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# Effects of Digitalisation on Higher Education in a Sustainable Development Framework—Online Learning Challenges during the COVID-19 Pandemic

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**Abstract:** Throughout the planet, the medical challenges posed by the pandemic caused by the SARS-Cov-2/COVID-19 coronavirus have overlapped, *inter alia*, with the necessity to continue the academic process on every level. Romania was no exception. With the new vaccines against COVID-19, the hope of resuming face-to-face activity, considered as 'normal' before 2020, has emerged. In these circumstances, not at all far-fetched, certain questions have arisen, such as: should and must the online university education be completely removed? Should this form of education be continued? If so, to what extent? We have used econometric methods related to ARDL (auto regressive distributed lag models) such as pooled mean group (PMG) and mean group (MG) and used different tests for unit roots for the stationarity check of the series implied. The results show the positive effect of digitalisation on tertiary education and also the positive impact of the latter on sustainable development, as a base for future stimulation in public policies. The present study also aims to harness the university experience of these times, from some of the main Romanian university centres; the method used was a quantitative and qualitative research based on a questionnaire, which was answered by a number of 258 university teachers and 1569 students from prestigious public and private universities. The results of this analysis allowed us to conclude that most of the participants in the university educational process have adapted to the online activity, and the latter 'saved' the academic years 2019–2020 and, respectively, 2020–2021. The present study is useful for tertiary education institution and policymakers in terms of formulating strategies and policy recommendations to support teachers and students during any future pandemics.

**Keywords:** COVID-19; university education; teaching; on-line; sustainability; ARDL; ECT; pooled mean group; mean group



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## 1. Introduction

In March 2020, upon analysing the evolution of the spread of COVID-19 infection, the World Health Organisation declared a pandemic, the first one caused by a coronavirus [1]. Following this fact, by Decree no. 195/16 March 2020, to prevent the spread of COVID-19 and to manage its consequences, a state of emergency was established in Romania, for a period of 30 days, which was extended by another 30 days. Among the additional measures to battle COVID-19 infection was the one regarding the suspension of the educational process in a classic, face-to-face format. In higher education, taking into account the recommendation of the Ministry of Education and Research of 10 March 2020 on the suspension of teaching activities and the organisation of online education [2], Romanian universities have decided to do so until the end of the state of emergency. In fact, online

teaching activities in universities have taken place during the entire second semester of the 2019–2020 academic year and continue even today.

As some studies have already stated [3–9], a successful transition to online education requires a high degree of adaptability, which involves technological and pedagogical support, as well as elements for monitoring and evaluation of participants to online education. In addition, a requirement arose for universities to be receptive to the needs of students, in the context in which online education is a challenge in itself, offering new opportunities for collaboration, training and communication for teachers [3,10–13]. Numerous other studies show that, in relation to online education, teachers are concerned not only with their personal lives, which in the time of a pandemic translates into uncertainties regarding the health and safety of their families and of themselves, but also with the impact on their professional life as education providers, needing support in the use of the new educational resources [3,14–19].

Digitalisation is not a novelty in higher education, and the vast majority of universities had, at the time of declaring the COVID-19 pandemic, their online educational platforms [8,20,21]. However, the digitalisation of higher education institutions cannot be reduced to online education, as the latter is only one of the elements involved in the digital transformation of universities, and online education refers to the educational use of technological tools and means, as well as the Internet [8,22]. Some researchers have argued that innovation, Internet accessibility and the ever-increasing growth of technology have increased the motivation for online education at the turn of the millennium [23], while others have argued that achieving sustainable online education is questionable, since it determines the absence of a face-to-face relationship between students, on the one hand, and between students and teachers on the other hand [24]. A recent study differentiated between planned, appropriate online education and courses taken in response to a crisis [25]. These researchers referred to online education during the pandemic as 'emergency distance learning', as it contrasts with quality and effective online education.

The digitalisation and on-line learning are related to information and life improvement in the context of the sustainable development. The latest concept is related to environmental concerns, the first appearance being spotted in The World Charter for Nature [26,27]. The notion is also connected to the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs). In this approach, the sustainable development suggests the aim for a combination of economic development, environmental sustainability and social inclusion, but the specific objectives differ globally, between and within societies [27–29]. SDGs are based on five pillars: people, prosperity, peace, partnership and planet [30]. The sustainable goals are also including mentions regarding the completion of secondary education [29], some of our variables being indicators of tertiary education.

The study aims to understand the impact that digitalisation and online education have had on higher education, from two perspectives:

- The impact of digitalisation on tertiary education, using data obtained from OECD Database regarding 22 countries from the European Union, and applying an auto-regressive distributed lag models (ARDL) methodology;
- The perspective of teachers and students from two of the largest university centres, Bucharest and Iași, considered as characteristic for Romanian higher education. The second objective was to examine the possibility of continuing online education in universities post-COVID, i.e., the extent to which it could become 'used on a daily basis' within our time.

