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Applied Econometrics: Empirical Project

To what extent GDP per capita is linked to the level of happiness?

I. Introduction

In a world where the search for wealth predominates, we almost forget to be happy. The purpose of this project is to study the link between these two elements.

To what extent GDP per capita is linked to the level of happiness?

Thus, we seek to determine whether the level of wealth of an individual, symbolized here by GDP per capita, have a link with the level of happiness. Nowadays, every government seeks to develop its own country. One indicator of this development is the GDP per capita. However, knowing the determinants of the happiness, for a government, can be very useful to develop public politics.

We are aware that today the level of wealth of an individual is correlated with the level of happiness. Thus, since the main objective of current governments is to seek growth, it is legitimate to wonder whether this level of wealth growth is accompanied by an increase in the level of happiness of the inhabitants of this country.

Whether we are rich or poor, there is always a positive correlation, which differs between continents, between GDP per capita and happiness level. However, it is necessary to take into account other variables as they play a significant role in being happy or not, such as the level of inequalities in the country. People satisfaction is linked in a positive way to their wealth, as we'll can see in our results. A better happiness could increase the GDP per capita, as well this one could increase the happiness. Also, a common factor could increase both. In these three cases, the governments have an interest in a better understanding of this relationship.

Firstly, we are going to introduce the literature review according to our question. In the second part, we will present the econometric models and the estimation of our results. Then, we are going to talk about the data in a third part. In a fourth part, we are going to present our results, before concluding.

II. Literature Review

Now turn our attention to the existing literature concerning the level of happiness and wealth of individuals.

Richard Easterlin's theory (1974) is the most famous and often repeated one. The latter shows that in the long run, despite a significant increase in GDP per capita, the link between GDP per capita and the level of happiness no longer exists. In other words, once a certain level of income is reached, it no longer affects the level of happiness. A recent study in this direction is the one of Angus Deaton and Daniel Kanheman (2010). They discovered that above a threshold of $75,000 the link between happiness and income no longer exists. One of the most important issues in the economy of happiness is the search for this famous threshold at which income no longer affects the level of happiness. That's why our first model is a linear model with only the explanatory variable to have a main view of the link between these two variables.

According to these theories of a threshold that shows the end of the link between GDP per capita and the level of happiness, we can assert the existence of other factors that can influence the level of happiness of an individual.

Paul Frijters and Ada Ferrer-i-Carbonell (2002) mention in their article that having children is a significant variable. But contrary to popular belief, having children does not necessarily increase the level of happiness. On the contrary, having children has a negative effect on happiness. Rafael di Tella, Robert J. MacCulloch and J. Oswald (2001) found the same type of results in their searches.

Another factor that could justify an individual's level of happiness might be the presence of inequalities in a country. Indeed, individuals have the unfortunate tendency to always compare themselves with each other and thus misrepresent their own view of happiness. It is therefore important to take into account the inequalities. Alberto Alesina, Rafael di Tella and Robert J. MacCulloch (2004) conducted a study on this subject. They state that: “Individuals tend to report lower levels of happiness when inequality is high”. Ruut Venhoven (1990) comes to the same conclusion: “Happiness is more evenly distributed in countries with small income differences”.

III. Conceptual framework

To implement this study and estimate the link between happiness level and GDP, three models are used. Two models are based on a multinomial logistic regression and one is based on an ordinary least squares regression. We anticipate a positive correlation between the happiness level and the GDP per capita, but we know that the GDP per capita isn't the only determinant of the happiness.

The fact that the people can judge their level of life according to the others is a problem and so a potentially source of endogeneity. Indeed, if there are a lot of inequality in the country our results can be biased. This problem of endogeneity can be solved by adding a variable representing the inequalities level per country.

With a look at the existing literature we see that the subjective health is one of the most important factor for have a good happiness level. The subjective health is affected by the level of pollution and should affect the level of happiness, which was one of the conclusion of the paper made by Glenn C. Blomquist, Mark C. Berger and John T. Hoehn (1988).

Pollution is something that can strongly affect health, which is one of the main determinants of happiness. We therefore include a variable representing pollution.

Having children is one of main goals in life for most people so logically a determinant of the happiness. We decide then to include all this variables in the study. Finally, we decide to include dummy variables to represent the continent membership. We do this because the happiness can be different across people and solve partially this endogeneity issue.

