG SIZE), energy constraint (ENE CON), industrialization rate (IND RATE), domestic innovation (DOMINV) and finally environmental constraint (ENVCON).

This is likely to be true since policy will affect consumption patterns while cost of transmission will be a function of regional size, energy consumption will depend on domestic demand will be a function of population density while environmental constraint will limit production and increase cost since issues of low temperature during winter will drive up demand and cost and availability of natural resources to generate energy will also be a significant variable for regions.

Energy Security f (POL, REG SIZE, ENECON, INDRATE, DOMINV, ENVCON)

Generation will also be a function of the aforementioned six variables, energy policy (POL) in countries across regions, Country and regional size (REG SIZE), energy constraint (ENE CON), industrialization rate (IND RATE), domestic innovation (DOMINV) and finally environmental constraint (ENVCON). The generation process will be affected by policy through the generating mix. Since countries are likely to depend more on cheaper and relatively easy methods of energy generation.

Renewables (i.e. renewable energy production sources) are likely to be exploited by developed countries that have invested significantly in improving their technical capability in those production sources to mitigate the cost of fossils. The relative cheapness in acquiring such capabilities will also have strategic implication for poor developing countries not endowed with fossils who can gain substantially for other methods of generation.

Generation f (POL, REG SIZE, ENECON, INDRATE, DOMINV, ENVCON)

In the third model the effect of the six variables energy policy (POL) in countries across regions, Country and regional size (REG SIZE), energy constraint (ENE CON), industrialization rate (IND RATE), domestic innovation (DOMINV) and environmental constraint (ENVCON), on the individual generation mix is also considered for five different generation mix;

Generation Sources f (POL, REG SIZE, ENECON, INDRATE, DOMINV, ENVCON)

The likely relevance of this is that energy demand is likely to promote dependence on some specific sources of generation, thus making countries vulnerable to supply threats. While for instance many developed countries will want to face out nuclear reactors in the generating mix, supply threats and growing consumer demand for energy is not likely to make this realizable in the near future. The model specifications are written below as

(1.) $Energy\ Security_{i,t} = \alpha_0 + \alpha_1 POL_{i,t} + \alpha_2 X_{i,t} + u_{i,t}$

(2.) $Energy\ Generation_{i,t} = \alpha_0 + \alpha_1 POL_{i,t} + \alpha_2 X_{i,t} + u_{i,t}$

(3.) $Generation\ Source_{i,t} = \alpha_0 + \alpha_1 POL_{i,t} + \alpha_2 X_{i,t} + u_{i,t}$

With policy and domestic innovation having positive implication in all three model specifications allowing us to state that they are increasing functions of energy security, energy generation and the individual generating sources $POL_{i,t} \geq 0$ and $DOMINV_{i,t} \geq 0$. While all other variables are a decreasing function of energy security, energy generation and the generation sources $INDRATE_{i,t} \leq 0$, $ENVCON_{i,t} \leq 0$, $REGSIZE_{i,t} \leq 0$ and $ENECON_{i,t} \leq 0$. The method of estimation used in the study is the quantile regression estimation technique. It uses the median as a measure of dispersion instead of the mean. It is based on the intuition that the median of the sample will tend to that of the population. It provides robust estimate in the presence of outliers in the sample measure particularly the quantile regression wrapper (qreg2) as presented by Machando and Silva (2013). The bootstrapped simultaneous quantile regression estimation also provides the opportunity for re-sampling the dataset and testing the predictive capability of dataset in cases of stringency in the data.

5.0 Sources of Data

All data are obtained from the data market of Iceland and the World Bank unless otherwise stated. Panel data for seven regions were used for a period of 31 years (1980 to 2010). The table below shows all descriptive data used in the study. Three dependent variables are used in the study these are energy security measured using diversification in production capability, energy generation and output generation from five different sources namely hydro, gas, coal, nuclear and renewable energy in kilowatts hour (KWh). The six independent variables used include; **1.)** Energy policy which is measured using score of 1 to 5 for country across regions specific commitment to emission cut, signatory and participation in Kyoto accord **2.)** Energy consumption in kilowatts/hour, this is the aggregate consumption of energy in countries across regions **3.)** Environmental constraint was represented using average regional temperatures since extreme cold temperature could drive up energy demands, **4.)** Domestic innovation was measured using country specific investment in innovation and research and development, **5.)** Industrialization rate was measured using GDP/capita **6.)** Regional size was captured using regional size measured in square kilometers and **7.)** Finally energy consumption which is the total energy consumed across regions in Kilowatts Hours (kWh).

Table-2 Descriptive Statistics Used in the Study

Variable	Observations	Mean	Std. Dev	Min	Max
Energy Security (ENESEC)	155	2.96	0.84	2	5
Total Energy Production in Regions	109	6790000	1260000	3300000	43000000
Production from Hydro Sources	155	8861	4464	26	16960
Production from Gas Sources	125	570	1391	0	8528
Production from Coal Sources	155	4266	2797	0	11750
Nuclear production Sources	155	660	1111.9	0	4006
Production from Renewable Sources	124	3820000	243000	310000000	920000000
Industrialization Rate (INDRATE)	154	1867753	226528.5	10000000	300000000
Energy Policy (POL)	155	1.4	0.57	1	3
Energy Consumption (ENECON)	154	1915535	947609.8	28.8	3300000
Domestic Innovation (DOM. INN)	132	3369.689	1812.66	-4.32	6694
Environmental Constraint (EVNCON)	144	2750.256	30.56	-0.06	16541

Note: Descriptive statistics is derived from author's dataset obtained from data market of Iceland and WDI data of the World Bank.

Table-3. List of Variables and Description

Variables	Sources	Abbreviations	Description
Energy Security	Authors Compilation	ENESEC	Energy security measured using diversification in production capability, energy generation and output generation from five different sources namely hydro, gas, coal, nuclear and renewable energy in kilowatts hour (kWh).
Total Energy Production	Data Market of Iceland	ENEPROD	Aggregate energy production across regions.
Production from Hydro Generation Sources	Data Market of Iceland	HYDROPROD	Production from hydro generation sources in kilowatts hour (kWh)
Production from Coal Generation Sources	Data Market of Iceland	COALPROD	Production from coal generation sources in (kWh)
Production from Gas Generation Sources	Data Market of Iceland	GASPROD	Production from gas generation sources in kilowatts hour (kWh)
Production from Nuclear Generation Sources	Data Market of Iceland	NUCPROD	Production from nuclear generation sources in kilowatts hour (kWh)
Production from Renewable Energy Generation Sources	Data Market of Iceland	RENEWROD	Production from renewable energy generation sources (e.g. wind, biogas, solar etc)in kilowatts hour (kWh)
Environmental Constraint	Data Market of Iceland	ENVCON	Production from hydro generation sources in kilowatts hour (kWh)
Regional Size	Data Market of Iceland	REGSIZE	Regional size in square kilometers
Industrialization Rate	Data Market of Iceland	INDRATE	Industrialization rate measured using GDP per capita.
Domestic Innovation	Data Market of Iceland	DOMINNV	Domestic innovation measured using regional specific investment in research and development.
Energy Consumption	Data Market of Iceland	ENECON	Aggregate consumption of energy across regions in kilowatts hour (kWh)
Energy Policy	Data Market of Iceland	POL	Energy policy was measured using score of 1 to 5 for country across regions specific commitment to emission cut, signatory and participation in Kyoto accord

Note: All data are obtained from Data Market of otherwise stated. Energy security variable is developed by authors.

6.0 Empirical Analysis and Results

In this section we present the intuition behind the study and the results of the three model specification. Regions will continue to strategically deploy their scare resources towards ensuring cheap and readily available energy for both domestic and industrial consumption. Issues of how to curb emissions and climatic challenges will also affect regional consumption patterns. Ensuring uninterruptible supply of energy generating resource will also encourage diversification in regions and in turn shape the development of different production capabilities across regions. Allowing us to state that;

a. Regions will use energy policy to shore up energy security and reduce supply risks by ensuring diversification of the production process.
b. Investing in domestic technology will ensure that cheaper and local resource dependent plants are built.
c. Domestic demand will inform dependence on certain energy generation sources for instance cost implications and rising demand for energy will cause developed regions to depend on nuclear generation sources despite the challenges associated with disposing nuclear waste.
d. The hazard associated with nuclear generation will reduce the dependence on nuclear energy as a generation source.

Results in Table 4 where we show the effect different factors on energy security show that energy policy and domestic innovation (captured using regional specific investment in domestic technology) were having useful effects on energy security across regions.

The results in table 5 also show that regional size was having a negative effect on energy generation while investment in domestic innovation was improving the generation process. The results in Table 6 where we study the effects of different factors on energy security provide interesting and useful insights into different factors that shape the individual sources of generation. Hydro generating sources were affected by regional size and energy consumption significantly which were both promoting regional dependence on hydro generation sources. Industrialization rate was also increasing the use of gas generating plants, since fossils were readily available and the relative cheapness of developing gas plants were also promoting the use of the source. However regional size had a negative effect on gas plants usage, this is attributable to the cost of transportation to gas generating plants.

Energy consumption was also driving dependence on nuclear generation sources while environmental concerns were having a reducing effect on energy use. Investments in domestic technology were continuing to yield results for renewable energy generation sources. This was probably due to the relative cheapness of the sources and the long run environmental friendly characteristics of the source.

The initial objectives of the study are achieved and reviewed below:

1. Regional policy had no significant effect on the generation process.
2. Regional energy policy had strong consequences for the supply process thus were positively mitigating risk of supply and aiding diversification in energy usage.
3. Industrialization rate had negative effects on energy security posing a threat to energy supply and diversification. However the results were not robust since the preferred Qreg2 regression results were not significant.

Table 4. The Effect of Regional Energy policy on Energy Security

	(1)	(2)	(3)	(4)
	Qreg	Qreg2	Sqreg	Bsqreg
Variables	Energy Security	Energy Security	Energy Security	Energy Security
Regional size	-8.77	-8.77	-8.77	-8.77
	(5.08)	(2.68)	(3.83)	(4.10)
Energy Policy	1.28***	1.28***	1.28***	1.28***
	(0.07)	(0.21)	(0.20)	(0.28)
Ind. Rate	-4.40***	-4.40	-4.40	-4.40
	(1.46)	(7.11)	(5.82)	(8.72)
Energy con.	-2.17***	-2.17	-2.17	-2.17
	(3.78)	(2.40)	(2.07)	(1.82)
Dom. Innov.	0.0003***	0.0003***	0.0003**	0.0003**
	(2.05)	(7.08)	(0.0001)	(0.0001)
Env. constraint	-0.0002***	-0.0002**	-0.0002**	-0.0002*
	(9.29)	(6.96)	(5.96)	(7.90)
Year Effect	No	No	No	No
Observations	113	113	113	113
R-squared		0.63		

Note: Standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$. The above result shows the effect of regional policy on energy consumption. Policy has strong effects on mitigating supply risks. Ind rate represents industrialization rate, energy con represents energy consumption, Dom. Innov. represents domestic innovation and Env. Constraint is environmental constraints.

Table 5. The Effect of Energy Policy on Energy Generation

	(1)	(2)	(3)	(4)
	Qreg	Qreg2	Sqreg	Bsqreg
Variables	Generation	Generation	Generation	Generation
Regional Size	-582.78***	-582.78	-582.78	-582.78
	(181.48)	(1.44)	(2.26)	(1.97)
Energy Policy	-1.94	-1.94	-1.94	-1.94
	(2.40)	(5.55)	(3.46)	(4.29)
Ind. Rate	-1.65**	-1.65	-1.65	-1.65
	(6.50)	(3.32)	(4.58)	(3.02)
Energy con.	913.48	913.49	913.49	913.49
	(1.08)	(3.19)	(1.00)	(6.09)
Dom. Innv.	2.17***	2.17	2.17	2.17
	(7.01)	(3.97)	(2.35)	(5.19)
Env. Constraint	2.00	2.00	2.00	2.00
	(2.63)	(1.19)	(8.05)	(6.73)
Year Effect	Yes	No	No	No
Observations	82	82	82	82
R-squared		0.14		

Note: Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. The above results show the effect of energy policy on the overall generation process. Ind. rate represents industrialization rate, energy con represents energy consumption, Dom. Innov. represents domestic innovation and Env. Constraint is environmental constraints.

Table 6. Effect of Regional Policy on Different Generation Sources

	(1)	(2)	(3)	(4)
	Qreg2	Qreg2	Qreg2	Qreg2
Variables	Hydro Sources	Gas Sources	Nuclear Sources	Renewable Sources
Regional size	0.001***	-2.00*	-2.30	-21.91
	(7.90)	(1.14)	(2.27)	(18.47)
Energy policy	1.60	93.5	693.8*	5.83
	(1.54)	(101.8)	(36.8)	(5.93)
Ind. Rate	9.42	5.40**	-0.0002***	4,835
	(0.0002)	(2.51)	(7.48)	(18.03)
Energy Con.	0.003**	2.09	0.0002**	-66.67
	(0.002)	(4.20)	(8.95)	(78.68)
Dom Innv.	0.67	-0.04	-0.17	1.21***
	(0.44)	(0.04)	(0.14)	(4.09)
Env. Constraint	-0.35	0.0002	-0.06**	-2.38
	(0.25)	(0.014)	(0.024)	(1.83)
Year Effect	No	No	Yes	Yes
Observations	112	88	113	112
R-squared	0.24	0.26	0.74	0.42

Note: Standard errors in parentheses*** p<0.01, ** p<0.05, * p<0.1. The above results show the effect of regional policy on the individual generation sources. Ind rate represents industrialization rate, energy con represents energy consumption, Dom. Innov. represents domestic innovation and Env. Constraint is environmental constraints.