To measure the impact of higher education on growth, we use as proxy for sustainable development the gross domestic product (GDP) in logarithmic values. GDP is the standard measure of the value added through the production of goods and services in a country, and in our investigation, is quantified as US dollars per capita. As such, it also measures the income earned from that production, or the total amount spent on final goods and services (less imports). The traditional measure of economic performance is related to gross domestic product and household income, along with some indicators regarding

the wellbeing of the population. In relation to the literature, our dependent variable that counts for sustainable development is gross domestic product per capita in logarithmic values (lnGDP). The use of a specific criterion is debated in the literature, and it is related to the policy framework that should ensure the given sustainability theme (e.g., climate change, education or sustainable economic growth) [27], but the importance of the (higher) education is usually taken into discussion. Sustainability is also directly related to teaching, being a key concept in education [31].

## 2. Materials and Methods

The next sections present the methodology regarding the analysis of the digitalisation effects on education and the perspectives of teachers and students in COVID times.

The aim of our research is to examine the log-run association between higher education (proxies used being the logarithmic value of population with tertiary education at different ages) in OECD countries, based on Solow endogenous growth model (in Equation (1)) [32]:

$$y(t) = K(t)^{\alpha} H(t)^{1-\alpha} \quad (1)$$

and human capital (in Equation (2)) can be interpreted as a function of education:

$$H(t) = E(t)^{\varphi} \quad (2)$$

where $y$ = is output, $K(t)$ is stock of physical capital and $H(t)$ is stock of human capital and $\varphi$ is assumed to be unity [33].

The variables selected in our research for identifying the relationship between tertiary education and development are in line with other studies, some of them being noted as follows: Hanusheck (2016) analysed the subject in OECD countries, using the average annual growth rate in GDP per capita, as dependent variable and years of tertiary schooling among independent variables (e.g., cognitive skills, share of students reaching basic literacy, years of non-tertiary schooling) [34]; C. Zhang and L. Zhuang (2011) used panel data set for Chinese provinces over the period of 1997–2006, using logarithm of real GDP per capita in GMM method, finding that *education plays a more important role than primary and secondary education on economic growth* [35]; J. Pereira and M. St. Aubyn (2009) used different levels of education to assess the impact on GDP per head, with VAR methodology [36]; Chatterji M. calculated the impact of tertiary education on the growth rates using GDP per capita [37].

Data used for quantifying the impact of digitalisation in education are obtained from OECD statistics database. We have used the logarithmic value of population with tertiary education (those having completed the highest level of education) as proxy for the tertiary education, by two age groups: between 25 and 34 years old (lnTER25), and between 55 and 64 years old (lnTER55), expressed as percentage in the same age group. We used the logarithmic value of Internet access (lnIA) as proxy for digitalisation, as percentage of all households. Our control variable is a variable that expresses the below upper secondary education, as percentage of 25–64-year-olds (lnSEC). The description of the variables is presented in Table 1:

Our variable of interest (upper secondary and Internet access in logarithmic values) quantifies the impact on dependent variables (education proxies). We expect the effect of Internet access on population with tertiary education (lnTER 25 and lnTER55) to be positive and statistically significant, with a higher value on population between 25 and 34 years old (lnTER25). We explain this positive relationship through the existence of higher levels of information of population with access to Internet, as a base for tertiary education. We also consider that the population with Internet access has a higher level of income, compared to other categories.

The methodology regarding the models is explained in the next Section 2.1.

**Table 1.** Variable description.

| Variable Name | Variable Description | Definition | Source | Expected Effect on DV (Sign) |
|---|---|---|---|---|
| lnTER25 | The logarithmic value of population with tertiary education 25–34 year-olds, % in same age group, 2000–2019 | Population with tertiary education is defined as those having completed the highest level of education, by age group. | Source: Education at a glance: Educational attainment and labour-force status, OECD Database | Not applicable |
| lnTER55 | The logarithmic value of population with tertiary education 55–64 year-olds, % in same age group, 2000–2019 | Population with tertiary education is defined as those having completed the highest level of education, by age group | Source: Education at a glance: Educational attainment and labour-force status, OECD Database | Not applicable |
| lnSEC | Upper secondary, % of 25–64 year-olds, 2000–2019 | Secondary education completes provision of basic education, usually in a more subject-oriented way and with more specialised teachers. | Source: Education at a glance: Educational attainment and labour-force status, OECD Database | Positive/Negative (+/−) |
| ***ln IA.*** | ***Logarithmic value of Internet access, total, % of all households, 2005–2020*** | ***the percentage of households who reported that they had access to the Internet*** | ***Source: ICT Access and Usage by Households and Individuals,*** *OECD Database* | ***Positive (+)*** |

Source: own calculation.

