

Are more hours of work bad for people and for the company?

Pop Paula, Toma Alexandra, Badut Alexandru, Raoulx Toanui

ENAC, Toulouse

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- 1 Introduction
- 2 First Model
- 3 Model Improved
- 4 Validation of the model
- 5 Conclusion

Introduction

Our database: how gathering informations?

Our target

- Working hours influence on the productivity of the company and the health of the employee.

Our spreading

- We gathered the data among 27 countries in Europe.
- Time period of the data is from 2019-2022, without 2020 due to COVID-19 pandemic.
- Trusted sources such as Eurostats and paper-works, were used in gathering the data.

Data influence

Main Variable - Working hours

- OECD - "Hours worked"
- EUROSTAT - "Hours of work - annual statistics"
- EURONEWS - "Average working hours in Europe: Which countries work the longest and shortest weeks?"

Productivity variables

- American Economic Review 2018, 108(1): 170–199 - "How Do Hours Worked Vary with Income? Cross-Country Evidence and Implications"
- Financial Times - "Burnout: can investment banks cure their addiction to overwork?"

Health variables

- RIETI Discussion Paper Series 16-E-037 - "Why Do People Overwork at the Risk of Impairing Mental Health?"
- Journal of Global Economics - "Overwork and Adverse Effects on Health"

Effects expected

Explanatory variables	Health	GDP/Capita
	Expected effects	Expected effects
Average temperature	?	?
Average sun hours	+	
Cigarette	+	?
Earnings	-	+
Happiness	-	+
HDI	-	+
Number of free days	-	-
Number of work hours	+	+
Life work balance index	+	?

Linear regression

Productivity and Health

Our first equation for productivity is therefore:

$$PRODUCTIVITY_i = X_i, j' \beta + U \quad (1)$$

$$i = 1, 2 \dots n, j = 1, 2 \dots n$$

And for health:

$$HEALTH_i = X_i, j' \beta + U \quad (2)$$

$$i = 1, 2 \dots n, j = 1, 2 \dots k$$

Where $n = 78$ which is the total number of observation, and $k=8$ for the productivity and $k=9$ for the health. ¹

¹The value of coefficients was calculated already with LN()

Results thanks to Eviews

1st Regression on Health

Dependent Variable: MED_CONSULT_IN_LN
 Method: Least Squares
 Date: 01/14/24 Time: 18:43
 Sample (adjusted): 1 78
 Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.96021	4.873861	3.274654	0.0017
AV_SUN_HOURS_IN_LN	-0.906023	0.256026	-3.538794	0.0007
AVERAGE_TEMPERATURE	0.367113	0.135010	2.719162	0.0084
CIGARRETTE_HAB	0.235390	0.125493	1.875729	0.0652
EARNINGS	-0.313191	0.136428	-2.295646	0.0249
HAPPINESS	2.103263	0.871712	2.412797	0.0187
HDI	-3.170449	1.532377	-2.068975	0.0425
NUMBER_OF_FREE_DAYS	-0.916294	0.398458	-2.299601	0.0247
NUMBER_OF_HOURS	-2.311286	0.958490	-2.411382	0.0187
LIFE_WORK_BALANCE_IN_LN	-0.150075	0.324182	-0.462936	0.6450
R-squared	0.579651	Mean dependent var	1.744080	
Adjusted R-squared	0.521449	S.D. dependent var	0.371667	
S.E. of regression	0.257109	Akaike info criterion	0.244935	
Sum squared resid	4.296839	Schwarz criterion	0.553934	
Log likelihood	0.814930	Hannan-Quinn criter.	0.368315	
F-statistic	9.959277	Durbin-Watson stat	2.243451	
Prob(F-statistic)	0.000000			

Results thanks to Eviews

1st Regression on Productivity

Dependent Variable: GDP_CAPITA

Method: Least Squares

Date: 01/18/24 Time: 10:48

Sample (adjusted): 1 78

Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.095536	4.953185	-0.423068	0.6736
AVERAGE_TEMPERATURE	-0.014574	0.121248	-0.120204	0.9047
CIGARRETTE_HAB	0.178624	0.128703	1.387872	0.1696
EARNINGS	0.775754	0.147101	5.273617	0.0000
HAPPINESS	0.697231	0.934646	0.745984	0.4582
HDI	2.670556	1.636828	1.631544	0.1073
LIFE_WORK_BALANCE_IN_LN	0.128097	0.291164	0.439948	0.6614
NUMBER_OF_FREE_DAYS	-0.063083	0.378425	-0.166698	0.8681
NUMBER_OF_HOURS	1.077546	1.037751	1.038347	0.3027
R-squared	0.830551	Mean dependent var	10.33703	
Adjusted R-squared	0.810905	S.D. dependent var	0.642639	
S.E. of regression	0.279452	Akaike info criterion	0.396194	
Sum squared resid	5.388445	Schwarz criterion	0.668122	
Log likelihood	-6.451580	Hannan-Quinn criter.	0.505052	
F-statistic	42.27538	Durbin-Watson stat	1.252565	
Prob(F-statistic)	0.000000			