7.0 Discussion and Conclusion

The study provides useful incites for policy makers who wish to understand factors that affect energy supply and generation in countries across regions. The results of the study show that energy policies across regions were not having useful implications for the generation process.

Furthermore energy policies were improving the supply process for generation, mitigating the risk of energy availability disruption but were not increasing the generation capacity across regions.

Industrialization trends prove to be faster than regional improvement in production capability. The risk is that developed countries were relying more on gas plants due to the relative cheapness in their acquisition and on nuclear generation sources making these two capabilities to be the mainstay in the generation process in many developed countries.

Renewable energy generation was being improved by increasing investment in domestic innovation. Developed countries were experiencing returns on investment on renewable energy production capabilities with relative increase in renewable energy production. The implication of this is that renewable energy sources were fast becoming popular and could be quite useful in the future.

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Using the median and the mean of the income to establish the poverty lines

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Abstract

One of the methods to estimate the poverty level inside a given population is based on how to define the poverty line values. Each person having his income under the poverty threshold will be considered to be poor. In the literature we distinguish at least three approaches: to evaluate the absolute poverty line, to find a relative poverty threshold depending on the main indicators of the income distribution in the analyzed community or to assume a subjective point of view.

The procedures for determining the relative poverty lines are based in practice on the mean or the median of the population income. To assure a concordance between the concrete estimation of several possible poverty thresholds and the poverty and inequality real phenomena we proposed to be verified three conditions. Finally, we also proved by examples that each of these restrictions are not obligatory satisfied by an arbitrary real positive data set.

The present study will be extended in the future to assure a theoretical support for estimating more exactly the relative poverty lines.

Keywords: relative poverty line, inequality, axioms, measurement, Gini index, income distribution, mean, median.

JEL classification: I32, C51, D63.

1. Measuring the inequality

To simplify our presentation we will consider in the next sections only the income of the persons in order to distinguish between the individuals. In reality the persons from a given population can be grouped using a multitude of criteria which are usually distinct from their monetary status. We must mention here the classifications based on the religion, education, age, gender, tradition, coefficient of intelligence, charisma, type of personality, individual skills, a variety of preferences, the acceptance of different social and cultural values, the possession of some goods, etc. The inequalities which appear inside a community define a complex phenomenon which takes into considerations all the attributes of a person.

The dispersion of the individual wage is often used in practice to measure the income inequality. Amartya Sen classified the inequality measures into objectives and normative ones. The normative indices are characterized by the effect on a social welfare redistribution. As an alternative way, the objective measures of inequality are based with priority on statistical methods to evaluate the effect of the income dispersion among the persons from the studied group.

For diminishing the social inequality is very important to emphasize the relevant causes of the income inequality. So, we distinguish in reality endogenous and exogenous causes too (for details see Jorge A. Charles-Coll [4]). In fact the income inequality is regarded as the cumulative effects of all endogenous and exogenous conditions which influence permanently, in an active way, the individuals, as well as the groups.

In [4] are analysed a lot of indicators designed to measure the inequality aspects from a population. The most well known coefficients are : relative mean deviation, variance, coefficient of variation, variance and standard deviation of the logarithm, income shares and income quantiles ratio, Theil and Pietra indices, Hoover indicator and Gini coefficient.

From all known inequality measures, Gini coefficient is the most popular index.

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Let X be the data set containing only nonnegative real numbers $x_1, x_2, x_3, \dots, x_n$ which are not necessary distinct values. We sort all these values x_i, $0 \le i \le n$, in an ascending order such that $x_{(1)}$ and $x_{(n)}$ are the minimum, respectively the maximum of the x_i quantities. More precisely

$$x_{(1)} \le x_{(2)} \le x_{(3)} \le \dots \le x_{(n-1)} \le x_{(n)}$$

To simplify our presentation we define the partial sums

$$S_k = x_{(0)} + x_{(1)} + x_{(2)} + x_{(3)} + \dots + x_{(k)}, \ 0 \le k \le n$$

with the convention

$$x_{(0)} = 0$$

In this context, the Gini coefficient determined by the data set X, has the following form (more details in [12])

$$Gini(X) = 2 \sum_{k=1}^{n} A_k$$

where the areas A_k are given by the expressions

$$A_k = \left(\left((k-1)/n - S_{k-1}/S_n\right) + \left(k/n - S_k/S_n\right)\right)\left(k/n - (k-1)/n\right)/2$$

Concluding

$$Gini(X) = \frac{1}{n} \sum_{k=1}^{n} \left(\left((k-1)/n - S_{k-1}/S_n\right) + \left(k/n - S_k/S_n\right)\right) \qquad (1.1)$$

The health status is a new other important characteristic of a person. Amartya Sen underlines in [10] that illness and health must figure too as a major condition regarding the quality of live of the persons. We emphasize here that the studies about the population health and health care are very important to propose an equitable public policy.

For this reason, to establish correctly the level of inequality which is present among the individuals of a given community, we often apply the concentration index of health (Erreygers, [5], [6]). Koolman and Van Doorslaer used also in [7] the concentration index, intending to measure the relative inequality of health in Europe. It is very well known the relationship between the concentration indicator, the coefficient of variation and a type of correlation index (see [7]).

The literature underlines a relevant link between the socio-economic status x of a person and his health status $h(p)$, p being the rank associated to the quantity x which belongs to the set values X ([14], [15], [7]). More precisely, if X are the wages of all individuals from a given population, then $p = F(x)$, where $F(x)$ is the cumulative distribution function of the income variable X.

In this context the health achievement indices defined by Wagstaff et all. ([14], [15], [16]) have the expression

$$W(X;r) = \int_0^1 r(1-p)^{r-1} h(p)\, dp \qquad (1.2)$$

where r is regarded as a health inequality aversion parameter.

The Wagstaff's health index $W(X;2)$, resulted for an aversion of risk $r = 2$, is just the standard health concentration index. This particular variant of the indicator $W(X;r)$ is widely used in practice for measuring the health inequality.

Makdissi and Yazbeck proposed in [9] a more general class of health achievement and inequality indices based on an axiomatic approach. The accepted health indices must verify five axioms, that is : monotonicity, pure healh transfer, socioeconomic health transfer, pure health trasfer sensitivity and socioeconomic health transfer sensitivity (more details in [9]).

2. The poverty lines

The poverty reduction is the main goal of all development policies. But in the literature there is little agreement about a consensus regarding the poverty definition. Concerning the poverty measures there are at least four theoretical approaches. Consequently, we mention here the implementation of very different principles as follows: the monetary point of view, take into consideration the human potential, social exclusion or the participatory activity ([8]).

The monetary approach is the most commonly used in practice. In fact this method measures the underperformance in income or consumption of the individuals. For the subsequent we will measure the poverty basing only on the income X of the persons.

As a result, any person which has his income x under the poverty threshold π will be considered poor. The value of this threshold π is usually known in socio-economic studies as the "poverty line".

The choice of a concrete method which defines the poverty threshold is extremely important to understand correctly the poverty phenomenon. Some basic criteria to estimate the poverty lines are presented in [3]. Many studies mentioned by the literature link the poverty line with the minimal labor wage, the social security assistance or with the minimal pension for retirement and age (see [3]).

Concerning the establishment of the poverty lines we identify in practice three basic approaches : an absolute poverty line, a relative poverty threshold or a subjective one. The subjective score cumulates the people's perception about the minimum necessary for a standard family budget to assure a decent life. The absolute poverty threshold takes into consideration the lowest amount of money necessary to satisfy the basic needs of the individuals from a given community. The income or the expenditures of the persons are also used to determine the relative poverty upper limit. More exactly, the relative poverty lines π_1 and π_2 are computed as a proportion from the mean or median income X of the whole population.

Preserving the previous notations, the arithmetic average $Mean(X)$ of all values x_i, $1 \le i \le n$, from the data set X has the expression

$$Mean(X) = (x_1 + x_2 + x_3 + ... + x_n)/n = (x_{(1)} + x_{(2)} + x_{(3)} + ... + x_{(n)})/n \tag{2.1}$$

The median indicator $Mdn(X)$ associated to the set x_i is computed by the formula

$$Mdn(X) = \begin{cases} (x_{(m)} + x_{(m+1)})/2 & ; \quad when \;\; n \;\; is\ even \\ x_{(m+1)} & ; \quad when \;\; n \;\; is\ odd \end{cases} \tag{2.2}$$

where m is the integer part of the real value $n/2$.

Respecting these notations in the literature are proposed

$$\pi_1 = \alpha\, Mean(X) \qquad \pi_2 = \beta\, Mdn(X) \tag{2.3}$$

with given proportion coefficients $0 < \alpha, \beta < 1$ (see for example Berthoud's approach, [2]).

Berthoud ([2]) mentioned the weights $\alpha = 0.5$ and $\beta = 0.6$ which were applied to year 1998 to determine the relative poverty lines.

In addition, the selected values of the coefficients α and β assured for year 1998 a very good approximation $\pi_1 \approx \pi_2$, that is

$$\alpha\, Mean(X) \approx \beta\, Mdn(X)$$

So, using a new other data set X we obtain different values for $Mean(X)$ and $Mdn(X)$ parameters which characterize the distribution of the income X . For this reason we could work in this case with another ratio α / β ,

$$\alpha / \beta = Mdn(X) / Mean(X) \quad (2.4)$$

It is clear that for a same socio-economic analysis the proportion α / β does not have to fluctuate very much when is taken into consideration another subgroup of the population. So, the ratio α / β must be comparatively unchanged.

In practice, for every country is defined its own relative poverty line. So, to compare the poverty phenomenon from more countries is necessary to calibrate all these poverty thresholds ([2], [1]). For this reason is indispensable to establish an unitary methodology to estimate comparable cross-nationality poverty indicators ([1]).

To work with realistic poverty thresholds we should establish a set of axioms which must be verified by the poverty lines. In this context we suggest to consult a practical study about the reconsideration of the poverty lines in Malaysia ([13]).

We saw that the relative poverty threshold could be taken as a proportion from the population mean. In [11] is discussed an empirical method to locate the mean $Mean(X)$ of a random variable X depending on the mode of its probability density function. The form of the p.d.f. tails performs many times an important role to establish the real position of the $Mean(X)$ indicator.

3. Restrictions for poverty and inequality indices

Now we intend to propose some axioms which must be validated by all relative poverty lines.

In section 1 we talked about a large variety of indices for measuring the degree of inequality which exist inside the data set X . From all these indicators we will choose Gini's coefficient $Gini(X)$ to analyze the disproportions of the wages of X (formula 1.1).

We remind that both the mean and the median distribution parameter were applied together in section 2 to characterize the relative "poverty threshold" π for the elements of the data set X .

Taking into consideration the relation (2.4) with the EU coefficients $\alpha = 0.5$ and $\beta = 0.6$ (Berthoud [2]) we deduce $Mdn(X) / Mean(X) = \alpha / \beta < 1$. Therefore we will require to be satisfied the following condition (at least for EU countries):

C1. For any data sets X and Y we have $Mdn(X) < Mean(X)$.

In practice is important to study the concordance of the functions $Mean(X)$, $Mdn(X)$ and $Gini(X)$ concerning the monotony property. For this reason we will associate to all data sets X and Y the symmetric indicators :

$$\Delta(X,Y) = (Mdn(X) - Mdn(Y))(Mean(X) - Mean(Y)) \quad (3.1)$$

$$\delta(X,Y) = (Mdn(X) - Mdn(Y))(Gini(X) - Gini(Y)) \quad (3.2)$$

Our approach uses the values of the indices $Mdn(X)$ and $Mean(X)$ to define the relative poverty thresholds which characterize the poor people from the population X . In this context, to assure a good comparison between the poverty levels of two distinct populations X and Y , we imposed the restriction:

C2. $\Delta(X,Y) \geq 0$ for any populations X and Y .

Frequently we relate in practice the poverty phenomenon with the inequality aspects. More precisely, increasing (diminishing) the number of poor people inside the community X is often grown (decreased) the degree of inequality existing between the individuals of X . Generally, in many sociological studies, the relative poverty line is based on the median coefficient. Having in mind all these aspects we must certify the following conditional demand:

C3. For two arbitrary data sets X and Y we must have $\delta(X,Y) \geq 0$.

4. Some examples

In the subsequent we will consider seven data sets *X1-X7* , every variable X having the values x_i, $1 \leq i \leq n$, which belong to the open interval $(0\ ,1)$. For this reason we always have the inequalities

$$0 < Mean(X) < 1 \ , \quad 0 < Mdn(X) < 1$$

Table 4.1 contains the concrete data sets *X1-X7* with the same volume $n = 21$.

In *Table 4.2* are listed the values of the indicators *Mean(X), Mdn(X), Gini(X)* and the ratio α / β which characterize the sets *X1-X7*.