### *2.1. Methodology Regarding Panel Data Fixed, Random Effects, System GMM, Mean Group (MG) and Pooled Mean Group (PMG) in Error-Correction Term Models (ECM)*

The classical linear model (Equation (3)) requires dependent variable(s) and independent ones to be stationary in levels regarding covariance.

$$Y_t = \beta_1 + \beta_2 X_t + \mu_t \quad (3)$$

One problem that could appear in panel data and time series with large time unit—T (usually not encountered in small T) is the non-stationarity. To check for non-stationarity an ADF test is used for testing the presence of unit root $\rho_i = 1$, as in Equation (4):

$$Y_{it} = \alpha_{it} + \rho_i Y_{i,t-1} + \mu_t \quad (4)$$

Unit root tests in panel data are similar to those in time series data, being based on the following first-order autoregressive model (Equation (5)). The model tests the null hypothesis $H_{0:}\ \delta_i = 0$, for all $i$, with the alternative hypothesis $H_a : \delta_i < 0$. To test the non-stationarity in panel data one could use the following tests: Im-Pesaran-Shin [38], Levin-Lin-Chu [39], Harris-Tzavalis [40], Breitung [41], and Hadri [42].

$$\Delta Y_{it} = \delta_i Y_{i,t-1} + Z'_{it}\beta_i + \mu_{it} \quad (5)$$

Considering the stationarity of series, a second problem is related to the impossibility of estimating the Equation (3) with N = $n \times T$ data points, so it is necessary to address several assumptions (restrictions), the most common being parameter homogeneity, which means $\alpha_{it} = \alpha$, for all $i$, $t$ and $\beta_{it} = \beta$, for all $i$, $t$.

In panel data it is also necessary to model the individual heterogeneity of the individual group, so the error term is assumed to have separate components (fixed and random effects), one of each being specific to individual and not changing over time, and/or one specific to time that is not changing regarding individuals (Equation (6))

$$y_{it} = \alpha + \beta x_{it} + \mu_i + \tau_t + \varepsilon_{it} \quad (6)$$

where the idiosyncratic error $\varepsilon_{it}$ is independent of both the regressors $x_{it}$ and the individual error component $\mu_i$.

In the case of dynamic models (the dependent variable can be modelled by its past values, Equations (7) and (8)), there are also several difficulties to report (see Roodman (2009)), the difference and system GMM being usually used [43].

$$y_{it} = \rho y_{it-1} + \beta x_{it} + \mu_i + \varepsilon_{it} \quad (7)$$

To control for individual effects in Equation (7), the Equation (8) is first differenced:

$$\Delta y_{it} = \rho\, \Delta\, y_{it-1} + \beta \Delta\, x_{it} + \Delta \epsilon_{it} \quad (8)$$

We decided to use the methodology proposed by Blackburne and Frank [44] because, above other advantages [44]:

- It can be used for panels in which the number of cross-sectional observations (N) and the number of time-series observations (T) are both large;
- Can estimate nonstationary dynamic panels in which the parameters are heterogeneous across groups (Equation (9));
- Can control for non-stationarity using ECM models (Equation (10)).

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{i,t-j} + \sum_{j=0}^{q} \delta'_{ij} X_{i,t-j} + \mu_i + \epsilon_{it} \quad (9)$$

In the case of non-stationary variables, the dependent variables can be cointegrated with independent ones, so an error-correction term is usually used. The model is presented in Equation (10).

$$\Delta y_{it} = \phi_i \left( y_{i,t-1} - \theta'_i X_{it} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} n \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta X_{i,t-j} + \mu_i + \epsilon_{it} \quad (10)$$

where:

$i = 1, 2, \ldots, N$ are the number of groups;
$t = 1, 2, \ldots, T$ are the number of periods;
$X_{it}$ is a k $\times$ 1 vector of explanatory variables;
$\delta'_{it}$ are the k $\times$ 1 coefficient vectors;
$(p, q, \ldots, qk)$ are A.R.D.L. lags
$ij$ are scalars;
and $\mu_i$ is the group-specific effect.

Based on the methodology above, we have constructed our models that use as dependent variable the tertiary education values (lnTER25 and lnTER55) and for independent variables the access to Internet (lnIA) and secondary education (lnSEC), as expressed in Equations (11)–(13).

$$\Delta \mathrm{lnTER25_{it}} = \phi_i \left( \mathrm{lnTER25_{i,t-1}} - \theta'_i \mathrm{X_{it}} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} n \Delta \mathrm{lnTER25_{i,t-1}} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta \mathrm{lnIA_{i,t-j}} + \mu_i + \epsilon_{it} \quad (11)$$

$$\Delta \mathrm{lnTER25_{it}} = \phi_i \left( \mathrm{lnTER55_{i,t-1}} - \theta'_i \mathrm{X_{it}} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} n \Delta \mathrm{lnTER55_{i,t-1}} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta \mathrm{lnIA_{i,t-j}} + \mu_i + \epsilon_{it} \quad (12)$$

$$\Delta \mathrm{lnGDPcap_{it}} = \phi_i \left( \mathrm{lnGDPcap_{i,t-1}} - \theta'_i \mathrm{lnTER25_{it}} \right) + \sum_{j=1}^{p-1} \lambda^*_{ij} n \Delta \mathrm{lnGDPcap_{i,t-1}} + \sum_{j=0}^{q-1} \delta'^*_{ij} \Delta \mathrm{X_{i,t-j}} + \mu_i + \epsilon_{it} \quad (13)$$

In Equation (13), X = ( lnTER25, lnTER55).

The null for Hypothesis 1 is that *the lagged values of the dependent variable (tertiary education*—models 1 to 8, and economic growth—models 9 and 10) do not influence its current values ($\lambda^*_{ij}$ can have zero values).