Verification that Expected effects = Real effects

Explanatory variables	Health problem		GDP/Capita	
	Expected effects	Real effects	Expected effects	Real effects
Average temperature	?	+	?	-
Average sun hours	+	-		
Cigarette	+	+	?	+
Earnings	-	-	+	+
Happiness	-	+	+	+
HDI	-	-	+	+
Number of free days	-	-	-	-
Number of work hours	+	-	+	+
Life work balance index	+	-	?	+

Our first equation for productivity is therefore:

- $PRODUCTIVITY_i = \beta_0 + \beta_1 * AVERAGE_TEMPERATURE + \beta_2 * CIGARETTE_HAB + \beta_3 * EARNINGS + \beta_4 * HAPPINESS + \beta_5 * HDI + \beta_6 * LIFE_WORK_BALANCE + \beta_7 * NUMBER_OF_FREE_DAYS + \beta_8 * NUMBER_OF_HOURS$

And for health:

- $HEALTH_i = \beta_0 + \beta_1 * AVERAGE_SUN_HOURS + \beta_2 * AVERAGE_TEMPERATURE + \beta_3 * CIGARETTE_HAB + \beta_4 * EARNINGS + \beta_5 * HAPPINESS + \beta_6 * HDI + \beta_7 * LIFE_WORK_BALANCE + \beta_8 * NUMBER_OF_FREE_DAYS + \beta_9 * NUMBER_OF_HOURS$

Validity of the model

R-square

- We obtain $R^2 = 0.579651$ for Health
- We obtain $R^2 = 0.830551$ for Productivity

Improvements

How to drop useless indicators?

- We'll have a look on the Probabilities
- We'll check the Correlation between variables

Results thanks to Eviews

1st Regression on Health

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Results thanks to Eviews

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Dependent Variable: GDP_CAPITA
 Method: Least Squares
 Date: 01/18/24 Time: 10:48
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 Included observations: 78 after adjustments

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Sum squared resid	5.388445	Schwarz criterion	0.668122	
Log likelihood	-6.451580	Hannan-Quinn criter.	0.505052	
F-statistic	42.27538	Durbin-Watson stat	1.252565	
Prob(F-statistic)	0.000000			

New Model

We drop out the indicator which have the highest probability for Productivity:

- Average temperature: 0.9047
- Life-Work Balance Index: 0.6614
- Number of free days: 0.8681
- Happiness: 0.4582

We drop out the indicator which have the highest probability for Health:

- Life-Work Balance Index: 0.6450
- Cigarettes: 0.0652

Verification of the correlation

	Correlation										
	AV_SUN_H...	AVERAGE_...	CIGARRET...	EARNINGS	GDP_CAPITA	HAPPINESS	HDI	LIFE_WOR...	MED_CON...	NUMBER_...	NUMBER_...
AV_SU...	1.000000	0.510706	0.034973	-0.373788	-0.407919	-0.526502	-0.470113	-0.120701	-0.300084	0.403721	0.080767
AVERA...	0.510706	1.000000	0.341737	-0.258944	-0.258081	-0.512395	-0.363043	-0.034308	0.244455	0.166244	-0.344744
CIGAR...	0.034973	0.341737	1.000000	-0.121013	-0.038527	-0.135237	-0.139878	-0.056992	0.268065	0.139625	0.073662
EARNI...	-0.373788	-0.258944	-0.121013	1.000000	0.901746	0.862750	0.879685	0.508913	-0.182497	-0.731136	0.293468
GDP_...	-0.407919	-0.258081	-0.038527	0.901746	1.000000	0.808620	0.840553	0.443298	-0.180248	-0.632652	0.286753
HAPPI...	-0.526502	-0.512395	-0.135237	0.862750	0.808620	1.000000	0.854533	0.377107	-0.066728	-0.729389	0.342104
HDI	-0.470113	-0.363043	-0.139878	0.879685	0.840553	0.854533	1.000000	0.438279	-0.169405	-0.693704	0.238293
LIFE_...	-0.120701	-0.034308	-0.056992	0.508913	0.443298	0.377107	0.438279	1.000000	-0.210562	-0.405903	0.402654
MED_...	-0.300084	0.244455	0.268065	-0.182497	-0.180248	-0.066728	-0.169405	-0.210562	1.000000	-0.157473	-0.476733
NUMB...	0.403721	0.166244	0.139625	-0.731136	-0.632652	-0.729389	-0.693704	-0.405903	-0.157473	1.000000	-0.041357
NUMB...	0.080767	-0.344744	0.073662	0.293468	0.286753	0.342104	0.238293	0.402654	-0.476733	-0.041357	1.000000

Verification of the correlation

High correlation between:

- Happiness and HDI: 0.854533
- Earnings and GDP per Capita: 0.901746
- HDI and Earnings: 0.879685

Correlation between the variables important for our problem:

- GDP per Capita and Number of Hours : -0.632652
- Number of medical consultations and Number of Hours : -0.157473

New model

(Linear regression of our new model - Health)