Table 4.1 **The data sets *X1-X7.***

X1 **:**						
0.2332	0.0794	0.0082	0.0683	0.9942	0.0852	0.8446
0.6496	0.0271	0.0525	0.8907	0.0810	0.7903	0.1047
0.8255	0.3399	0.0436	0.9569	0.9914	0.1028	0.7525
X2 **:**						
0.7620	0.9886	0.9806	0.2988	0.9357	0.9492	0.9946
0.9155	0.9681	0.6408	0.0022	0.2161	0.9786	0.1358
0.9712	0.2207	0.0092	0.7013	0.1516	0.9142	0.8019
X3 **:**						
0.1592	0.7845	0.7974	0.6231	0.1423	0.7782	0.6810
0.5910	0.0920	0.0837	0.0178	0.9963	0.0402	0.1319
0.1712	0.9778	0.8741	0.9804	0.0706	0.1340	0.9388
X4 **:**						
0.7649	0.8084	0.7062	0.7037	0.0525	0.1401	0.8132
0.1971	0.5504	0.8323	0.0191	0.6570	0.6229	0.9089
0.0818	0.4858	0.0980	0.6403	0.6664	0.2556	0.0301
X5 **:**						
0.9140	0.0169	0.0410	0.1140	0.7097	0.5125	0.9660
0.1539	0.2550	0.1086	0.3585	0.5579	0.1673	0.9905
0.9838	0.9393	0.8057	0.5147	0.4281	0.0242	0.7740
X6 **:**						
0.9299	0.0442	0.9902	0.9427	0.1680	0.0519	0.9169
0.9746	0.1406	0.9185	0.9327	0.0979	0.7015	0.3001
0.9083	0.8628	0.0196	0.8414	0.2232	0.8555	0.0211
X7 **:**						
0.5541	0.2498	0.9642	0.1116	0.7625	0.7570	0.4609
0.8994	0.9012	0.4822	0.5389	0.2056	0.7568	0.6112
0.0669	0.2622	0.8433	0.9843	0.5792	0.2476	0.2129

Table 4.2. **The statistical characteristics of the data sets *X1-X7*.**

Data set	*Mean*(*X*)	*Mdn*(*X*)	*Gini*(*X*)	α / β
X1	0.42483	0.23317	0.49392	0.54885

X2	0.64461	0.80188	0.30690	1.24398
X3	0.47932	0.59102	0.43065	1.23304
X4	0.47784	0.62293	0.35888	1.30364
X5	0.49217	0.51246	0.40472	1.04123
X6	0.56389	0.84139	0.37683	1.49212
X7	0.54533	0.55409	0.30372	1.01606

Now we intend to distinguish between the sets *X1-X7* using the criteria ***C1-C3***.

First, only the data set *X1* validates the condition ***C1***. All the other variables, that is *X2-X7*, do not verify the restriction ***C1***. From the point of view of the requirement ***C1*** the variable *X1* plays a distinct role.

In an opposite way, most of the pairs of variables (X_j, X_k) accomplished the constraint ***C2***, We enumerate here the cases : *(X1 , X2) ; (X1 , X3) ; (X1 , X4) ; (X1 , X5) ; (X1 , X6) ; (X1 , X7) ; (X2 , X3) ; (X2 , X4) ; (X2 , X5) ; (X2 , X7) ; (X3 , X6) ; (X4 , X6) ; (X5 , X6) ; (X5 , X7) ; (X6 , X7) . As alternative, the pairs (X2 , X6) ; (X3 , X4) ; (X3 , X5) ; (X3 , X7) ; (X4 , X5) ; (X4 , X7)* do not verify the axiom ***C2***.

The condition **C3** is satisfied by the pairs of variables : (X2 , X6) ; (X2 , X7) ; (X3 , X5) ; (X3 , X7) ; (X4 , X6) ; (X4 , X7) ; (X6 , X7) . But we do not include here the pairs of data sets : (X1 , X2) ; (X1 , X3) ; (X1 , X4) ; (X1 , X5) ; (X1 , X6) ; (X1 , X7) ; (X2 , X3) ; (X2 , X4) ; (X2 , X5) ; (X3 , X4) ; (X3 , X6) ; (X4 , X5) ; (X5 , X6) ; (X5 , X7).

Concluding, the restrictions ***C1-C3*** are satisfied only by a part of the real data X . A lot of imagined data sets X do not verify necessary all these axioms.

5. Concluding remarks

The relative poverty lines were defined in practice by using a proportion from the mean or from the median of the wages for the individuals of a known population.

Having in mind a possible link between the poverty and the inequality phenomena and to ensure a concordance among different poverty thresholds we proposed three axioms ***C1-C3***. These axioms must be verified by all income data sets X .

Finally we proved that an arbitrary real data set do not satisfy necessary the conditions ***C1-C3***. Therefore, more elaborate theoretical studies about the concrete selection of the relative poverty lines are needed to be developed in the future.

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R-evolution in Time Series Analysis Software Applied on R-omanian Capital Market

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Abstract

Worldwide and during the last decade, R has developed in a balanced way and nowadays it represents the most powerful tool for computational statistics, data science and visualization. Millions of data scientists use R to face their most challenging problems in topics ranging from economics to engineering and genetics. In this study, R was used to compute data on stock market prices in order to build trading models and to estimate the evolution of the quantitative financial market. These models were already applied on the international capital markets.

In Romania, the quantitative modeling of capital market is available only for clients of trading brokers because the time series data are collected for the commercial purpose; in that circumstance, the statistical computing tools meet the inertia to change. This paper aims to expose a small part of the capability of R to use mix-and-match models and cutting-edge methods in statistics and quantitative modeling in order to build an alternative way to analyze capital market in Romania over the commercial threshold.

Keywords: quantmod, financial modeling, R, capital market, trading models.

1. Introduction

Forecast the financial asset prices has become a challenge in the more unpredictable and volatile world. The use of software have become very extensive in the financial field, most of the econometric models focuses on the capital market data. In this sense, *"if you don't go with R now, you will someday"*[5]. In last period of time, progress in statistics has been marked by the increasing availability of software, such as the most known and open source R system. This has the potential to continue the transformation from a set of techniques used and developed by statisticians and computer scientists to an essential system of analysis tools for a much larger community. A large area of new and improved software packages has facilitated the implementation burden for many statistical analysis methods.

At the same time, there is growing a greater recognition of the statistical computational methods using R as a powerful tool with important practical applications across a number of research areas, from economics to the social sciences and beyond of these. This trend will continue with the increasing availability of huge quantities of data and the software to analyze it. R, as a statistical application development environment, merges many forms of innovation, even if initially it belongs, as intrinsic value, of innovation itself by introducing a new concept analysis tools market data. Empowering of innovation is achieved by enabling the possibility that scientific community has to create and introduce scientific software packages, which summarize a number of functions in a particular area of research. The second form of innovation is achieved because of the potential of the scientific community to contribute to improve the existing packages by changing these functions or by adding new functions within the legal framework of open source licensing.

In this study, R was used to compute data on stock market prices in order to build trading models and to estimate the evolution of the quantitative financial market. These models were already applied on the international capital markets.

In Romania, the quantitative modeling of capital market is available only for clients of trading brokers because the time series data are collected for the commercial purpose; in that circumstance, the statistical computing tools meet the inertia to change.

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2. Documentation/Literature review

Finance issues have traditionally been one of the two key users of the S language, and this constituency has moved from S+ to R. In recent years, R has grown tremendously both in terms of capabilities and users, being also increasing use in Finance field. Hence, R provides an excellent platform for academic research and teaching - as well as investment research and trading.

R is used for statistical analysis, data manipulation, visualization and exciting applications in various fields like: statistics, economy, financial, business, genetics, engineering, biology and many more. One of its big advantages is the linkage with the way statisticians think and work (e.g.: keeping the track of missing values). The wide area of use - statistics, mapping, finance, forecasting, social networking, computational biology and many more – makes R a common language for all the researchers and data analysts.

The most recently used R packages for modeling the quantitative data on capital market was started to develop in 2008 and upgraded in 2013 [8]. Besides these packages, a very wide variety of functions suitable for empirical work in Finance is provided by both the basic R system (and its set of recommended core packages), and a number of other packages on the Comprehensive R Archive Network (CRAN).

Although there are many books on finance across the world, being a very new statistical tool to explore quantitative data on capital market, few deal with the statistical aspects of modern data analysis as applied to financial problems. This paper is the first step in filling this gap by addressing some of the most challenging issues facing any financial analysis.

3. Modeling financial data with R

This paper aims to expose a small part of the capability of R to use mix-and-match models and cutting-edge methods in statistics and quantitative modeling in order to build an alternative way to analyze capital market in Romania over the commercial threshold. It also supplies for academic research area an accessible approach to financial econometric models and their applications to real-world empirical research.

Econometric models can be used to predict values for next period of time. For that, many model systems in R use the same function, conveniently called *predict*. Predict is a generic function for predictions from the results of various model fitting functions. The function invokes particular methods which depend on the class of the first argument. Most prediction methods which are similar to those for linear models have an argument *newdata* specifying the first place to look for explanatory variables to be used for prediction. Some considerable attempts are made to match up the columns in *newdata* to those used for fitting, for example that they are of comparable types and that any factors have the same level set in the same order. Building a quantmod model with a given specified fitting method currently uses some function as the followings: lm, glm, loess, step, ppr, rpart, tree, random Forest, mars, polymars, lars, rq, lqs, rlm, svm, and nnet. Additional methods wrappers can be created to allow for modelling using custom functions. The only requirements are for a wrapper function to be constructed taking parameters quantmod, training.data. The function return the fitted model object and have a predict method available.

3.1. Data source

Extraction of financial time series from available Internet sources is a highly discussed topic lately, both in academia and in the specific brokers. For this there are at least two solutions. The most common are commercial solutions, but have both financial and technical barriers. Financial barriers are taxes connecting to databases or even the cost of a software environment that provides access to such databases. Technical barriers consist of dependency that we have from the software provided by the broker or the entity through which we access to these data sets. In recent years more and more available open access database and access them are designed for a variety of software environments. In this paper we have chosen to present some packages available in R, and the most used are quantmod and Quandl (Table 1, Annex1, 2).

The authors of the present study did the computation of data, but the ensuring the quality and correctness of statistical or scientific software constitutes the responsibilities of scientific software developers and scientists who provide the codes to solve a specific computational task.

Table 1. Financial Data Sources and R packages

Source	R package	Free access	Available on CRAN	Provider url
Yahoo, FRED, Oanda, Google	Quantmod	Yes	Yes	Quantmod
Quandl	Quandl	Yes	Yes	Quandl
TrueFX	TFX	Yes	Yes	TrueFX
Bloomberg	Rbbg	No	No	findata
Interactive Broker	IBrokers	No	Yes	InteractiveBrokers
Datastream	rdatastream	No	No	Datastream
Penn World Table	pwt	Yes	Yes	Penn World Table
Yahoo, FRED, Oanda	fImport	Yes	Yes	Rmetrics
ThinkNum	Thinknum	Yes	Yes	ThinkNum
DataMarket	rdatamarket	Yes	Yes	DataMarket

Source: The R Trader, "Financial Data Accessible from R – part IV", December 2013, [Online], Available: http://www.r-bloggers.com/financial-data-accessible-from-r-part-iv/ [Accessed Jan. 15, 2014]

The package quantmod has capability of downloading stock and index prices from Yahoo Finance and Google Finance and contains plotting and charting functionality. The Quandl package is a bit different in that it is tied in with the Quandl website, a source of financial data itself, as well as a portal to economic and social science data [7]. In our analysis we used version 3.0.2. R software with different packages explained adequately before running code.

3.2. Using quantmod package

The quantmod package is a *Quantitative Financial Modelling & Trading Framework* for R, designed like an environment to assist the quantitative trader in the development, testing, and deployment of statistically based trading models. The quantmod has been created to have functions which could easily use to replicate in R data modeling, so that we could access that functionality using a function with defaults and naming consistent with common usage in the finance literature.

As with any other R package, one must install the quantmod package in the usual way. As an aside, included with the installation is also the xts package for time series data, which we will discuss briefly later on.

To install the package we run the following code:

```
> install.packages("quantmod")
```

Then, we load the package:

```
> library(quantmod)
```

The traders are quite familiar with the finance sites on Yahoo and Google as sources for tracking stock, mutual fund, and exchange traded fund (ETF) prices and returns. With quantmod, we can easily load this data into R by specifying the same ticker symbol that is used in these two web sources. Also, an important data series providers is Oanda.com trader, especial for Romanian users.

```
> getSymbols("RONEUR" , src="oanda")
[1] "RONEUR"
```

The data set is returned to the R session in the form of an xts object with the name `RONEUR`. To check the contents we use the head(.) and tail(.) R functions:

```
> head(RONEUR)
           RON.EUR
2012-09-14  0.2224
2012-09-15  0.2222
2012-09-16  0.2224
2012-09-17  0.2224
2012-09-18  0.2226
2012-09-19  0.2224
```

```
> tail(RONEUR)
           RON.EUR
2014-01-10  0.2215
2014-01-11  0.2204
2014-01-12  0.2202
2014-01-13  0.2202
2014-01-14  0.2208
2014-01-15  0.2211
```

We can have access to any stock price history available on Yahoo or Google Finance, as another example, let's download Apple's stock price data series:

```
> # use single quotes and specify data source:
> getSymbols("AAPL", src = "yahoo")  # but src = "yahoo" is the default
```

Visualizing data with head(**.**) and tail(**.**) R functions:

```
> head(AAPL)
           AAPL.Open AAPL.High AAPL.Low AAPL.Close AAPL.Volume AAPL.Adjusted
2007-01-03     86.29     86.58    81.90      83.80    44225700         81.03
2007-01-04     84.05     85.95    83.82      85.66    30259300         82.83
2007-01-05     85.77     86.20    84.40      85.05    29812200         82.24
2007-01-08     85.96     86.53    85.28      85.47    28468100         82.64
2007-01-09     86.45     92.98    85.15      92.57   119617800         89.51
2007-01-10     94.75     97.80    93.45      97.00   105460000         93.79
> tail(AAPL)
           AAPL.Open AAPL.High AAPL.Low AAPL.Close AAPL.Volume AAPL.Adjusted
2014-01-08    538.81    545.56   538.69     543.46     9233200        543.46
2014-01-09    546.80    546.86   535.35     536.52     9969600        536.52
2014-01-10    539.83    540.80   531.11     532.94    10892000        532.94
2014-01-13    529.91    542.50   529.88     535.73    13517600        535.73
2014-01-14    538.22    546.73   537.66     546.39    11877200        546.39
2014-01-15    553.52    560.20   551.66     557.36    13987100        557.36
```

We can then extract the closing prices to an R vector:

```
# coerce from an xts object to a standard numerical R vector:
> AAPL_vector <- as.vector(AAPL[, "AAPL.Close"])
```

3.3. Using Datamarket from within R

The rdatamarket package is an R client for the DataMarket.com API, fetching the contents and metadata of datasets on DataMarket.com into R.