The alternative Hypothesis 1 is that *the lagged values have influence on the current value of the variable*.
The null for Hypothesis 2 is that *there is no long-run relationship between dependent and independent variable* (tertiary education and digitalization—models 1 to 8, and economic growth and tertiary education—models 9 and 10), or $\phi_i$ can have zero values.
The alternative for Hypothesis 2 is that *long-run relationship between dependent and independent variable exists*. The dependent variable can be explained in long-run by the variations in independent variable(s): digitalization, and tertiary education.
The null for Hypothesis 3 is that *there is no short-run relationship between dependent and independent variable* (tertiary education and digitalization—models 1 to 8, and economic growth and tertiary education—models 9 and 10), or $\delta'^{*}_{ij}$ can have zero values.
The alternative for Hypothesis 3 is that *short-run relationship between dependent and independent variable exists.* The dependent variable can be explained on short-run by the variations in independent variable(s): digitalization, and tertiary education.
The economic interpretation of the null Hypothesis 1 for model 1 to 8 is that *there is no influence of the lags tertiary education on current levels*, while the null Hypothesis 2 and 3 is that *there is no influence of digitalisation on tertiary education (on long and short-run)*.
The economic interpretation of the null Hypothesis 1 for model 9 and 10 is that *there is no influence of the lags of gross domestic product per capita on current levels*, while the null Hypothesis 2 and 3 is that *there is no influence of tertiary education on gross domestic product per capita (both on long and short-run)*.

Due to the importance of sustainable education in promoting balanced growth, the second part of the study refers to the mutations and challenges during the COVID-19 pandemic in tertiary education. The analysis mainly tackles the case of Romanian universities, but a comparison with European instance is also presented.

### *2.2. The Questionnaire Method*

This section presents the methodology used to quantify the effects of COVID-19 pandemic on tertiary online education. The perspective of teachers and students was quantified by using a research conducted between 17 and 23 December 2020. The questionnaire method was managed, by using collected quantitative and qualitative data from 258 university teachers and 1569 students from three major universities, characteristic for state and private education. Through Google Forms, two separate questionnaires were created, for each of the two categories of respondents considered as a target group, each of which is structured in two sections. Section 1 addressed general, socio-demographic questions, and Section 2 included questions on online higher education, respondents' perceptions of it and the possibility of continuing online education after the COVID-19 pandemic. Most of the questions were common to the two categories of respondents. Potential participants in the questionnaire were recruited by e-mail, through institutional addresses; at the same time, social platforms such as Facebook were a useful tool for disseminating the questionnaire. The answers to the questionnaires were voluntary and anonymous, and the personal data of the respondents were not stored.

The conclusions of our study are based on a mixed system of quantitative and qualitative questions, which also constituted the study hypotheses of the research. The quantitative hypotheses, which were also worded as questions in our study, were the following:

1. How have teachers and students adapted to online university education?
2. Do you think that, after the time that required the organisation of online courses, they should be kept as a part of the online teaching activities?
3. Which student assessment system do you consider to be the most effective and objective: exclusively online, hybrid or face-to-face?

The qualitative hypotheses were the following:

1. Does online education at university level have mainly advantages or disadvantages?

2. In higher education, is there a different perception of teachers and students regarding the possibility of continuing online education even after COVID-19?

## 3. Results

Data description used in econometric model are presented in Table 2.

**Table 2.** Descriptive statistics.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| year | 330 | 2012 | 4.3270 | 2005 | 2019 |
| lnTER25 | 330 | 3.5772 | 0.2770 | 2.6554 | 4.0284 |
| lnTER55 | 330 | 3.0084 | 0.3627 | 1.9821 | 3.7139 |
| lnIA | 330 | 4.2297 | 0.3215 | 2.7588 | 4.5890 |
| lnSEC | 330 | 3.8224 | 0.3415 | 2.6105 | 4.3420 |
| lnGDPc | 330 | 10.4733 | 0.3885 | 9.538 | 11.7008 |

Source: own calculation.

The dataset has 330 observations, regarding a time span between 2005 and 2019.The unit panel refers to 22 countries from the European Union (Union (AUT, BEL, CZE, DEU, DNK, ESP, EST, FIN, FRA, GRC, HUN, IRL, ITA, LTU, LUX, LVA, NLD, POL, PRT, SVK, SVN, SWE) that have the longest data records to construct a strongly balanced data set (the methodology used requires this restriction). The variable lnTER25 has an average mean of 3.58, a minimum of 2.66, a maximum of 4.03, a variance of 0.08 and a standard deviation of 0.28. The variable lnTER55 has an average mean of 3.01, a minimum of 1.98, a maximum of 3.71, a variance of 0.13, and a standard deviation of 0.36. The variable lnIA has an average mean of 4.23, a minimum of 2.76, a maximum of 4.59, a variance of 0.10 and a standard deviation of 0.32. The variable lnSEC has an average mean of 3.82, a minimum of 2.61, a maximum of 4.34, a variance of 0.12 and a standard deviation of 0.34. The variable lnGDPc has a mean 0f 10.47 with a Std. dev around 0.38. The data description and summarised data by units (see Appendix A Table A1) show that there is enough variability to consider individual unit analysis in panel data.