IV. Econometric model and estimation results

All the variables are expressed by country c and by years y. The level of happiness that lies between 4 and 7 because we have no value for 0, 1, 2, 8, 9 and 10 in our dataset. Moreover, we exclude the values 3 and 8 for the sake of the simplification and understanding and because we had a real lack of data for these values.

The first model is a multinomial logit model with only the log of the GDP per capita as explanatory variable.

$$RLadder_{c,t} = \beta_0 + \beta_1 . logGDP_{c,t} + \varepsilon_{c,t}$$

We do this to have a main view of the link between GDP per capita and the level of happiness. We choose to use a multinomial logit for have more than two different levels of happiness. This model is the best way to implement a more precise and valuable study. We assume a logistic distribution of the errors. Here *logGDP* is the log of the GDP per capita and *RLadder* is the level of happiness.

The second model is still a multinomial logit model, but it contains all the other variables.

$$\begin{aligned} RLadder_{c,t} = {} & \beta_0 + \beta_1 . logGDP_{c,t} + \beta_2 . GINI_{c,t} + \beta_3 . CO2_{c,t} + \beta_4 . CPW_{c,t} \\ & + \beta_5 . WestEurope + \beta_6 . EastEurope + \beta_7 . Africa + \beta_8 . MiddleEast \\ & + \beta_9 . AsiaOceania + \beta_{10} . America + \varepsilon_{c,t} \end{aligned}$$

GINI represents the GINI index, *CO2* represents the pollution rate, *CPW* represents the number of children per women and the other variables are dummy variables which take the value 1 if the country c is in the continent specified.

Finally, our third model is the ordinary least squares regression.

$$RLadder_{c,t} = \beta_0 + \beta_{Rich}.Rich.\left(\log\left(GDP_{c,t}\right) - \log(k)\right) + \beta_{Poor}Poor.\left(\log\left(GDP_{c,t}\right) - \log(k)\right) + \varepsilon_{c,t}$$

We use this model to test Easterlin's hypothesis that for the rich people, the level of income had no effect on the level of happiness. To do this we use the model used by Betsey Stevenson and Justin Wolfers in their study published in the American economic review in 2013. Moreover, this model will allow us to test the "weak" version of the Easterlin's hypothesis (according to Betsey Stevenson and Justin Wolfers) which is $\beta_{Poor} > \beta_{Rich}$. We assume a normal distribution of the errors. *Rich* (resp. *Poor*) is a dummy variable which takes the value if the GDP per capita is superior or equal to k (resp. inferior to k). In this case, if the Easterlin's hypothesis is true we should have $\beta_{Rich} = 0$. For k, we choose three different values: $10,000 – from Bruno S. Frey and Alois Sutzer (2002) – $15,000 and $20,000 – from Richard Layard (2003 and 2005).

V. Data

Our sample consists of 110 different countries, broken down by continent. For each country, we’ve collected data for each of our variables between 2006 and 2014. We have 567 observations. We took our data on Happiness from a World Happiness Report. It comes from a survey released by the Gallup World Poll and covers the years from 2006 to 2014. We have a certain confidence in this measure because the asked question is extremely precise and demands to imagine a ladder from 0 to 10 with 0 being the worst possible life and 10 being the best possible life and choose at what level we are at this moment. So, we have the average level of happiness by country and by years. We took from the database of the World Bank, the GDP per capita and the fertility rate. For the Gini index, our data comes from the United Nations University. Finally, we took our data on pollution, CO2 emissions per capita from Carbon Dioxide Information Analysis Center.

To summarize this, you can see in the appendix, on the Table 1, a short description of the variables used in our project and, on Table 2 and Table 3, a summary of the descriptive statistics.

VI. Results

1. The First Model

$$\boxed{RLadder_{c,t} = \beta_0 + \beta_1 . logGDP_{c,t} + \varepsilon_{c,t}}$$

As we expected, the sign of the coefficients $logGDP$ for the three levels of happiness are all positive, as you can see in the Table 4. GDP per capita and the happiness are positively correlated. Also, there are significant at 1% level. A possible interpretation of $\exp(\beta_1)$ for the level 6 of happiness is: the probability to reach the level 6 regarding the level 4 is increasing by 8,016% when the *logGDP* is increased by one. As the coefficients of a multinomial logistic model are complicated to interpret as is, we will introduce one way to understand the significance of these coefficients.