To install the package we run the following code:

```
> install.packages("rdatamarket")
```

Then, we load the package:

```
> library(rdatamarket)
```

Then, we load the package:

```
> library(rdatamarket)
```

Loading de data series from datamarket.com and plotting these data is possible with just on line of code:

```
> plot(dmseries("17tm", Country=c("Romania", "United Kingdom")))
```

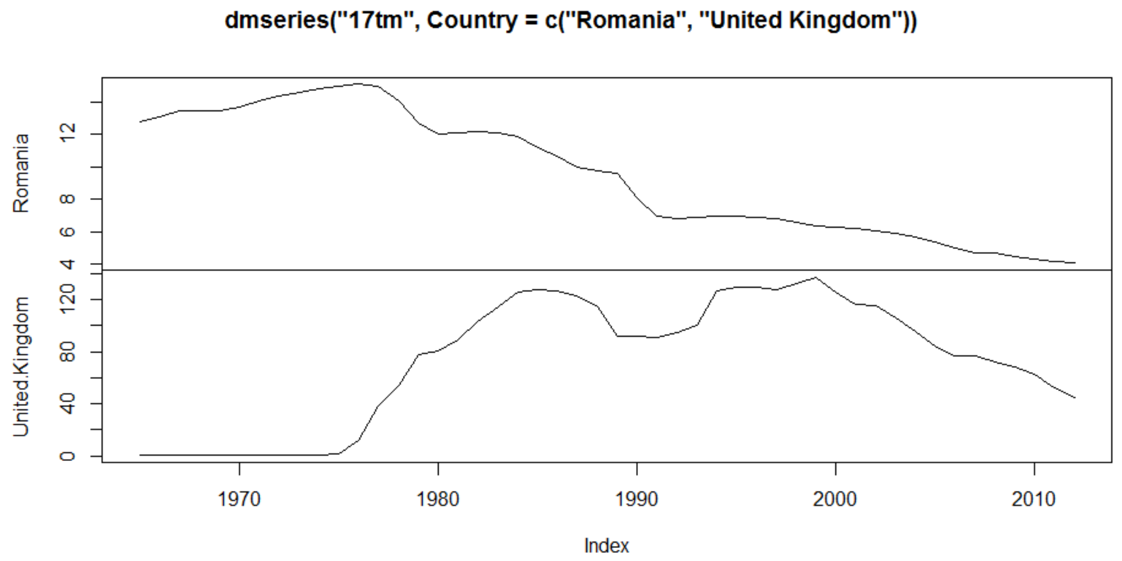

Fig. 1. Output plot for dataseries '17tm'

We can read metadata, for example, a dataset with two dimensions:

```
> p <- dminfo("http://datamarket.com/data/set/12r9/male-population-thousands")
```

Fetch the UN's population prediction for Romania and Sweden in the constant-fertility scenario.

```
> dmseries(p, 'Country or Area'=c("Romania", "Sweden"),
           Variant="Constant-fertility scenario")
```

Table 2. The UN's male population prediction for Romania and Sweden, in the constant-fertility scenario

Year	Romania	Sweden
2010	10655.359	4671.687
2015	10474.793	4828.263
2020	10241.697	4990.339
2025	9947.068	5146.432
2030	9605.094	5282.872
2035	9236.157	5404.798
2040	8849.399	5530.330
2045	8443.669	5668.217
2050	8015.484	5814.996
2055	7564.344	5954.044
2060	7096.434	6082.121
2065	6627.191	6200.868
2070	6172.537	6312.981
2075	5744.062	6416.869

Year	Romania	Sweden
2080	5350.278	6507.474
2085	4992.423	6582.797
2090	4662.182	6643.501
2095	4350.431	6688.996
2100	4053.578	6716.262

Source: datamarket.com, author's computation [Accessed Jan. 15, 2014]

This example illustrates dimension filtering and their values can be specified by their $id or their $title, to fetch the data filtered to specific values of a dimension. By default, in case we don't specify the filter, all of the dataset is fetched. In this situation be careful to some datasets, because could be very big and the DataMarket.com API may truncate extremely large responses.

4. Looking towards the future

The plans of the authors are related to continue developing in and contributing to implement the R environment in order to provide a free and open source software for data analysis in various research and academic fields in Romania and among the individual persons, investors, financial institutions and commercial and noncommercial organizations [9].

Acknowledgement

The present paper is part of the research project of Romanian R-userRs Team. The authors are thankful to their team for the great collaboration. Also, the authors of this paper would like to express the special thanks to Jeffrey Ryan, the author of the R package *Quantitative Financial Modelling Framework*. He is perhaps best known in the R community as one of the primary organizers of the annual R/Finance conference. In addition to his efforts on the R/Finance organizing committee, he has also developed a number of popular R packages for financial analysis.

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[9] http://www.r-project.ro/

Annexes

Annex 1

Data description

- Yahoo: Free stock quotes, up to date news, portfolio management resources, international market data, message boards, and mortgage rates that help you manage your financial life

- FRED: Download, graph, and track 149,000 economic time series from 59 sources
- Oanda: Currency information, tools, and resources for investors, businesses, and travelers
- Google: Stock market quotes, news, currency conversions & more
- Quandl: Futures prices, daily. Quandl is a search engine for numerical data. The site offers access to several million financial, economic and social datasets
- TrueFX: Tick-By-Tick Real-Time And Historical Market Rates, Clean, Aggregated, Dealer Prices
- Bloomberg: Financial news, business news, economic news, stock quotes, markets quotes, finance stocks, financial markets, stock futures, personal finance, personal finance advice, mutual funds, financial calculators, world business, small business, financial trends, forex trading, technology news, bloomberg financial news
- Interactive Broker: Interactive Brokers Group, Inc. is an online discount brokerage firm in the United States
- Datastream: Datastream Professional is a powerful tool that integrates economic research and strategy with cross asset analysis to seamlessly bring together top down and bottom up in one single, integrated application
- pwt: The Penn World Table provides purchasing power parity and national income accounts converted to international prices for 189 countries/territories for some or all of the years 1950-2010
- Thinknum: Thinknum brings financial data from a variety of useful sources together on one platform. We use this data to develop applications
- DataMarket: DataMarket brings complex and diverse data together so you can search, visualize and share data in one place and one format

Annex 2

Package Detail

- Quantmod: Specify, build, trade, and analyse quantitative financial trading strategies
- Quandl: This package interacts directly with the Quandl API to offer data in a number of formats usable in R, as well as the ability to upload and search
- TFX: Connects R to TrueFX(tm) for free streaming real-time and historical tick-by-tick market data for dealable interbank foreign exchange rates with millisecond detail
- Rbbg: Handles fetching data from the Bloomberg financial data application
- IBrokers: Provides native R access to Interactive Brokers Trader Workstation API
- rdatastream: RDatastream is a R interface to the Thomson Dataworks Entreprise SOAP API (non free), with some convenience functions for retrieving Datastream data specifically. This package requires valid credentials for this API
- pwt: The Penn World Table provides purchasing power parity and national income accounts converted to international prices for 189 countries/territories for some or all of the years 1950-2010
- fImport: Rmetrics is the premier open source software solution for teaching and training quantitative finance. fImport is the package for Economic and Financial Data Import
- Thinknum: This package interacts directly with the Thinknum API to offer data in a number of formats usable in R
- rdatamarket: Fetches data from DataMarket.com, either as timeseries in zoo form (dmseries) or as long-form data frames (dmlist). Metadata including dimension structure is fetched with dminfo, or just the dimensions with dmdims.

Modelling in happiness economics

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Abstract

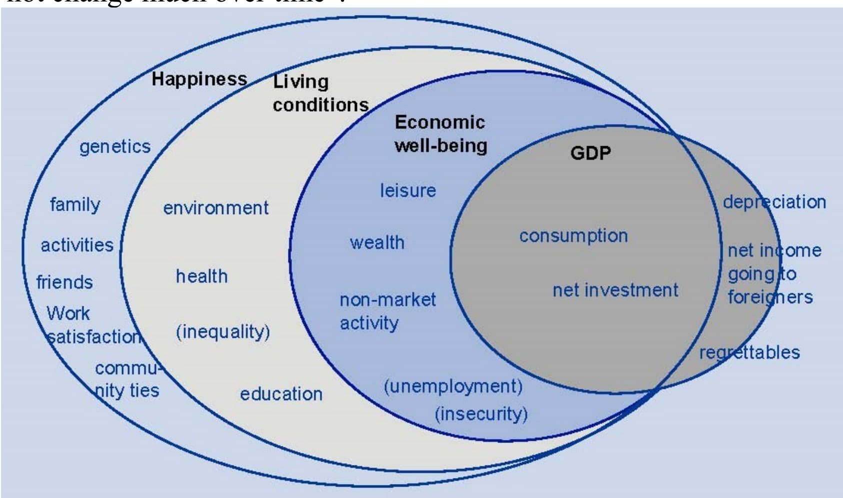
In modern times, in the context of an increasingly quantitative approach to economics, welfare has been related mostly to an economic actor's income. With increasing complexity in social and economic life, studies moving beyond the income approach to welfare enriched economic literature. Modelling the economic concept of 'happiness' is one of the new ways to design welfare policy. Even if it has been shown, using econometric techniques, that an accurate measurement of the true welfare effects is not possible, researchers estimated, for example, the income required for a typical individual in different countries to ascertain the same change, due to various events, in declared happiness as in welfare. This paper introduces the concept of happiness as one of the measures of well-being in economics and presents a brief survey of the literature on this topic.

Keywords: happiness economics, Easterlin paradox, welfare, well-being, model

1. Introduction

Bergheim [1] discusses four measures of well-being: GDP, economic well-being, individual living conditions and happiness. Figure 1 shows the components of the four measures of welfare.

- *GDP* measures the market value of all final goods and services produced in a country in a given period of time and it is not fully compatible with welfare, because some of its components are not conducive to welfare, such as depreciation and external debt.
- *Economic well-being* is a broader concept which is influenced by some GDP elements, non-market activities, leisure and wealth. Unemployment and income inequality tend to reduce economic welfare. The Centre for the Study of Living Standards reports that in Norway, France and Belgium the highest level of economic welfare is achieved.
- *Individual living conditions* also include features such as health, life expectancy, education and environmental conditions.
- *Happiness* as 'the goal' in life depends on family, friends, job satisfaction and activities while income is not involved. An interesting observation is that "the happiness level of society - as assessed through surveys - does not change much over time".



Source: Bergheim, S. 2006, p. 3

Fig. 1 Four measures of well-being

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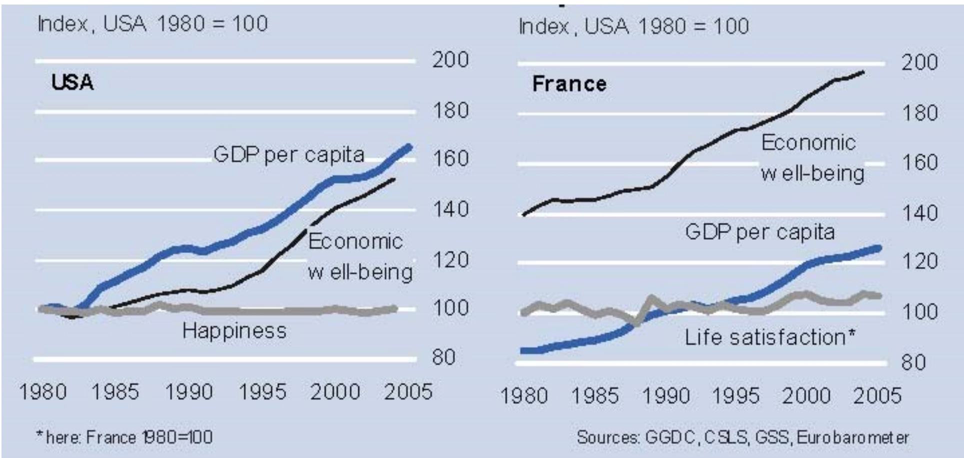
It is important to note that the measure chosen is very important because the resulting narrative will vary depending on the measure; for example, when comparing two or more countries from the point of view of well-being. Figure 2 illustrates this situation for the U.S. and France[1].



Source: Bergheim 2006, p. 3

Fig. 2 Different measures, different stories! (U.S. and France)

2. The concept of happiness in economics

Since Aristotle, searching for human happiness was of interest for philosophers and later for economists such as Jeremy Bentham, John Stuart Mill, and Adam Smith. In modern times, an increasing quantitative approach for studying the economy, utility and later on welfare were considered to be related only to the income of a rational economic actor who makes individual choices and whose preferences are dependent on individual budget constraints.

In the 1970s, the revival of economists' interest in happiness began with Richard Easterlin [2], and nearly thirty years later it was already widely spread ([3], [4], [5], [6]).

McCloskey [7] defines happiness as "a good story of your life" and points to the ancient Greek version of the word happiness, "eudaimonia" which means "to have a good guiding angel" and to Aristotle's definition of happiness as an "exercise of vital powers along lines of excellence in a life affording them scope."