### *3.1. Preliminary Tests*

In the preliminary tests, we have conducted several checks regarding the stationarity of the series to be modelled. The objective was to determine if the series are stationary at least in first-difference, because the proposed methodology does not permit non-stationarity in differenced values (noted I(2)). The results from the proposed tests Levin-Lin-Chu (2002), Harris-Tzavalis (1999), Breitung (2000), Im-Pesaran-Shin (2003), Hadri (2000) are presented in the following table (Table 3). The table synthetises the results of forty tests (4 variables * 2 * 5 tests/variable = 40), explained as follows: we have four variables (dependent and independent) in levels, resulting in also four variables in first-difference, each variable being checked by five tests per variable. The tables with comprehensive results are available in Appendix A—Table A1. The tables in the Appendix A also show the null hypothesis and the associate conclusion (the null is accepted, so the result is $H_0$, or is rejected, in this case the result being $Ha_.$)

For the dependent variable in the first model, proxy for the population with tertiary education (*lnter25*), four of five tests (LLC, HT, B and H) suggest that the series is not stationary in level (the null hypothesis cannot be rejected since the values are not statistically significant, meaning that $\rho_i = 1$ can be accepted). In this case the first-differenced series is checked, and the values suggest stationarity (four of the tests reject the null hypothesis of non-stationarity). It is, though, recommended to check for the co-integration of the series (the results are available on demand, and coefficients in Tables 4–6 confirm them). The logic is the same for the other variables implied in the models.

**Table 3.** Unit root tests results.

| Tests [∂] | LLC | IPS | HT | B | H |
|---|---|---|---|---|---|
| ***Variable name:*** | | | ***lnTER25*** | | |
| Tests in levels | 0.4764 | −5.3558 *** | 2.425 | 7.6504 | 36.5985 *** |
| Tests in first-difference | −5.8155 *** | −7.5625 *** | −15.9675 *** | −4.6404 *** | 5.9478 *** |
| ***Variable name:*** | | | ***lnTER55*** | | |
| Tests in levels | 5.2895 | −1.3054 * | 3.1303 | 7.5222 | 35.3752 *** |
| Tests in first-difference | −7.4817 *** | −12.9887 *** | −21.3188 *** | −7.4357 *** | −1.993 |
| ***Variable name:*** | | | ***lnSEC*** | | |
| Tests in levels | 3.9982 | −0.8241 | 4.8682 | 5.8177 | 33.7009 *** |
| Tests in first-difference | −6.0405 *** | −9.2288 *** | −15.3844 *** | −4.8592 *** | 3.7728 *** |
| ***Variable name:*** | | | ***lnIA*** | | |
| Tests in levels | −9.4786 *** | −18.8772 *** | −0.633 | 7.4566 | 32.1079 *** |
| Tests in first-difference | −5.4317 *** | −13.1995 *** | −9.0817 *** | −0.7765 * | 15.7989 *** |
| ***Variable name:*** | | | ***lnGDPc*** | | |
| Tests in levels | 4.1602 | 1.913 | 3.493 | 10.3498 | 35.7986 *** |
| Tests in first-difference | −6.7383 *** | −9.2249 *** | −15.1186 *** | −4.5047 *** | 0.3027 |

[∂] Test names: LLC—Levin-Lin-Chu, IPS—Im-Pesaran-Shin, HT—Harris-Tzavalis, B—Breitung, H—Hadri. Source: own calculation, *** $p < 0.01$, * $p < 0.1$.

In conclusion regarding the stationarity, the tests conducted for all the variables show that all series are stationary in first-difference—I(1), none of the variables being I(2), so the proposed methodology should be applied, using error correction models.

The results from mg, pmg models, considering one independent variable Internet access (lnIA) and lnSEC, respectively, are presented in the following table (Table 4):

**Table 4.** Results for nonstationary heterogeneous panels models (mean group—mg and pooled mean group—pmg, the impact of Internet access on tertiary education with no control variables).

| Model Name<br>Variables | (1)<br>mg (a)<br>lnTER25 | (2)<br>pmg (a)<br>lnTER25 | (3)<br>mg (b)<br>lnTER55 | (4)<br>pmg (b)<br>lnTER55 |
|---|---|---|---|---|
| ECT | −0.3158 *** | −0.193 *** | −0.320 *** | −0.104 ** |
| | (0.0431) | (0.0531) | (0.0564) | (0.0522) |
| D.lnIA | −0.1223 * | −0.0857 | −0.0510 | 0.0293 |
| | (0.0638) | (0.0884) | (0.0670) | (0.0724) |
| ***lnIA*** | ***0.5423*** *** | ***0.8474*** *** | ***1.585*** ** | ***1.332*** *** |
| | *(0.104)* | *(0.0537)* | *(0.710)* | *(0.162)* |
| C. | 0.209 | 0.00500 | 0.0289 | −0.271 * |
| | (0.158) | (0.0134) | (0.213) | (0.144) |
| Obs. | 308 | 308 | 308 | 308 |

Source: own calculation, standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The estimates for mg model show that the speed of adjustment is −0.3158, the short-run coefficient is −0.1223, while the long-run one is 0.5423, all coefficients on long-run being significant at 1% level (error-correction term ECT and Internet access proxy lnIA). The estimates for the pooled mean group model imply that the speed of adjustment is −0.1930, the short-run coefficient is −0.0857, while the long-run one is 0.8474, all long-run and ECT coefficients being significant at 1% level. The results show that the dependent variable is influenced both on short and long-run term by the independent variable. The models show that there is cointegration between variables, the error-correction term being negative and statistically representative, and on the long-run there is a positive impact of digitalisation on tertiary education levels. The effect appears to be the largest on 55–64 years group (the coefficients are above 1). In the short-run, the effect seems to be negative, but it is corrected on the long-run with a positive effect.