A possible way to show how the GDP per capita and the happiness are connected is to compute the marginal effects.

$$\Pi_p = \frac{\exp\left(\beta_{p,0} + \beta_{p,1} \cdot logGDP\right)}{1 + \sum_{i=4}^{n=7} \exp\left(\beta_{p,0} + \beta_{p,1} \cdot logGDP\right)} \ \forall p \in (4,7)$$

For each level of happiness p, there exists its corresponding probability Π_p to reach it. Obviously, we know that $\sum_{i=4}^{n=7} \Pi_p = 1$. So, to make our results as clear as possible, we have plotted the probability to reach a level of happiness according to the GDP per capita on the Figure 1.

The probability to reach the lower level of happiness is superior to the others when the log of GDP per capita (resp. the GDP per capita) is between 6 and 7.87 (resp. 403.43 and 2,617.57). While the probability to reach the higher level of happiness is superior to the other when the log of GDP per capita (resp. the GDP per capita) is between 10.06 and 12 (resp. 23,388 and 162,754).

Moreover, we want to notice that the shape of the blue curve is always negative while the shape of the green curve is always positive. This means that higher the GDP per capita is, lower will be the probability to be “unhappy” and higher will be the probability to be “happy”. These results are completely in accordance with our expected results.

Now we have shown, with a simple model, that the GDP per capita is really correlated with the happiness level, we will present a more robust model, with more explanatory variables.

2. The Second Model

$$
\begin{aligned}
RLadder_{c,t} = \beta_0 + \beta_1.logGDP_{c,t} + \beta_2.GINI_{c,t} + \beta_3.CO2_{c,t} + \beta_4.CPW_{c,t} \\
+ \beta_5.WestEurope + \beta_6.EastEurope + \beta_7.Africa + \beta_8.MiddleEast \\
+ \beta_9.AsiaOceania + \beta_{10}.America + \varepsilon_{c,t}
\end{aligned}
$$

The sign coefficients *logGDP* stay positive, as expected, and those of the level 7 has doubled, as displayed on the Table 5. The capacity to reach the level 7 demands less level of GDP. We notice that these coefficients are in ascending order of happiness level. Moreover, the GINI coefficients are negative and significant at least at the 10% level. Indeed, an increase in the GINI Index will decrease the probability to reach the levels 5, 6, or 7 regarding the 4th.The CPW coefficients are non-significant. Finally, the dummies coefficients are either negative or positive, which means that being in a certain continent will increase or decrease the probabilities to reach a better level of happiness. Now, we decide to focus our interpretation on the marginal effects which raise interesting facts.

First, we've plotted two graphs, on the Figure 2, including or not, the GINI coefficient, and not including yet the dummies variables. Looking at the top graph, we notice a weak density of probability of levels 4 et 6, when the log of GDP is between 6 and 12. The level 4 is reached when is GDP is very low, so most of the country in our database don't reach it. But, we can clearly see that the density of probability of the level 6 is much higher when the GINI coefficient is removed. The strength of the GINI coefficient for the level 6 is such that, when the log of GDP is between 7.04 and 8.48, the probability to reach the level 6 is the higher. When the GINI effect is taking in account, we miss out a level. In fact, the transition between levels is more abrupt, an increase in GDP per capita can make us either stay in the same state or increase our happiness by two.

Second, using the dummy variables, we've plotted the probability to reach a certain level of happiness, regarding the log of GDP per capita, per continent, in the Figure 3. To compute the marginal effects, all the other variables, considered as parameters here, have been fixed to their respective means. These are not computed per continent to avoid that a difference between two continents can be explicated by two different means. In addition, for a better interpretation between those continents, we study the level of GDP the country must obtain to be the happiest, at 10% error.

A country which want to reach the level 7 (the maximum level, here) must get a log of GDP per capita (resp. the GDP per capita) greater than 9.90 (resp. 19,930) if it's located in America, versus 10.59 (resp. 39,735) if it's located in the Western Europe. With a GDP per capita equal to 19,930, we begin to be happiest in America. But, in all others continent with the same level of GDP, the probability to be happiest is close to zero. A way to explain this is that the countries which need less GDP than the others to be happy, has already all the health infrastructures, schools, etc. So, the others might need more GDP to compensate this lack of infrastructures.