In terms of methodology, Graham defines happiness economics as "an approach to assessing welfare which combines the techniques tipically used by economists with those more commonly used by psychologists."[2] Happiness surveys use questions like "Overall, how satisfied are you with your life" or "How satisfied are you with your life" with the possible responses on a scale of four to seven points.

This approach is used to investigate situations for which the revealed preference approach is not very strong and expressed preferences are a better indicator. Some examples include the effects on welfare of inequality, inflation and unemployment, and also poverty research based on Amartya Sen's capabilities approach. Standard concepts of utility and welfare are extended to include interdependent utility functions, procedural utility, and the interaction between rational and non-rational influences in determining economic behavior.

Regarding public policy, although useful, the analysis of happiness may be biased due to unobserved idiosyncratic events, unobserved personality traits and correlated measurement errors, and when policies should be designed based on those analyses precautions must be taken ([8], [9], [10]). There is public support for this approach. A 2005 BBC study asked if the main objective of the government should be "the greatest happiness" or "the greatest wealth" and 81% felt that happiness should be the main objective of the government [11].

[1] Bergheim, S., "*Measures of well-being*", Deutsche Bank Research, September 8, 2006, p. 3

[2] Graham, C. *"happiness, economics of"*, "The New Palgrave Dictionary of Economics", Eds. Steven N. Durlauf and Lawrence E. Blume, Palgrave Macmillan, The New Palgrave Dictionary of Economics Online, Palgrave Macmillan, 2008, p.1.

Econometric techniques associated with happiness economics have evolved over time. Van Praag and Ferrer-i-Carbonell [12] use panel data and advanced econometric techniques such as Probit Ordinary Least Square (POLS). Graham[3] makes clear that it is not possible to accurately measure the effects of independent variables on the actual welfare. Despite this drawback of the method, researchers used OLS coefficients. For example, it was estimated the income required for a typical individual to achieve the same change in declared happiness as from a welfare loss from divorce ($ 100,000) or from a job loss ($ 60,000)[4].

Bergheim [13] distinguishes four varieties of capitalism, based on the results of a systematic review of happiness in 22 rich countries:

1. *The happy variety of capitalism*: Australia, Switzerland, Canada, the UK, the US, Denmark, Sweden, Norway and the Netherlands, and more or less Finland and New Zeeland.
2. *The less happy variety of capitalism*: Germany, Spain, France, Belgium and Austria.
3. The unhappy variety of capitalism: Portugal, Italy and Greece.
4. *The Far East variety*: Japan and Korea have very different institutions compared to the other countries discussed.

Easterlin et al. [14] discussed the interesting case of *transition countries*, in particular China and Eastern European countries. Despite the unprecedented increase in production per capita in the last two decades, satisfaction with life in China has followed essentially the path recorded in the transition countries of Central and Eastern Europe. As in European countries, in China, the trend and the U-pattern model seem to be related to a marked increase in unemployment followed by a slight decrease and the corresponding dissolving of the social protection system along with increasing income inequality. In China, most of the burden of the worsening life satisfaction fell on the lower socioeconomic groups. An initially very egalitarian distribution of life satisfaction has been replaced with one increasingly unequal, with a decreasing life satisfaction for people in the bottom third of the income distribution and an increasing life satisfaction for the top third.

Other happiness measures are:

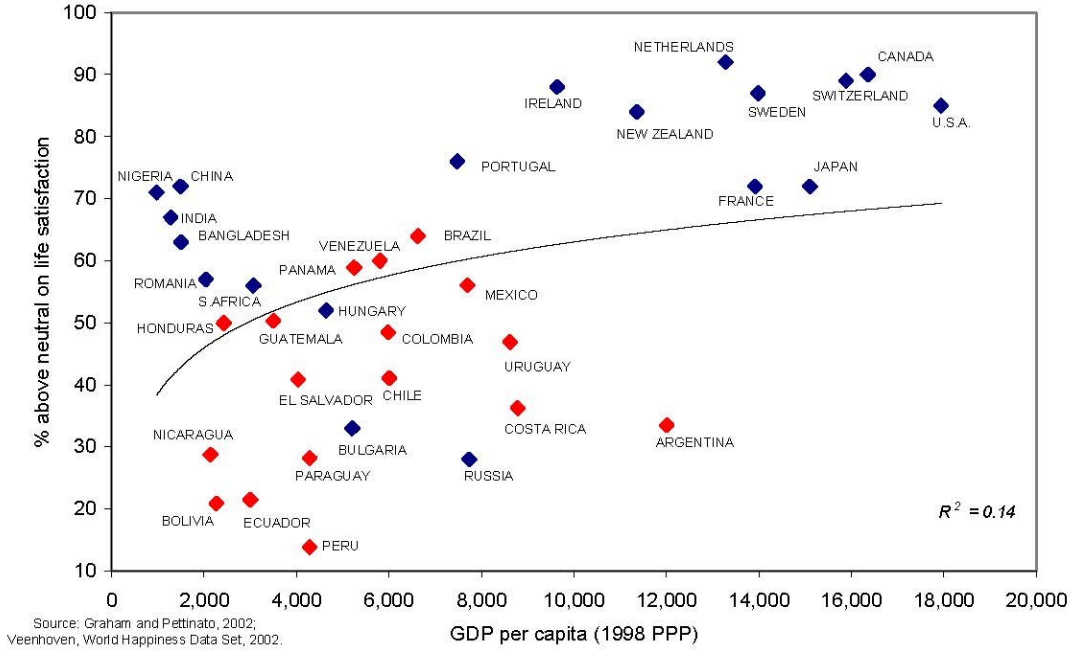
- Your Better Life Index created by OECD
- Gross National Happiness (GNH) from Bhutan [15]. GNH was invented in 1972 by the fourth Dragon King of Bhutan, Jigme Singye.
- The Happy Planet Index (HPI) was developed by the New Economics Foundation (NEF), with support from Friends of the Earth. Essentially, HPI argues that a long and happy life must be the ultimate goal of the economy and not only an insatiable economy activity. It recognizes that all material possessions are based on planetary resources converted to products, processes and services.

3. Easterlin Paradox

Easterlin paradox was mentioned for the first time in Easterlin's 1974 study and states that for the long-term, usually 10 years or more, "at a point in time both among and within nations, happiness varies directly with income, but over time, happiness does not increase when a country's income increases" [16]. Graham provides more details (Fig. 2):

[3] Graham, C. *"happiness, economics of"*, "The New Palgrave Dictionary of Economics", Eds. Steven N. Durlauf and Lawrence E. Blume, Palgrave Macmillan, The New Palgrave Dictionary of Economics Online, Palgrave Macmillan, 2008

[4] Blanchflower, D., Oswald, A., *"Well-being over time in Britain and the USA",* Journal of Public Economics 88, 1359–87, 2004.



Source: Graham 2008

Fig. 3 Happiness and income per capita, 1990

“While most happiness studies find that *within* countries wealthier people are, on average, happier than poor ones, studies across countries and over time find very little, if any, relationship between increases in per capita income and average happiness levels. On average, wealthier countries (as a group) are happier than poor ones (as a group); happiness seems to rise with income up to a point, but not beyond it. Yet even among the less happy, poorer countries, there is not a clear relationship between average income and average happiness levels, suggesting that many other factors – including cultural traits – are at play... Thus, a common interpretation of the Easterlin paradox is that... aspirations increase along with income and, after basic needs are met, relative rather than absolute levels of income matter to well-being.”[5]

Clark et al. show that for a country, beyond the Easterlin paradox, happiness inequality matters because “if raising the income of all can not raise the happiness of all, it will at least to reduce the gaps between them, provided that income inequality is not too large” [17].

In 2010, Easterlin and a group of co-authors[6] have revisited the income-happiness paradox. The study was conducted in a number of developing countries, including Eastern European countries in transition from socialism to capitalism, and a larger than previously group of developed countries. The results show that the long-term paradoxical relationship between happiness and income still holds. For the short term, however, for all three groups of countries, happiness and income have a similar behavior. Striking are the studies for China, South Korea, Chile which recently had very high growth rates (corresponding to a doubling of real per capita income in less than 10 years for China, in 13 years for South Korea, and in 18 years for Chile). Despite such a strong income growth, subjective well-being improvements were not as expected.

The conclusion of this study suggests that welfare policy should move beyond achieving mere material accumulation: “Possibly more useful are studies that point to the need to focus policy more directly on urgent personal concerns relating to such things as health and family life and to the formation of material preferences[7] rather than on the mere escalation of material goods.”[8]

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[5] Graham, C. *“happiness, economics of”*, “The New Palgrave Dictionary of Economics”, Eds. Steven N. Durlauf and Lawrence E. Blume, Palgrave Macmillan, The New Palgrave Dictionary of Economics Online, Palgrave Macmillan, 2008, p. 4-5.

[6] Easterlin, R. A., Angelescu McVey, L., Switek, M., Sawangfa, O., Smith Zweig, J., *“The happiness–income paradox revisited”*. Proc Natl Acad Sci USA, 107(52), p. 22463–22468, 2010.

[7] Easterlin, R. A. *“Explaining happiness”*. Proc Natl Acad Sci USA, 100, p.11176–11183, 2003.

[8] Easterlin, R. A., Angelescu McVey, L., Switek, M., Sawangfa, O., Smith Zweig, J., *“The happiness–income paradox revisited”*. Proc Natl Acad Sci USA, 107(52), p. 22463–22468, 2010, p. 22467.

4. Models in happiness economics

Hayo [18] makes the distinction between two main lines of research in the empirical literature. First, individual level variables determining happiness and affecting life satisfaction for countries, between countries and over time, are found. Then is analyzed the influence of other variables on welfare, such as macroeconomic inflation and unemployment variables.

According to Graham [19], in micro-econometric happiness research, equations have the standard form given by:

$$W_{it} = \alpha + \beta x_{it} + \varepsilon_{it} \quad (1)$$

where W is the welfare of the individual i at moment *t*, and *X* is a vector of known variables, including socio-demographic and socio-economic characteristics. Unobservable characteristics and measurement errors are captured in the error term ε_{it}..

In 2012, Graham and Chattopadhyay [20] presented a gender and welfare model using Gallup World Poll (2005-2011) data for countries "around the world, both across and within countries - comparing age, income and education cohorts ". Subjective well-being is measured using Cantril scale.

Their results "highlight a seeming paradox, in which the changes that are associated with improving gender rights can be associated with lower levels of well-being for women, while contexts which have longer standing and well-established equality in gender rights are associated with higher levels of well-being for women."

The basic models are:

$$LL_i = X_{1i}\beta_1 + X_{2i}\beta_2 + \varepsilon_i \quad (2)$$

and

$$LLfuture_i = X_{1i}\beta_1 + X_{2i}\beta_2 + \varepsilon_i \quad (3)$$

where:

X_1 is a person-specific vector of individual characteristics such as age, sex, marital status, personal experience of the joys and sorrows of the previous day, and satisfaction with freedom.

X_2 is a person-specific vector of household socio-economic conditions such as annual household income (in deciles for the country), the location of the household (ranging from rural to large urban areas), and household size.

LL and *LLfuture* are Cantril scale questions. The first asks individual respondents to evaluate their present life compared to the best possible life (on a scale ladder of 0-10), and the second asks them to predict their position on the ladder five years in the future. Zero indicates the worst possible life and ten is the best possible life on this 11-step scale.

In the literature there is a large number of happiness studies on Eastern European countries; four of them are presented below.

Blanchflower and Freeman [21] use a set of pooled cross-sectional data for Hungary and Slovenia in comparison with Western countries (at that time); they found that, on average, life satisfaction was lower for developing countries.

Blanchflower and Oswald [22] analyze the impact of unemployment on happiness and conclude that it is relatively similar to that for Western countries.

Hayo and Seifert [23] focus on economic welfare analysis and note that in the early stages of transition subjective well-being is not too well approximated by indicators based on national accounts such as GDP per capita.

Hayo[9] studied happiness in Eastern Europe, especially the Czech Republic, Slovakia, Slovenia, Hungary, Poland, Romania and Bulgaria, using a data set containing representative population surveys collected in 1991

[9] Hayo, B. "*Happiness in Eastern Europe*". Working Paper 12/2004, Phillips Universität Marburg, 2004.

by Paul Lazarsfeld Society in Vienna [24]. He estimates a model for the average happiness in Eastern Europe with GDP per capita and unemployment as explanatory variables.

The results show that compared to other societies, even in 1991, during the transition period at the beginning of the transformation process, the drivers of happiness are similar. Rural respondents reported a higher satisfaction with life than urban resident. A possible explanation may be related to the differences in purchasing power and to the slower adjustment of the level of aspirations for rural residents.

5. Conclusions

Human welfare can be analyzed using different measures; one of which is happiness. The philosophical interest in human happiness started with Aristotle, and centuries later was taken to the realm of economics by Jeremy Bentham, John Stuart Mill, and Adam Smith. Today, happiness evaluation is done using econometric techniques which have evolved over time, which this paper briefly surveyed the literature on the topic. A string of research investigated long-term happiness and Easterlin paradox synthesizes the finding that happiness does not increase when a country's income increases. Some authors used panel data and advanced econometric techniques, such as Probit Ordinary Least Square (POLS), while others estimated the income required for a typical individual to ascertain the same change, due to various events, in declared happiness as in welfare. The road ahead is open for research on the concept of happiness and well-being changes due to the recent global economic and financial crisis.

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Nonlinear Models for Economic Forecasting Applications: An Evolutionary Discussion

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Abstract

This article follows the main contributions brought to the nonlinear modeling literature. We investigate and review a series of parametric initiatives, focusing on the evolution of TAR and ARCH – GARCH model families in econometric and forecasting applications.