To test the robustness of our results we used a control variable, the level of upper secondary education (lnSEC). The results are presented in Table 5:

**Table 5.** Results for nonstationary heterogeneous panels models (mean group—mg and pooled mean group—pmg, the impact of Internet access on tertiary education, secondary education used as control variable).

| Model Name<br>Variables | (5)<br>mg (a)<br>lnTER25 | (6)<br>pmg (a)<br>lnTER25 | (7)<br>mg (b)<br>lnTER55 | (8)<br>pmg (b)<br>lnTER55 |
|---|---|---|---|---|
| ECT | −0.429 *** | −0.166 *** | −0.487 *** | −0.0635 |
| | (0.0856) | (0.0545) | (0.0803) | (0.0577) |
| D.lnIA | −0.192 *** | −0.0808 | −0.0822 | 0.0341 |
| | (0.0704) | (0.0832) | (0.0730) | (0.0862) |
| D.lnSEC | −0.709 * | −0.535 * | −0.148 | −0.510 ** |
| | (0.368) | (0.289) | (0.344) | (0.200) |
| ***lnIA*** | ***0.452 ****** | ***0.769 ****** | ***0.271 **** | ***1.597 ****** |
| | ***(0.122)*** | ***(0.0459)*** | ***(0.194)*** | ***(0.181)*** |
| lnSEC | −2.563 | 0.0198 | −1.348 | 0.275 |
| | (1.770) | (0.0815) | (0.836) | (0.228) |
| C. | 1.336 | 0.0538 *** | 3.760 ** | −0.306 |
| | (0.951) | (0.0171) | (1.555) | (0.288) |
| Obs. | 308 | 308 | 308 | 308 |

Source: own calculation, standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The estimates for mg model, in Equation (5) show that the speed of adjustment is −0.4290, as expected, being statistically significant at 1% level. The short-run coefficients are: −0.1919, −0.7095, 1.3359 and the long-run coefficients are: 0.4524, −2.5628. The results from the first mg model show that the dependent variable D.lnTER25 is influenced both on short and long-run term by the independent variables. The estimates for pmg model in Equation 6, identify a speed of adjustment as −0.1658. The short-run coefficients are: −0.0808, −0.5347, 0.0538, while the long-run coefficients are: 0.7687, 0.0198. The results from pooled mean group model also show that the dependent variable D.lnTER25 is influenced both on short and long-run term by the independent variables (lnIA, lnSEC). The estimates for mg model, in model (7) show that the speed of adjustment is −0.4872. The value is negative, as expected and statistically significant at 1% level, so the model is correctly defined. The short-run coefficients are: −0.0822 and −0.1477, while the long-run coefficients are found to be: 0.2706, −1.3476. The (last) estimates for pooled mean group model, in model no. 8 show that the speed of adjustment is −0.0635. The short-run coefficients are identified as: 0.0341 and −0.5101. The long-run coefficients are: 1.5974, 0.2755. The results from pooled mean group model show that the dependent variable D.lnTER55 is influenced both on short and long-run term by the independent variable. The models also show that there is cointegration between variables, the error-correction term being negative and statistically representative. On the long-run there is a positive impact of the digitalisation on tertiary education levels. The effect appears also to be the largest on 55–64 years group (the coefficient is above 1.0000 on pooled mean group model no. 8). In the short-run, the effect seems to be negative, but it is corrected on the long-run with a positive effect.

Our results suggest that higher (tertiary) education levels are influenced positively by the presence of digitalisation, quantified by the Internet access. We can explain that positive relationship through the access to information, which is strongly developed and increased in the context of digital documents (e-books, articles, e-papers, informational web sites, data access and so on). On the other hand, digital applications (e.g., Zoom, Teams, Google Meating, Cisco to example only some) can interconnect easily foreign teachers and students in classes, and also scholars from different parts of the world in conferences, as a base for information dissemination. The information about the curricula in universities or online classes provided by different teaching institutions is nowadays also available online, being a premise for a better choice of individual future studies in accordance to personal needs.

We also tested the impact of tertiary education on sustainable development, the variable that is considered as proxy being logarithm of GDP per capita. The results are presented in Table 6.