Dependent Variable: MED_CONSULT_IN_LN

Method: Least Squares

Date: 01/18/24 Time: 10:36

Sample (adjusted): 178

Included observations: 75 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.87562	4.464130	3.556263	0.0007
AV_SUN_HOURS_IN_LN	-1.034733	0.243611	-4.247482	0.0001
AVERAGE_TEMPERATURE	0.481982	0.117210	4.112115	0.0001
EARNINGS	-0.360693	0.134472	-2.682286	0.0092
HAPPINESS	2.427022	0.856312	2.834272	0.0061
HDI	-3.284503	1.550194	-2.118769	0.0378
NUMBER_OF_FREE_DAYS	-0.792996	0.343394	-2.309290	0.0240
NUMBER_OF_HOURS	-1.969638	0.944288	-2.085843	0.0408
R-squared	0.553319	Mean dependent var		1.744080
Adjusted R-squared	0.506650	S.D. dependent var		0.371667
S.E. of regression	0.261055	Akaike info criterion		0.252363
Sum squared resid	4.566013	Schwarz criterion		0.499561
Log likelihood	-1.463603	Hannan-Quinn criter.		0.351066
F-statistic	11.85643	Durbin-Watson stat		2.368655
Prob(F-statistic)	0.000000			

New model

(Linear regression of our new model - Productivity)

Dependent Variable: GDP_CAPITA

Method: Least Squares

Date: 01/18/24 Time: 10:58

Sample (adjusted): 1 78

Included observations: 78 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.539691	3.655143	0.147653	0.8830
CIGARRETTE_HAB	0.163881	0.113699	1.441363	0.1538
EARNINGS	0.825055	0.119670	6.894429	0.0000
HDI	3.281116	1.477073	2.221364	0.0294
NUMBER_OF_HOURS	0.742342	0.875899	0.847520	0.3995
R-squared	0.827617	Mean dependent var		10.33703
Adjusted R-squared	0.818171	S.D. dependent var		0.642639
S.E. of regression	0.274030	Akaike info criterion		0.310800
Sum squared resid	5.481764	Schwarz criterion		0.461871
Log likelihood	-7.121214	Hannan-Quinn criter.		0.371277
F-statistic	87.61879	Durbin-Watson stat		1.301447
Prob(F-statistic)	0.000000			

Points to check

Productivity

- Homoskedasticity test

Heteroskedasticity Test: White

Null hypothesis: Homoskedasticity

F-statistic	0.832031	Prob. F(4,73)	0.5092
Obs*R-squared	3.401022	Prob. Chi-Square(4)	0.4931
Scaled explained SS	3.824272	Prob. Chi-Square(4)	0.4303

Figure: Homoskedasticity white test

Points to check

Health

- Homoskedasticity test

Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

F-statistic	1.608947	Prob. F(7,67)	0.1481
Obs*R-squared	10.79311	Prob. Chi-Square(7)	0.1479
Scaled explained SS	4.704838	Prob. Chi-Square(7)	0.6959

Figure: Homoskedasticity white test

Points to check

Productivity

- Jarque Bera test

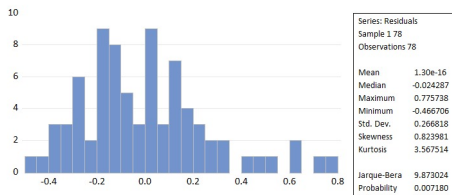


Figure: Stats and histogram

Points to check

Health

- Jarque Bera test

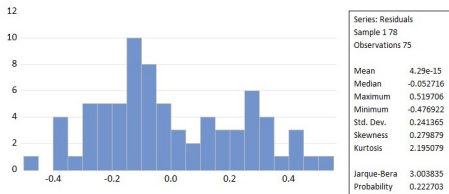


Figure: Stats and histogram

Points to check

Productivity

- Quantile quantile plot

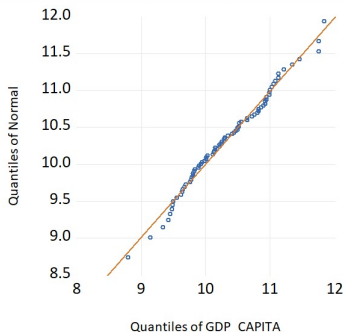


Figure: Quantile quantile plot

Points to check

Health

- Quantile quantile plot

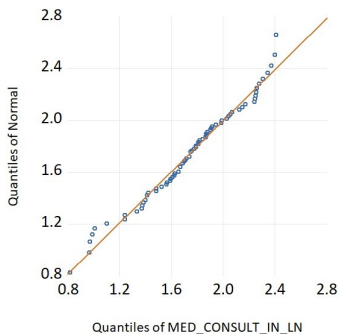


Figure: Quantile quantile plot

Conclusion

Good points

- β_k close to initial intuition
- Correct model, except for some values

Limits

- Normality of errors is verified
- Productivity R^2 is high: 0.827617
- Health R^2 is relatively high: 0.553319

Thank you for listening

Questions??



Some resources

- WorldOMeter : GDP per Capita
- Average Monthly Salary in European Union
- World Happiness Report
- Human Development Insights
- Human Development Index
- Average Sunshine a Year at Cities in Europe
- World Data : The climate in Slovakia
- OCDE : Medical Consultations
- EViews Analysis Guide