Keywords: nonlinear parametric models, threshold models, ARCH - GARCH models

1. Introduction

Around the 1980's, the modeling of the nonlinear dynamics becomes one of the most popular methodologies in the study of financial markets, macroeconomics, regional studies and environmental issues. The growth of this approach was based on various motivations that circled around technical aspects such as the limitations of the neoclassic models that seemed incapable of capturing certain features of the economic reality and the weak results offered by the traditional linear stochastic models.

In spite of this, the first attempts towards nonlinear modeling date back to the end of the Great Depression. The same moment saw the expansion of another field, macroeconomics, which was focusing on business cycles and their fluctuations. The dynamic analysis came to be deeply rooted into the expansion of macroeconomics to such an extent that [1] argued about the appearance of a new research field: macrodynamics.

The origins of econometric nonlinear modeling can be traced back to the pioneering work of [2]. A few years earlier, [3] had launched a business cycle model that incorporated a time lag between a decision on an investment and its subsequent effect on capital stock. [2] builds on these results and succeeds in explaining fluctuations by the use of nonlinearity. Since these early attempts, a strong and very active literature emerged. Given the dimension of the topic, the purpose of this paper is to concentrate only on the parametric nonlinear models.

2. The Threshold Model Class

One very extensively used class of nonlinear time series models is the TAR (threshold autoregressive) model class brought forward by [4] and later refined in [5]. The basic idea behind these models consists in linear approximations of subspaces of the initial space. This segmentation is done by the use of a threshold variable.

The most important features of the TAR models are their simplicity and versatility, but in spite of this schematic nature, they are able to generate a complex image of the nonlinear dynamics. The main limitation of the TAR models derives from the large number of parameters that need to be estimated in their construction.

By definition, a TAR model with *n* regimes has the following form:

$$X_t = \sum_{i=1}^{n}\{b_{i0} + b_{i1}X_{t-1} + \cdots + b_{i,pi}X_{t-pi} + \sigma_i\varepsilon_t\}I(X_{t-d} \in R_i) \quad (1)$$

Where:

$\{\varepsilon_t\} \sim IID(0,1)$,

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d *and* $p_1, \cdots, p_n$ represent a series of unknown positive, variables

$\sigma_i > 0$ *and* $b_{i,j}$ represent unknown parameters

And $\{R_i\}$ is a partition of the $(-\infty, \infty)$ interval so that:

$U_{i=1}^{n} R_i = (-\infty, \infty)$ and $R_i \cap R_j = \emptyset$, for any given $i \neq j$.

Due to their general tractability, TAR models became popular and saw a wide use in many fields of modern economics, ranging from macroeconomics to finance.

An example of the use of TAR models in macroeconomics is [6]. In their study on recessions and output they offer a modeling scheme that considers GNP rates of growth as a function of the deviation of the current GNP from the historical maximum values of this parameter.

[7] argue that the above model is actually a particular form of TAR model and extend the logic to incorporate floor and ceiling effects.

While studying the US unemployment rate, [8] test the performance of several time-series models and conclude that the TAR models outperform linear models during contraction intervals.

TAR models are also extensively used in the study of financial markets. Addressing the problem of modeling the difference in princes of equivalent assets, [9] use TAR models and discuss the statistical estimation and testing procedures. Using the example of an index futures contract and the equivalent cash index, the authors clearly reject the linearity hypothesis and observe the threshold nonlinearity.

By combining TAR modeling with an error-correction component, [10] show the impact in mispricing for intraday futures and index returns. This approach allows the authors to model the behavior of arbitragers.

In the modeling context of equation (1), each R_i can be set to a linear form. The segmentation is given by the threshold variable X_{t-d}, where *d* stands for a delay parameter. Thus, $R_i = (r_{i1}, r_i]$, where where $-\infty = r_0, < r_1 < \cdots < r_n = \infty$, and the r_i variables represent the thresholds. As observed by [11], in this case the original TAR model turns into self-exciting threshold model (SETAR).

Generating from the work of Tong from 1977, SETAR became quickly popular in a wide range of econometric applications.

Assuming the $R_1, \cdots, R_l$ intervals as to allow $R_1 \cup \cdots \cup R_l = \mathbb{R}$ and $R_i \cap R_j = \emptyset\ \forall i, j$, each interval R_i is expressed as $R_i =]r_{i-1}; r_i]$, where $r_0 = -\infty, r_1, \cdots, r_{l-1} \in R$, and $r_l = \infty$. Under these assumptions, [12] draw the standard form for the SETAR (l; d;$k_1, k_2, \cdots, k_l$) model as:

$$X_t = a_0^{(J_t)} + \sum_{i=1}^{k_{J_t}} a_i^{(J_t)} X_{t-i} + \epsilon_t^{(J_t)} \qquad (2)$$

Where:

$$J_t = \begin{cases} 1 & X_{t-d} \in R_1 \\ 2 & X_{t-d} \in R_2 \\ & \cdots \\ l & X_{t-d} \in R_l \end{cases} \qquad (3)$$

[13] investigate the nonlinear dynamics of short-term interest rate in the US using a SETAR model and evaluate the performance of the model through the point of view of the term structure.

[14] study SETAR models on macroeconomic time series and conclude that these are more eficient in forecasting in comparison to AR models. On the contrary, [7] report that the AR models are more efficient in predicting the conditional mean but not also in terms of variance.

[15] report that SETAR models are more efficient than AR models in certain regimes, though this characteristic isn't relevant throughout the entire data set.

[16] also conduct a performance test involving SETAR, AR and GARCH models, on data sets representing the exchange course of the EURO. The authors conclude that at an aggregate level, the GARCH model is the most performant in capturing the properties of the time series.

If the SETAR models involve a finite number of regimes, [17] proposes a model for perpetual regimes, called the Smooth Transition Autoregressive (STAR) model. The general form of STAR models according to [18] is:

$$y_t = \phi_0 + \sum_{i=}^{p} \phi_i y_{t-i} + \left(\theta_0 + \sum_{i=1}^{p} \theta_i y_{t-i} \right) F(y_{t-d}) + \varepsilon_t \quad (4)$$

where $F(y_{t-d})$ represents a continuous transition function that can be either logistic or exponential.

$$F(y_{t-d}) = \left[1 + exp\big(-\gamma(y_{t-d} - r)\big)\right]^{-1} \quad (5)$$

$$F(y_{t-d}) = 1 - \left[exp\big(-\gamma(y_{t-d} - r)\big)^2\right] \quad (6)$$

These transition functions determine the type of STAR model used: LSTAR (logistic STAR) or ESTAR (exponential STAR).

One example of the use of LSTAR models is [19]. The authors investigate various time series that characterize the business cycle and observe the nonlinear characteristics of these data sets. ESTAR models have been applied in finance in the study of exchange rates [20] or [21].

One of the most used applications of nonlinear TAR models is the vector error-correction model (VECM). This is actually a mix between the classical TAR background and the model of cointegration of Engle and Granger [22] and was put forward by [23].

Another interesting solution was introduced by [24] and represents the vector TAR (VTAR) model.

The theoretical literature that builds on these modeling initiatives is extensive, key studies having been brought forward by [25], [26] or [27].

Vector error-correction models have been extensively used in the study of the dynamics of financial markets. [28] use a VECM to obtain monthly stock market levels and monthly stock returns for the case of the Singapore market.

In an investigation on the existence of long-run equilibrium between stock prices and industrial production, real exchange rate, interest rate, and inflation for the United States, [29] uses a VECM model similar to [28] and reports that the S&P 500 price is positively related to the industrial production but negatively to the rest of the variables.

[30] build on the VECM model, and use their methodology on a set of U.S. disaggregated CPI data. They find evidence of threshold cointegration especially for tradable goods.

There is an important number of generalizations or special cases of TAR models that circulated in the literature. One of these models is the Open Loop Threshold AR (TARSO), launched by [31] which uses an exogenous input time series. The general form of the model is the following:

$$X_t = a_0^{(J_t)} + \sum_{i=1}^{k_{J_t}} a_i^{(J_t)} X_{t-i} + \sum_{i=1}^{k'_{J_t}} b_i^{(J_t)} U_{t-i} + \epsilon_t \quad (7)$$

As observed by [12], in this case the regimes shifts are determined by:

$$J_t = \begin{cases} 1 & U_{t-d} \in R_1 \\ 2 & U_{t-d} \in R_2 \\ & \dots \\ l & U_{t-d} \in R_l \end{cases} \quad (8)$$

TARSO models have been used in estimations on stock returns and real economic activity ([32], [33]) and in forecasting spot prices [34]

Another generalization of the SETAR model is the self-exciting Threshold ARMA (SETARMA) which is an obvious extension given by the following equation.

$$\boldsymbol{X_t = a_0^{(J_t)} + \sum_{i=1}^{k_{J_t}} a_i^{(J_t)} X_{t-i} + \sum_{i=1}^{k'_{J_t}} b_i^{(J_t)} \epsilon_{t-i} + \epsilon_t} \quad (9)$$

3. The ARCH – GARCH model class

ARCH models (AutoRegressive Conditional Heteroscedasticity) had their genesis in the study conducted by [35] which sought to model variances for British inflation rates and in the meantime became a common and apreciated solution for the investigation of volalitilities.

The original ARCH (q) model as proposed by [35] has the following form:

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 = \omega + \alpha(L)\varepsilon_t^2 \quad (10)$$

Where $\omega > 0, \alpha_i \geq 0$ and L represents the lag operator.

This linear setup is very useful in financial aplication as it holds the tendency for volatility clustering, meaning the tendancy that price changes to be followed by other price changes of an unpredictable sign.

A more popular alternative to the above model is the Generalizez ARCH or GARCH(p,q) developed by [36] and [37].

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 = \omega + \alpha(L)\varepsilon_t^2 + \beta(L)\sigma_t^2 \quad (11)$$

The characteristic that made the GARCH (p,q) so popular is the dependence in ε_t^2.. The equaton above can be easily translated as an ARMA model for ε_t^2 with the autoregressive aparameters *α(L)+β(L)* [38].

In the above GARCH (p,q) specification, the variance depends on the size, but not also on the sign of ε_t. This fact is inconsistent with the actual evolution of financial data. This shortcoming was fixed by [39] who treats σ_t^2 as an asymmetric function of the evolution of the values of the past ε_t:

$$log\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i(\phi z_{t-i} + \gamma[|z_{t-i}| - E|z_{t-i}|]) + \sum_{i=1}^{p} \beta_i log\sigma_{t-i}^2 \quad (12)$$

Unlike its linear precursors the EGARCH model imposes no restrictions on the sign of the conditional variances.

The scientific literature abounds in nonlinear ARCH alternatives such as the models of [40] and [41].

Another interesting innovation was the GJR-GARCH model established by [42]. Its distinctive characteristic was the fact that it captured the asymmetric effects of shocks (both positive and negative), which is a useful aspect in the study of the leverage effect.

The general form of the model can be described as:

$$\sigma_t^2 = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{s} \alpha_j a_{t-j}^2 + \sum_{j=1}^{s} \gamma_j I_{t-j} a_{t-j}^2 \quad (13)$$

[43], and [44] use smooth transitions between regimes in order to obtain a nonlinear version of the GJR-GARCH model. This resulted in the Logistic Smooth Transition GARCH (LSTGARCH(1,1)) model defined as:

$$\sigma_t^2 = w + \left(1 - F(\varepsilon_{t-1})\right)\alpha_1\varepsilon_{t-1}^2 + F(\varepsilon_{t-1})\gamma_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2 \quad (14)$$

where F represents the transformation function. If F is an exponential function as depincted by [43], the model becomes an Exponential Smooth Transition GARCH (ESTGARCH). [45] also build on this idea incorporating a continous bounded function.

[46] develop a nonlinear threshold model called Double Threshold ARCH (DTARCH). In this case both the autoregressive conditional mean and the conditional variance are built on a threshold patterns. Threshold ARCH models originated from the work of [47] and assume that the conditional standard deviation is a function of the value of the shocks.

Other nonlinear ARCH - GARCH models with interesting properties are: the Asymmetric Power ARCH (A-PARCH - [48]), the Volatility Switching GARCH (VSGARCH [49], the Asymmetric Nonlinear Smooth Transition GARCH (ANST-GARCH - [50] (1999)), the Quadratic GARCH (QGARCH – [51]), or the Markov-Switching GARCH (MSW-GARCH – [52]).

4. Conclusions

Nonlinear parametric models have been very successful in the analysis of a wide range of economic fields, ranging from macroeconomics to financial markets. In this paper we have aimed to review a selection of the existing literature on nonlinear models that are used in econometric and forecasting application. We focused only on the parametric models and especially on the TAR and ARCH – GARCH families of models

The survey was concentrated on the updates brought by each modeling initiative, from an evolutionary perspective.

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Corporate environmental responsibility – a key determinant of corporate reputation

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Abstract

This paper aims to determine the trend of the relationship between corporate environmental responsibility and corporate reputation by focusing on a study of the European automotive sector. The starting point of our research is content analysis of the sustainability or social responsibility reports published in 2010, 2011, and 2012 by 13 businesses operating in the European automotive industry. Content analysis was carried out in order to identify the indicators used to assess corporate environmental responsibility.

The methodology aimed to produce an evaluation model for corporate environmental responsibility based on the following variables reported by companies: carbon dioxide emissions, water consumption, energy consumption, and amount of waste. Corporate reputation of sampled organizations was assessed based on content analysis of the 2010, 2011, and 2012 reports of the Reputation Institute. We applied the correlation of panel data and emphasised the fact that high levels of corporate environmental responsibility sustain high levels of corporate reputation.