3. The Third Model

$$RLadder_{c,t} = \beta_0 + \beta_{Rich}.Rich.\left(\log\left(GDP_{c,t}\right) - \log(k)\right) + \beta_{Poor}Poor.\left(\log\left(GDP_{c,t}\right) - \log(k)\right) + \varepsilon_{c,t}$$

On the Table 6, we see that for all thresholds β_{Rich} and β_{Poor} are significant at 1%. We see that the higher the threshold is the higher β_{Rich}. Then we can think that the richer we are, the more important the income is to be happy.

We test the Easterlin's hypothesis: $\beta_{Rich} = 0$, on the Computation 1. For all cut-off levels β_{Rich} is significantly different from 0 at the 1% level, consequently the GDP per capita is positively correlated with the happiness even for the rich people.

Next, we test the "weak" version of the Easterlin's hypothesis, on the Computation 2. For all thresholds we reject this hypothesis at the 1% level. Then the influence of the GDP per capita is stronger among the rich than the poor people. In conclusion our results are at the opposite of those of Richard Easterlin.

VII. Conclusion

As you know, we're looking here in what extent GDP per capita and level of happiness are linked. As mentioned earlier, to implement this study and estimate the link between theses 2 variables, three models are used.

The first model is a multinomial logit model with only the log of the GDP per capita as explanatory variable. After observing our results, we can say that the GDP per capita is really positively correlated with the happiness level.

In our second model which contains all the other Variables the sign coefficients of *logGDP* stay positive, as expected.

Finally, our third model is the ordinary least squares regression to test the Easterlin's hypothesis which claims that for rich people, the level of income had no effect on the level of happiness. After analysing of our results, the GDP per capita is positively correlated with the happiness even for the rich people. So, we reject the Easterlin's hypothesis. What can we say about the relationship between inequalities symbolized by the Gini Index and the level of Happiness? Inequalities play an important role because they negatively influence the probability of being happy. This result is in line with the literature which tells us that happiness is more evenly distributed in countries with small income differences.

Moreover, according to the interpretation of the dummies coefficients which are either negative or positive, we observe that the belonging to a certain continent will increase or decrease the probabilities to reach a better level of happiness.

Overall our results are in agreement with the existing literature that clearly evokes this positive relationship between our two variables. So, whatever the econometric model used, it is certain that there is a positive correlation between the level of income and happiness.

VIII. Appendix

Table 1. Description variables

Variables	Description
`RLadder`	Average level of hapiness (integer): btw. 4 and 7 in our data.
`logGDP`	Log of GDP per capita.
`GINI`	GINI Index.
`CO2`	CO2 emissions per capita.
`CPW`	Fertility rate: number of children per woman.
`WestEurope`	= 1 if located in Western Europe, = 0 otherwise.
`EastEurope`	= 1 if located in Eastern Europe, = 0 otherwise.
`Africa`	= 1 if located in Africa, = 0 otherwise.
`MiddleEast`	= 1 if located in MiddleEast, = 0 otherwise.
`AsiaOceania`	= 1 if located in AsiaOceania, = 0 otherwise.
`America`	= 1 if located in America, = 0 otherwise.

Table 2. Means of the variables, grouped by continent

	West Europe	Africa	America	Asia/Oceania	Middle East
`Rladder`	6.01	4.32	6.59	6.14	5.63
`logGDP`	10.17	7.90	9.83	9.77	9.43
`GINI`	0.32	0.42	0.45	0,34	0.37
`C02`	6.83	1.58	7.87	8.25	4.79

Table 3. Descriptive statistics

	logGDP	GINI	CO2	CPW
Min.	6.485	0	0.037	1.227
1st Qu.	8.986	0.308	1.725	1.498
Median	9.690	0.355	4.441	1.893
Mean	9.562	0.373	5.254	2.191
3rd Qu.	10.261	0.433	7.468	2.570
Max.	11.423	0.700	21.616	7.566

Table 4. Coefficients of the First Model

	Dependent variable:		
	5	6	7
	(1)	(2)	(3)
logGDP	1.265***	2.199***	4.451***
	(0.202)	(0.244)	(0.340)
Constant	-9.948***	-18.876***	-41.540***
	(1.745)	(2.177)	(3.259)
Akaike Inf. Crit.	1,146.237	1,146.237	1,146.237
Note:	*p<0.1; **p<0.05; ***p<0.01		