**Table 6.** Results for nonstationary heterogeneous panels models (mean group—mg and pooled mean group—pmg, the impact of education on sustainable economic development).

| Model Name | (9) mg (a) | (10) pmg(a) |
|---|---|---|
| **Variables** | **D.lngdpc** | **D.lngdpc** |
| ECT | −0.329 *** | −0.0687 * |
| | (0.0604) | (0.0416) |
| D.lnTER25 | −0.552 *** | −0.334 *** |
| | (0.160) | (0.112) |
| D.lnTER55 | 0.0453 | −0.0229 |
| | (0.111) | (0.0751) |
| **lnTER25** | **0.00144** | **2.775 *** ** |
| | **(0.755)** | **(0.551)** |
| **lnTER55** | **0.806** | **0.253 ** ** |
| | (0.886) | (0.116) |
| Constant | 2.303 *** | 0.00152 |
| | (0.528) | (0.0234) |
| Observations | 308 | 308 |

Source: own calculation, standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The estimates for mg model show that the speed of adjustment is −0.3289, the long-run ones are 0.8064, 0.0014, while the short ones are −0.552 and 0.0453, most of the coefficients being significant at 1% level. The results show that the dependent variable D.lngdpc is influenced both on short and long-run term by the independent variable.

The estimates for pmg model, in equation, show that the speed of adjustment is −0.0687, the short–run coefficients are −0.334 *** and −0.0229, while the long-run one is 2.7755, and 0.253, most of the coefficients being significant at 1% level. The results show that the dependent variable D.lngdpc is influenced both on short and long-run term by the independent variable. For all the models, Hausman test [45] suggests that pooled mean group models should be considered (the results are available on demand).

The results suggest the positive long-run effect of the tertiary education (all age groups) on economic sustainable development, GDP per capita in logarithmic values used as proxy. The largest effect is encountered in the pooled mean group model, suggesting that an increase with one unit in tertiary education (25+) positively impacts on growth with 2.77 units. Our results confirm the necessity of public intervention and better funding of education on all levels, but most importantly higher education. Our findings are in line with economic literature [46–50], that emphasises the positive role of (tertiary) education on economic growth (sustainable development).

The following part analyses the challenges that universities face during the COVID-19 pandemic in Romania. Considering the important role of education in sustainable development, our study wants to identify the needs of the students, teachers and institutions when the activity cannot be held onsite, but online, as in a pandemic case. The methodology used is the questionnaire method, the methodology and results being discussed in the following sections.

### *3.2. Challenges during COVID-19 Pandemic—The Romanian Universities Case*

We present primarily the teacher and student profiles as a base for future analysis. The profile of respondents is depicted below, in Tables 7 and 8, for each of the two categories of target groups. The University teachers' profile is presented in Table 7.

Table 7 presents the data of university teachers, classified according to age, teaching degree and level of university studies where they primarily taught, during the online education. The student's profile information is illustrated in the next table.

Table 8 refers to the data of the students, classified according to age, area of residence and level of undergoing university studies; it can be seen from the above-mentioned table that most students come from urban areas (46%), where, as a rule, access to the Internet and higher education is high.

**Table 7.** University teachers' profile.

| Age | Number | Percent |
|---|---|---|
| 24–35 | 26 | 10% |
| 36–45 | 103 | 40% |
| 46–55 | 96 | 37% |
| 56–65 | 25 | 10% |
| over 65 | 8 | 3% |
| **Teaching degree** | **Number** | **Percent** |
| Professor | 70 | 27% |
| Associate professor | 92 | 36% |
| University lecturer | 69 | 27% |
| Assistant lecturer | 19 | 7% |
| Associate lecturer | 8 | 3% |
| **You teach mainly at:** | **Number** | **Percent** |
| B.A. university studies | 199 | 47% |
| M.A. university studies | 161 | 38% |
| PhD university studies | 63 | 15% |

**Table 8.** Students' profile.

| Age | Number | Percent |
|---|---|---|
| 18–25 | 1.487 | 95% |
| 26–30 | 30 | 2% |
| 31–40 | 29 | 2% |
| over 40 | 23 | 1% |
| **Area** | **Number** | **Percent** |
| rural | 578 | 37% |
| urban | 721 | 46% |
| urban-county residence | 270 | 17% |
| **Level of undergoing university studies** | **Number** | **Percent** |
| B.A. | 1.335 | 85% |
| M.A. | 231 | 15% |
| PhD. | 3 | 0% |

As it can be noticed, regarding university teachers, the respondents teach mainly in the first level of university studies and have mostly didactic degrees that presuppose a certain seniority in the didactic and/or research activity: 69 university lecturers (27%), 92 associate professors (36%) and, respectively, 70 professors (27%). The students who answered the questionnaire are also mostly in the same level of university studies—B.A., aged between 18 and 25 years old (95%), thus representing, from this point of view, a true 'voice of youth'.

### *3.3. The Quantitative Hypotheses*

The quantitative hypotheses considered the degree of the adaptation of university teachers and students to online education and were translated into 24 questions, common or similar for the two categories of respondents.

Thus, first we considered it is relevant to find out if universities enabled Internet access for teachers and students by purchasing the technical equipment and subscriptions. The results are shown in Table 9.

**Table 9.** Ensuring Internet access in order to support online university teaching activities.

| Status | | Internet Access Is Provided by: Your Own Equipment and Subscriptions | Equipment and Subscriptions Provided by the University |
|---|---|---|---|
| University teachers | Number | 192 | 66 |
| | Percent | 74% | 26% |
| Students | Number | 1.535 | 34 |
| | Percent | 98% | 2% |

Most teachers (74%) and students (98%) used their own equipment and subscriptions for online teaching activities. These data are, in fact, consistent with Eurostat's assessment of the devices used to connect to the Internet, which showed that, in Romania's case, the difference between the percentage of people using a smartphone to connect to the Internet (42%) and the percentage of people which connects to the Internet from a desktop computer/laptop/notebook/tablet (53%) is insignificant [51]. Otherwise, in the academic world, where educational activities are mainly theoretical, having a smartphone is enough to have access to them.