The study highlights the theoretical considerations that support this relationship. As companies become increasingly accountable, the methodology described in our study can be developed in further research by using other variables to measure corporate environmental responsibility.

Keywords: corporate social responsibility, corporate environmental responsibility, corporate reputation, European automotive industry.

1. Introduction

The neoclassical view on corporations and their role in society considers their responsibility for achieving objectives, including maximizing profit, and their accountability to stakeholders [1], a category that also includes the environment.

Corporate environmental responsibility is a new form of cooperation between business and environment. Companies promoting environmental objectives generate economic, political and social consequences. Consumers and competitors perceive responsible organizations as friendly, consumers prefer their products and services and believe that they are the result of responsible and sustainable business.

Also, corporate environmental responsibility can contribute to the development of sustainable businesses, while social responsibility actions can be profitable business strategies. In this context, our paper aims to demonstrate the relationship between corporate environmental responsibility and corporate reputation. Section 2 describes the evolution of the concept of corporate environmental responsibility. Section 3, "Corporate reputation", presents the evolution of the concept and various studies that approach it. Section 4 describes the research methodology and the hypothesis testing. The study ends with formulating the conclusions.

2. Corporate environmental responsibility

Scholarly literature highlights some contradictions on the impact of corporate social responsibility. To Reference [2], "an action counts as an act of CSR only if it is unprofitable. Socially beneficial actions that increase profits are merely hypocritical window dressing". On the other hand, Reference [3] differentiates between corporate social responsibility (unprofitable and driven by altruistic motives) and strategic corporate social responsibility (profitable). Reference [4] emphasize the idea that corporate social responsibility requires sacrificing the profit for the social interest.

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A transition occurred from the idea that "the only social responsibility of a company is to use its resources and engage in business designed to increase profits, while obeying the rules of the game" [5] to the idea that caring for the environment and for the people should be a matter of concern. Corporate social responsibility is an umbrella for sustainable practices and the adoption of "green" management is often done due to strategic reasons [6].

Reference [7] known for his interest in corporate social responsibility and sustainable development, outlined three stages in the emergence and development of the concept of corporate social responsibility interacting with the environment. Each stage highlights the on-going construction of the concept of corporate environmental responsibility [8]:

a) The period between 1960 and 1978 saw numerous changes in the legislation of Western states, changes aimed at reducing the environmental consequences of economic activities and encouraging the responsible use of natural resources. International environmental standards were created and all businesses were to comply with them.

b) A shift towards sustainable consumption of natural resources and "green" production occurred between 1980 and 1999. This moment coincides with the emergence and international expansion of the concept of sustainable development.

c) After 1999, new concerns have marked the business world: developing social responsibility practices, relations with the stakeholders, improving corporate governance practices and implementing social responsibility strategies as integral parts of the overall business strategy.

An interesting analysis performed on a total of 37 definitions of corporate social responsibility published by different authors between 1980-2003, Reference [9] shows that the environmental dimension is least mentioned. The environmental dimension has been used in only 8 of the analysed definitions, although the World Business Council for Sustainable Development distinguishes between the concepts of corporate social responsibility and corporate environmental responsibility ([10], [11]).

Corporate environmental responsibility encompasses "environmentally friendly actions not required by law, also referred to as going beyond compliance, the private provision of public goods, or voluntarily internalizing externalities" [12]. Based on the analysis of frontiers of theoretical economic research on corporate environmental responsibility, we can explain the motivations of organizations to engage in such actions: reducing pollution and costs creates opportunities for organizations and the environment, the new generation of "green" consumers is willing to pay a higher price for clean products, businesses tend to become proactive and react before public pressure occurs. It is clear that corporate environmental responsibility can cover a wide range of ecological and environmental objectives that can affect business decisions and policies [13].

Some organizations believe that social responsibility actions regarding the environment lead to lower profits. "This simplistic perception implies that, because of competition, a good manager has no other option in the market economy than to buy as cheap and sell as expensive as possible. The existence of a legal framework to comply with is only acknowledged without enthusiasm: under the law, all is allowed to reach the sole purpose of any serious business - profit maximization" [14].

Conversely, supporters of sustainable business practices argue that corporate environmental responsibility is inextricably linked to achieving important long-term profits. "The relationship between socially responsible activities and profitability may be best characterized as *some* firms will generate long-term profits from some socially responsible activities *some* of the time" [15].

Studies focused on assessing the environmental performance of organizations revealed conflicting results due to small samples or subjective assessment criteria. Thus, assessing the environmental performance of organizations may seek to determine: the environmental impact, the environmental compliance, and the implementation of organizational processes [16]. Based on economic and statistically significant results, Reference [17] have shown that a low level of environmental performance has a significant negative effect on the intangible assets of S&P 500 companies. Also, Reference [18] ranked 15 organizations based on environmental performance and demonstrated that high levels of environmental performance and compliance with environmental standards lead to better environmental reporting and the adoption of pollution prevention activities.

Achieving high environmental performance is possible when an environmental management system is in place and allows the development, implementation, coordination and monitoring of activities with environmental impact, in order to reach two objectives: compliance with standards and reduced waste [19]. This idea is supported by other studies that show significant relationships between the presence of an environmental management system and increased environmental performance: reduced costs, increased quality, reduced waste [20].

3. Corporate reputation

Scholarly literature highlights the expanding research on corporate reputation, along with the difficulty of formulating a unified vision on the significance of the concept of reputation. These barriers arise from confusions regarding the concepts of identity, image and reputation [21].

Reference [22] identify in scholarly literature several distinct approaches to corporate reputation (economic, strategic, marketing, organizational, sociological, and accounting). In these authors' opinion, image and identity are core components of corporate reputation: "corporate reputation is a collective representation ... It measures the relative position of the company in relation to employees internally, and other stakeholders externally" [23].

Over time, various attempts to define image, identity and corporate reputation highlighted their interchangeable use. Corporate image is defined as "a collective mood underlying internal efforts to communicate the success or failure of the organization to others" [24]. Corporate identity encompasses "presenting the organization to various stakeholders and the means to distinguish the organization from others" [25]. There are even similarities in how corporate image and corporate identity are defined. For Reference [26], the image of an organization is "what is meant to be viewed from the outside by stakeholders as most important, enduring and distinctive about the organization", while for Reference [27], corporate identity is the "set of values and principles that employees and managers associate with the organization".

Some research highlights three different groups of definitions of corporate reputation: reputation as a state of awareness, as an assessment, and as an asset [28]. This approach allows defining corporate reputation as "judgments of collective observers on the organization based on the evaluation of economic, social and environmental impact over time" [29].

Management research recognizes corporate reputation as an intangible asset with two dimensions: the economic outlook, or how to extend the stakeholders' perceptions about the ability of organizations to produce quality goods, and the institutional perspective, which involves the expansion of what is important for stakeholders [30].

4. The relationship between corporate environmental responsibility and corporate reputation

Numerous studies highlight the positive relationship between corporate reputation and financial performance [31], but relevant to the present research are studies that highlight the influence of corporate social responsibility actions on reputation [32] or the role of innovation in corporate social responsibility practices in creating corporate reputation [33].

Other studies highlight how companies develop their corporate reputation by meeting international standards of corporate social responsibility [34].

Reference [35] produced one of the most interesting studies that establish the relationship between corporate responsibility and corporate reputation, using stakeholder theory. The results show considerable similarity between the concepts of responsibility and reputation and the possibility to use reputation models as a potential standard for many conceptualized aspects of corporate responsibility.

We believe corporate environmental responsibility can help increase corporate reputation. Thus, reducing pollution generates confidence and safety for employees, local communities and consumers, and impacts corporate reputation.

5. Research methodology

This paper aims to assess corporate environmental responsibility of companies operating in the European automotive sector. Research was carried out for 2010, 2011 and 2012 and was based on content analysis of reports published by European automotive sector companies. We created an index of performance of environmental commitment, based on a methodology developed in previous research [36].

Because analysed organizations operate in a sector characterized by strong environmental impact, restrictive legislation on reducing pollution and carbon dioxide emissions, strong competition, and pressure from various external stakeholders with regard to reducing the environmental impact, it is important to investigate the performance of environmental responsibility.

The objectives of this research are:

O1. Create the sample to be investigated;

O2. Perform a content analysis of reports published by these companies in 2010, 2011, and 2012 and create a database with indicators evaluating the performance of environmental commitment;

O3. Create an index of performance of environmental commitment, based on an original methodology;

O4. Rank European automotive industry organizations according to the values of the index of performance of environmental commitment in 2010, 2011, and 2012;

O5. Perform a content analysis of the Reputation Institute reports and add the values of the reputation index to the database;

O6. Apply panel data correlation to highlight the relationship between corporate environmental responsibility and corporate reputation.

The hypothesis of the study is as follows: There is a relationship between the overall index of corporate reputation and the index of performance of environmental commitment.

The 13 companies included the sample are members of the European Automobile Manufacturer's Association. Performing content analysis of sustainability, CSR or environmental reports published in 2010, 2011, and 2012 helped select the variables used to assess the performance of environmental commitment.

The performance of environmental commitment (PEC) was assessed using an original evaluation model based on four measuring variables: CO2 emissions in g/km per vehicle, water consumption per vehicle, energy consumption per vehicle, and waste in kg/vehicle.

The methodology to calculate the index of performance of environmental commitment (IPEC) involved several steps: we ordered in descending order the values of each variable and determined the value that contributes to performance of environmental commitment; we scored each value of the indicators using a 0 to 1000 scale (0 for the minimum and 1000 for the maximum); we normalized values; aggregation was achieved by multiplying the points awarded by normalizing with a weighting coefficient of 0.25; we calculated the index by summing the scores obtained by each organization after aggregation; we ranked organizations according to the results of IPEC, the organization with the highest index value being also the organization with the highest environmental performance [37]. The data are summarized in Table no. 1.

Table no. 1. Ranking European automotive sector organizations by IPEC

Company	$IPEC_{2010}$	$IPEC_{2011}$	$IPEC_{2012}$	Average $IPEC_{M}$
TOYOTA	747	858	862	822
BMW	777	831	854	821
RENAULT GROUP	741	788	765	765
PSA PEUGEOT CITROEN	786	790	706	761
FORD	704	757	793	751
VOLKSWAGEN	662	684	701	682
VOLVO	618	649	615	627
JAGUAR/LAND RO	535	652	645	611
HYUNDAI	607	615	587	603
GM	557	579	575	570
PACCAR	502	544	518	521
DAIMLER GROUP	385	548	556	496
FIAT GROUP	483	499	495	492

Source: calculated by authors

It appears that the majority of analysed organizations have average and above average environmental performance. Performance evaluation of environmental commitment highlights BMW Group in the leading position and a homogeneous spreading of scores among the first nine analysed producers. The leading position of

BMW Group is supported by their ability to recycle waste. An analysis of each evaluation variable shows that Ford is the organization with the lowest CO2 emissions, and the lowest water and energy consumption is reported by Toyota [38].

Hypothesis testing was done using panel data and the Eviews 8 software. Data processing involved documenting the values of the index of performance of environmental commitment (IPEC) and the values of the corporate reputation index (ICR), available in the Reputation Institute 2010, 2011, and 2012 reports ([39], [40], [41]). This led to 12 observations, given the lack of data for nine of the companies included the sample.

We studied the relationship between the two indexes using statistical correlation. The correlation coefficient is -0.372 and it shows a negative and moderate link between IPEC and ICR (Table no. 2).

Table no. 2. IPEC and ICR correlation matrix

	IPEC	ICR
IPEC	1	-0.372
ICR	-0.372	1

Source: calculated by authors

Consequently, the hypothesis of our study, according to which "There is a relationship between the overall index of corporate reputation and the index of performance of environmental commitment", is partially validated, requiring additional statistical analysis when longer data series are available. Organizations focused on obtaining a high level of corporate reputation realize the importance of going beyond the minimum environmental requirements imposed by law or regulations, and implement additional, voluntary actions to ensure business sustainability.

We believe that the methodology used to determine IPEC for the automotive industry organizations can be improved and applied to other sectors.

6. Conclusions

This research allows the assessment of corporate environmental performance based on an original methodology, which facilitates the identification of corporate strengths and weaknesses using four indicators, and it provides all stakeholders with an overview of environmental performance and of each measurement indicator. It offers researchers and practitioners an overview of environmental indicators reported by companies in the automotive industry and of their interest to adhere to the voluntary principles of sustainability reporting, it offers the possibility to complete and perfect the methodology by including new indicators that could be applied to businesses, regardless of industry.

The study demonstrates that there is a relationship between corporate environmental responsibility and corporate reputation.

The limits of this study arise from the existence of restrictions in the choice of indicators, due to the need to report similar indicators, the exclusive use of reports published by companies (sustainability reports, annual reports, CSR reports), the necessity of calculations in the case of companies that reported custom indicators, the need to place equal importance to all indicators evaluated to determine the total index, the lack of data for few of the companies included the sample.

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M1 and M2 indicators- new proposed measures for the global accuracy of forecast intervals

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Abstract

This is an original scientific paper that proposes the introduction in literature of two new accuracy indicators for assessing the global accuracy of the forecast intervals. Taking into account that there are not specific indicators for prediction intervals, point forecasts being associated to intervals, we consider an important step to propose those indicators whose function is only to identify the best method of constructing forecast intervals on a specific horizon. This research also proposes a new empirical method of building intervals for maximal appreciations of inflation rate made by SPF's (Survey of Professional Forecasters) experts. This method proved to be better than those of the historical errors methods (those based on RMSE (root mean square error)) for the financial services providers on the horizon Q3:2012-Q2:2013 .