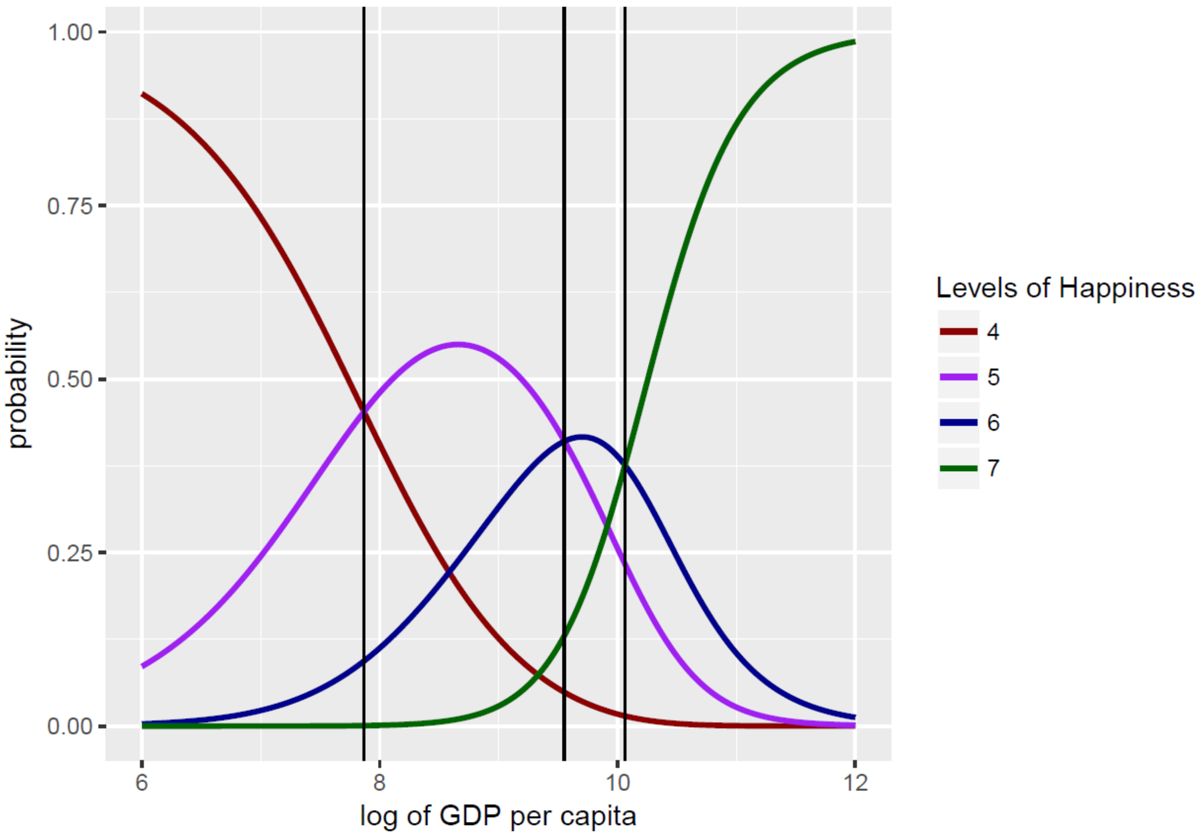
<u>Table 5</u>. Coefficients of the Second Model

	Dependent variable:		
	5	6	7
	(1)	(2)	(3)
logGDP	0.677*	2.243***	8.896***
	(0.409)	(0.524)	(1.018)
GINI	-4.998*	-13.433***	-9.432**
	(2.693)	(3.525)	(4.791)
CO2	0.347***	0.338**	0.372**
	(0.134)	(0.140)	(0.161)
CPW	-0.227	-0.483	0.753
	(0.315)	(0.484)	(0.706)
WestEurope	4.912**	3.790	-7.605***
	(2.245)	(3.558)	(2.394)
EastEurope	-3.579***	-4.922	-17.532***
	(0.848)	(6.015)	(2.044)
Africa	-1.798*	-10.834	-18.478***
	(1.087)	(33.213)	(0.092)
MiddleEast	-0.384	-1.437	-11.500***
	(1.311)	(6.122)	(2.528)
AsiaOceania	-1.766**	-2.538	-14.421***
	(0.742)	(5.999)	(2.105)
America	1.488	3.836	-3.376
	(1.256)	(6.100)	(2.175)
Constant	-1.126	-12.106*	-72.912***
	(3.277)	(7.355)	(8.719)
Akaike Inf. Crit.	881.958	881.958	881.958
Note:	*p<0.1; **p<0.05; ***p<0.01		

Table 6. Coefficients of the Third Model

	Dependent variable:		
	RLadder		
	(1)	(2)	(3)
richGDPL	1.016***		
	(0.079)		
poorGDPL	0.528***		
	(0.054)		
richGDPL2		1.260***	
		(0.104)	
poorGDPL2		0.524***	
		(0.046)	
richGDPF			0.914***
			(0.060)
poorGDPF			0.469***
			(0.068)
Constant	5.612***	5.777***	5.323***
	(0.052)	(0.050)	(0.055)
Observations	567	567	567
R^2	0.474	0.485	0.472
Adjusted R^2	0.472	0.484	0.470
Residual Std. Error (df = 564)	0.715	0.707	0.716
F Statistic (df = 2; 564)	253.770***	265.995***	252.187***
Note:	*p<0.1; **p<0.05; ***p<0.01		

<u>Figure 1</u>. The probability to reach a specific level of happiness, regarding the GDP per capita



<u>Figure 2</u>. The probability to reach a specific level of happiness, regarding the GDP per capita and including or not the GINI Index coefficient

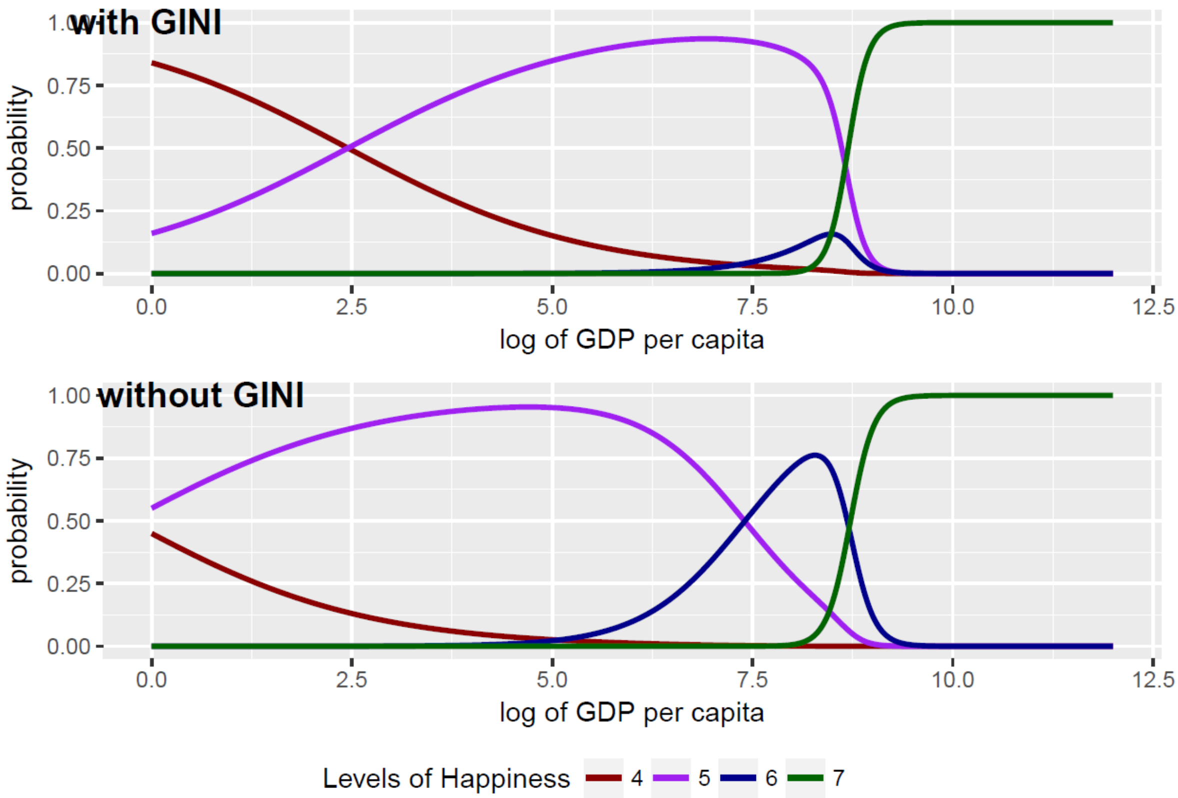
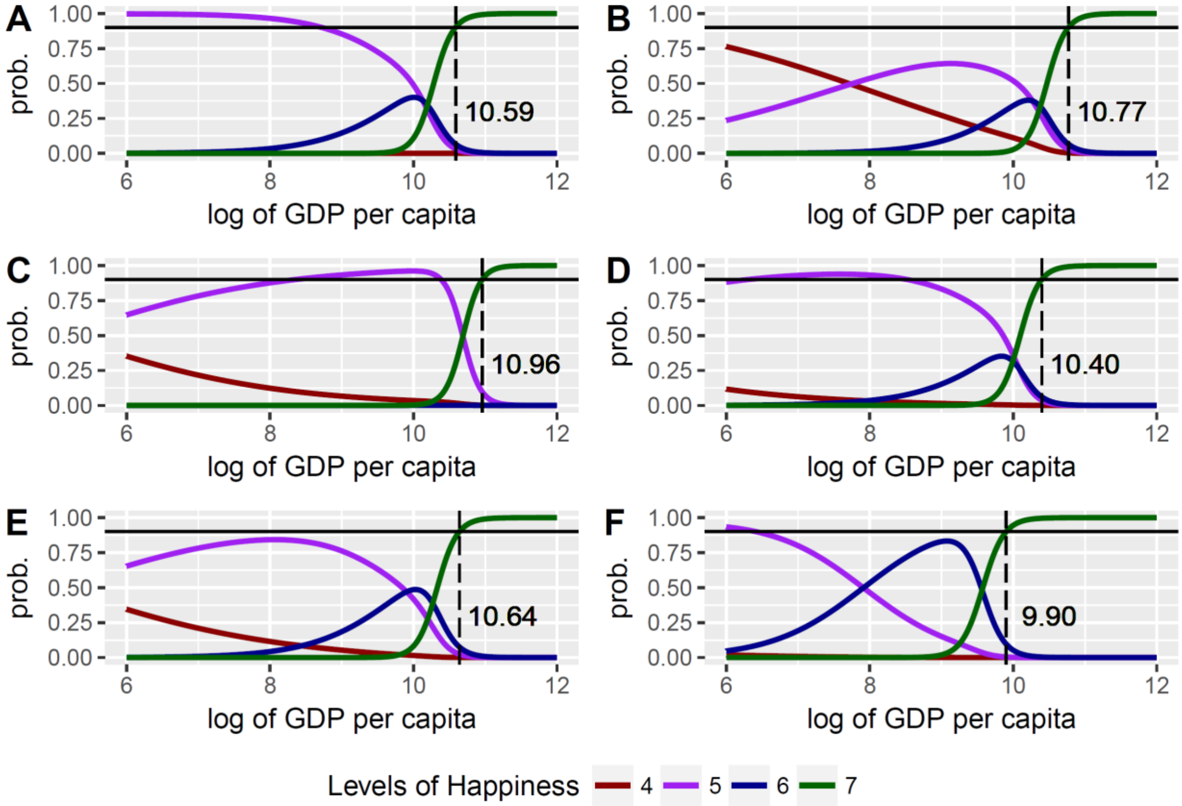