Keywords: forecast intervals, accuracy, historical errors method, RMSE, M1 indicator, M2 indicator

JEL Classification: E21, E27,C51, C53

1. Introduction

This research brings into attention to the researchers/academic environment some global accuracy indicators proposed by the author for the forecast intervals. Indeed, in literature there is not a specific measure of accuracy only for prediction intervals. The common solution is to consider the limits or the midpoints as point forecasts and then to compute the classical measures of accuracy.

The M1 and M2 indicator s proposed by the author have a single objective: to allow us to choose the best method of constructing forecast intervals. Obviously, a lower value for an M indicator compared to another one implies that the method corresponding to the first indicator generated better forecast intervals.

Another objective of this research is to proposed different versions of the historical errors method used in constructing the intervals. On the other hand, we proposed another empirical method of building prediction intervals by taking into account the specific evolution of the maximal forecasts offered by the SPF (Survey of Professional Forecasters). Moving average models are used to describe this evolution and the best forecast is built.

2. Literature

A retrospective presentation of the methods used to construct a confidence interval is done by Chatfield (1993). Williams and Goodman (1971) proposed the estimation of forecast intervals by using the historical forecast errors. The main hypothesis is that future prediction errors will have almost the same repartition as the historical forecast errors. A part of the data is used to construct the model and the errors are determined. Then, another observation is added up in the data set, increasing the sample utilized to determine forecast errors.

An empirical method was proposed by Gardner (1988), who used the forecasting model for entire set of data, computing within-sample prediction errors at 1, 2, 3, …k-steps-ahead from the time origins, and then calculating the variances of the errors for each of the lead times.

The model is not updated, and the different variances are computed using within-sample fitted errors. Confidence intervals use two main assumptions: errors normality and the standard deviation of the k-step-ahead errors. Makridakis and Winkler (1988) showed that actual forecast errors in average are too larger compared to in-sample fit errors. Therefore, Gardner (1988) used Chebychev inequality. This method gave good results compared to theoretical approaches of Bowerman and Koeler (1989) and Yar and Chatfield (1990). Taylor and Bunn (1999)

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proposed a combination of theoretical and empirical approaches, the regression models fitting the empirical errors as a function of predicted lead time. The specification uses the theoretically derived prediction variance formulae.

Kjellberg and Villani (2010) presented the advantages and disadvantages of the interval based on models and of those built by the experts. Forecast methods based on models describe the complex relationships using endogenous variables, the transparency making easy the identification of mistakes that generated wrong predictions. The disadvantages are related to the difficulty of adapting the model to recent changes in the economy, as well as the too simple form of the models. Chatfield (1993) shows that forecast intervals are often too narrow not taking into account the uncertainty related to model specification, problem that is encountered also in the experts' assessment.

Christoffersen (1998) explains how to evaluate these intervals while the methods for measuring forecasts density are introduced later, being extended for bivariate data. There are proposed tests for forecasts intervals, then bayesian prediction intervals are built, that analyse the impact of estimator error on interval. Hansen (2005) built asymptotic forecasts intervals to include the uncertainty determined by the parameter estimator.

3. Methodology and results

Forecast intervals consider the assumption that the forecast error series is normally distributed of null average and standard deviation equals root mean square error (RMSE) corresponding to historical forecast errors. For a probability of (1-α), forecast interval is calculated: $(X_t(k) - z_{\alpha/2} \cdot RMSE(k), X_t(k) + z_{\alpha/2} \cdot RMSE(k)), k = 1,...,K$.

$X_t(k)$ - punctual forecast for variable X_{t+k} at time t

$z_{\alpha/2}$ - the α/2 quintile of standardized normal distribution.

Fischer, Garcia-Barzana, Tillmann și Winker (2012) assessed the predictions' accuracy using the forecast intervals, using the classical accuracy measures by comparing the intervals' centres with the realizations. Knüppel (2012) considered not only the case of middle points but also the limits in order to compute some accuracy measures.

We start from point forecasts that are represented in our case by the maximal appreciations of the financial services providers and by the non-financial services providers for the USA quarterly inflation rate. The source of data is the Survey of Professional Forecasters (SPF). The horizon of quarterly data series covers the period Q1:2003-Q2:2013. The real values are added to the set of predictions.

The methods for constructing the forecast intervals are:

Meth1- the method of historical errors when the deviation of the last quarter is used as accuracy indicator

Meth2- the method of historical errors when the root mean square error (RMSE) of the last 4 quarters is used as accuracy indicator

Meth3- the method of historical errors when the deviation of the last corresponding quarter is used as accuracy indicator

Meth4- the method of historical errors when the root mean square error (RMSE) of the entire previous period is used as accuracy indicator

Meth5- the predictions data series follows MA(1) processes, forecast intervals being constructing for the corresponding predictions

The horizon for the forecast intervals is: Q3:2012-Q2:2013.

Table 1: Maximal appreciations for the USA inflation rate (%) and the registered values (%)

Quarter	Forecasts of the financial services providers	Forecasts of the non-financial services providers	The registered values
Q3:2012	3.7	4.4	2.1641
Q4:2012	3.4	3.42	2.1314
Q1:2013	2	4.1	2.1364
Q2:2013	2.2	2.7	2.0743

Source: Survey of Professional Forecasters (SPF)

The inflation rate at time "t" is denoted by inf(t), the error being "eps". MA(1) processes were built in order to describe the evolution of SPF's predictions.

Table 2: MA(1) models for the predictions provided by the two types of services providers

Data series horizon	MA(1) model for predictions made by financial services providers	MA(1) model for predictions made by non-financial services providers
Q1:2003-Q2:2012	inf(t)= 3.591+0.5975*eps(t-1)	inf(t)= 4.528+0.3899*eps(t-1)
Q1:2003-Q3:2012	inf(t)= 3.567+0.5920*eps(t-1)	inf(t)= 4.526+0.3903*eps(t-1)
Q1:2003-Q4:2012	inf(t)= 3.567+0.592*eps(t-1)	inf(t)= 4.526+0.3903*eps(t-1)
Q1:2003-Q1:2013	inf(t)= 3.541+0.571*eps(t-1)	inf(t)= 4.503+0.3889*eps(t-1)

Source: own computations

For a moving average process in describing the evolution of our indicator, the prediction at a future time "n+h" has the following form:

$inf_{t+n} = \sum_{j=0}^{h-1} c_j eps_{n+h-j} + \sum_{j=h}^{\infty} c_j eps_{n+h-j}$

c_j - the coefficient

j- the index of time

The best forecast (f) is in this case:

$$f_{n,h} = \sum_{j=h}^{\infty} c_j eps_{n+h-j}$$

In our case, for one-step-ahead predictions, h equals 1 and the prediction is $f_{n,1} = c_1 eps_n$.

The forecast error is given by:

$$e_{n,h} = inf_{n+h} - f_{n,h} = \sum_{j=0}^{h-1} c_j eps_{n+h-j}$$

The mean of forecast errors is considered to be null. The errors' variance is:

$$var(e_{n,h}) = \sigma_{eps}^2 \sum_{j=0}^{h-1} c_j^2$$

In our particular case, the variance is: eps_n^2

Considering the hypothesis that the errors distribution is a normal one, the forecast interval is determined as: $f_{n,h} \pm 1.96\sqrt{var(e_{n,h})}$. In our case, the forecast interval has the following form: $c_1 \cdot eps_n \pm 1.96 \cdot eps_n$, that becomes $eps_n \cdot (c_1 \pm 1.96)$.

Table 3: Forecast intervals based on the mentioned methods

Method	Horizon	Lower limit1	Upper limit1	Lower limit2	Upper limit2
Meth1	Q3:2012	**-1.90464**	**9.304642**	**-3.04508**	**11.84508**
	Q4:2012	**0.389637**	**6.410363**	**-0.96236**	**7.802363**
	Q1:2013	**-0.48634**	**4.486344**	**1.574456**	**6.625544**
	Q2:2013	**1.932628**	**2.467372**	**-1.14863**	**6.548628**
Meth2	Q3:2012	0.651016	6.748984	-1.0739	9.873904
	Q4:2012	0.093345	6.706655	-2.23632	9.076323
	Q1:2013	-1.53135	5.531355	-1.56222	9.762216
	Q2:2013	-1.21788	5.617883	-2.1945	7.594504
Meth3	Q3:2012	**2.115191**	**5.284809**	**-2.6364**	**11.4364**
	Q4:2012	**3.589524**	**3.210476**	**-3.2832**	**10.1232**
	Q1:2013	**-2.0829**	**6.082904**	**-7.1504**	**15.3504**
	Q2:2013	**-4.82318**	**9.223182**	**-9.11684**	**14.51684**
Meth4	Q3:2012	-0.31511	7.715115	-4.42	13.22
	Q4:2012	-0.59251	7.392512	-5.78729	12.62729
	Q1:2013	-1.96184	5.961842	-5.05304	13.25304
	Q2:2013	-1.71345	6.113452	-6.42742	11.82742
Meth5	Q3:2012	**-0.88445**	**1.660185**	**-0.34129**	**0.510817**
	Q4:2012	**-1.46243**	**0.783929**	**-1.92617**	**1.286335**
	Q1:2013	**-1.46243**	**0.783929**	**-0.13103**	**0.087505**
	Q2:2013	**-2.98166**	**1.636258**	**-0.01837**	**0.02747**

Source: own computations

We proposed a new accuracy indicator, named M1 indicator, which is computed as a sum of errors for two situations: when the real value is outside the forecast interval and when it is inside the interval. For the first case, it is computed the square root of the average square deviations between the real value and the lower limit (if the real value is lower than the inferior limit) and, respectively, the superior limit (if the real value is greater than the upper limit). This square root of the average square deviations could be assimilated to a modified RMSE, because the reference is not related to a certain limit of all intervals, but in a variable way to the limits as to have a minimal distance between the real value and a certain limit. This indicator will be denoted by RMSE* and it will be divided to the average of real values in order to get an indicator similar to the coefficient of variation. For the second case, when the effective value is inside the interval, it is calculated the square root of average square deviations based on the minimum between the lower limit and the real value, respectively, the difference between the superior limit and the registered value. This average square deviation, denoted by RMSE**, is divided to the real values average. For M2 indicators, the denominators are represented by the average minimal deviations. According to the previous explanations, the following formulae are proposed as measures of global accuracy:

$$M1 = \frac{RMSE*}{realizations'average} + \frac{RMSE**}{realizations'average} = \frac{RMSE*+RMSE**}{realizations'average}$$

$$M2 = \frac{RMSE*}{average\ of\ minimal\ deviations1} + \frac{RMSE**}{average\ of\ minimal\ deviations2}$$

M1 and M2 indicators allow us to make comparisons between methods or intervals according to the type of services providers.

Table 4: M1 and M2 indicators for forecast intervals associated to financial services providers

Forecast method	Meth1	Meth2	Meth3	Meth4	Meth5
M1	1.210058	2.725057583	3.777895478	3.233240844	**0.475537261**
M2	1.200378951	1.522405865	2.516285298	2.017803225	**1.110706108**

Source: own computations

A value closer to zero for each accuracy measure will indicate a better method for constructing the forecast interval and a better services provider. According to M1 and M2, the fifth method, proposed by the author according to the particular predictions, is the best for financial services providers.

Table 5: M1 and M2 indicators for forecast intervals associated to non-financial services providers

Forecast method	Meth1	Meth2	Meth3	Meth4	Meth5
M1	1.618909142	1.84330988	3.819136806	3.565935309	**0.808855517**
M2	1.139244793	1.006849258	1.058443756	**1.004606526**	1.043421295

Source: own computations

According to M1 measure, the fifth method (meth5) proposed by me, gave the best results, for the financial services providers the forecast intervals being the best. The M2 indicator is a measure of the minimal deviations compared to the minimal deviations average (the weight of minimal deviations in the cumulated minimal deviations average for the two situations (when the real value is or not inside the interval)), the fifth method generating the best results for financial services financial, while the fourth method determined better intervals for non-financial providers. If M2 is decomposed on the two cases, we have to check which of the components has a higher value. It is preferred to have a small as possible weight of the errors outside the intervals. We have different results for the best provider according to M2. Therefore, we analyse the decomposition of the indicator on components and we chose the method for which the weight of errors for values outside the intervals is the lowest, in order to take the correct decision. In our case, all the values are inside the intervals; so, we take the decision according to M1 indicator. If we make a comparison with the accuracy of point forecasts, M1 measure corresponds to the measures based on errors' percentage.

4. Conclusions

The main goal of this research was to introduce in literature a global accuracy measure specific to forecast intervals, taking into account that a particular accuracy indicator has not been proposed yet. Our M1 and M2 indicators were used in order to make comparisons between forecast intervals. For SPF maximal forecasts offered by financial and non-financial services providers our indicators put into evidence the superiority of our method for constructing intervals corresponding to financial institutions. On the other hand, the historical RMSE method gave the best results for non-financial agents if the longest historical horizon is taken into account.

Another important contribution of this research is the empirical method proposed by me to build forecast intervals (Method 5). This method takes into account the particular evolution of the SPF's predicted maximal values for the inflation rate. Knowing that the forecasts follow moving average processes, an optimal forecast is determined and making the assumption of a normal distribution, we have a certain form for the prediction interval.

A limitation of the proposed indicators is the fact that we can't assess the accuracy/uncertainty by putting into evidence the specific sources of uncertainty. The interpretation should be done in a prudent way, because it does not have an economic significance. We use these measures only to fix the best method to construct the prediction intervals. We also checked the case when the centres of the intervals are considered instead of specific limits, but in this case lower values are obtained for all situations. Therefore, we concluded that M1 and M2 with higher values cover more sources of uncertainty.

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