Figure 3. The probability to reach a specific level of happiness, regarding the GDP per capita, grouped by continent



*with **A**: The Western Europe; **B**: The Eastern Europe; **C**: The Africa; **D**: The Middle East; **E**: The Asia/Oceania and **F**: The America.*

Computation 1. Test method for Easterlin's hypothesis:

$H_0: \beta_{Rich} = 0 \qquad H_1: \beta_{Rich} \neq 0$

$$\hat{t} = \frac{\hat{\beta}_{Rich}}{se(\hat{\beta}_{Rich})} \xrightarrow{d} N(0,1) \text{ under } H_0$$

We reject H_0 if $|t| > z$, z the quantile of order 0,995 of a standard normal distribution.

Computation 2. Test method for the "weak" version of the Easterlin's hypothesis:

$H_0: \beta_{Poor} \geq \beta_{Rich} \qquad H_1: \beta_{Poor} < \beta_{Rich}$

$$\hat{t} = \frac{\hat{\beta}_{Rich} - \hat{\beta}_{Poor}}{se(\hat{\beta}_{Rich} - \hat{\beta}_{Poor})} \xrightarrow{d} N(0,1) \text{ under } H_0$$

We reject H_0 if $t < -z$, z the quantile of order 0,995 of a standard normal distribution.

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