At the same time, a favourable factor of online university education was the previous experience, capitalised through e-learning platforms created by both private and state universities. Generally, prior to 2019, one could have operated a hybrid system, meaning that, on those platforms, teachers were posting support materials for courses and seminars.

Table 10 shows that 46% of teachers had provided online materials to students on the college/university platform. We also found that 44% of students accessed that platform, while a large proportion of students (27%) said that online support was not necessary.

**Table 10.** Previous experience with online university education.

| Status | | Before the Suspension of the Face-To-Face Courses, during October 2019–February 2020, You Offered/Received Materials or Online Support in Carrying Out Teaching Activities? It Was Not Necessary | Through Communication Groups (e.g., WhatsApp, Facebook Messenger) | On a Dedicated Page /Platform, which I Developed Myself | On a Dedicated Page/ Platform, which I Developed with Other Colleagues | On the Platform of College /University |
|---|---|---|---|---|---|---|
| University teachers | Number | 23 | 77 | 28 | 12 | 118 |
| | Percent | 9% | 30% | 11% | 4% | 46% |
| Students | Number | 425 | 355 | 39 | 54 | 696 |
| | Percent | 27% | 23% | 3% | 3% | 44% |

It follows, therefore, that, in face-to-face education, materials adjacent to teaching activities were provided mainly in print, and that online teaching platforms were not commonly used.

The COVID-19 pandemic brought to the fore a public health measure—the lockdown—which led to isolation at home, and, regarding the university education, to educational activities being held through the online system, as presented in Table 11.

As such, in the second semester of the academic year 2019–2020 there were some teaching activities that involved a hybrid system of education (for 40% of teachers and 5% of responding students), while starting with the first semester of the academic year 2020–2021, all universities with a theoretical profile switched to an exclusively online type of education. This explains the high percentage of students involved in this kind of activity (95%).

**Table 11.** Carrying out university teaching activities in lockdown.

| Starting with the Declaration of the State of Emergency and, Subsequently, with the Declaration of the State of Alert on the Territory of Romania in 2020, in the University of Which You Are a Part, the Teaching Activities Took Place: | | | | |
|---|---|---|---|---|
| **Status** | | **Exclusively Online** | **in a Hybrid System** | **Face-to-Face** |
| University teachers | Number | 154 | 103 | 1 |
| | Percent | 60% | 40% | 0% |
| Students | Number | 1.488 | 73 | 8 |
| | Percent | 95% | 5% | 0% |

The platforms used for online university education, mentioned in Table 12, were mixed, in the sense that the university's own platform was primarily used, and, complementary to it, one of the platforms developed by the technology giants. To the question in Table 12, teachers and students were able to choose several variants from the presented tools of online university education.

**Table 12.** Online university education tools.

| The Platforms Used for Online Education Throughout This Time Were: | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Status** | | **Own Platform** | **Zoom** | **WhatsApp** | **Microsoft Teams (Office 365)** | **Google Suite** | **Others** |
| University teachers | Number | 124 | 167 | 17 | 109 | 19 | 97 |
| | Percent | 23% | 31% | 3% | 21% | 4% | 18% |
| Students | Number | 862 | 1.250 | 302 | 616 | 160 | 369 |
| | Percent | 24% | 35% | 9% | 17% | 5% | 10% |

A significant percentage of teachers (23%) and students (24%) used the university's/college's own platform, but the experience of the authors of the present study showed that these platforms were insufficiently developed to allow a sudden and complete transition from face-to-face education to online education. Thus, some of them did not have a video-conferencing system, which made it almost impossible to hold lectures during courses, and there were frequent situations in which the platforms were blocked or even shut down due to the large number of simultaneous users. All this has led universities to allow the use of alternative platforms such as Zoom or Google Meet; the table above is a good indicator to show the extent to which such platforms have actually been used: for example, Zoom has been used by 31% of teachers and 35% of students, Office 365 by 21% of teachers and 17% of students and Google Suite by 4% of teachers and 5% of students.

Despite these setbacks, both teachers and students have adapted to online education, as shown in Appendix A—Table A2, although some results are contrary to expectations. To determine the degree of adaptation of the respondents to online university education, we used a partial Likert scale, in which we measured only the total disagreement, partial agreement and total agreement of the respondents by reference to various statements considered relevant. The impact of online education on education participants was more obvious in the second semester of the 2019–2020 academic year. Our study took place at the end of 2020 and this may be one of the reasons why teachers' responses are in a buffer zone (of the partial agreement), in which most consider they have adapted to the new conditions: 62% of teachers acknowledge that the suspension of face-to-face teaching activities negatively affects lectures and course/seminar activities, but have little difficulty in effectively organising/structuring learning activities to facilitate student interaction (57% of teachers and 51% of students), and (49% of teachers and 44% of students) do not even have problems in providing/receiving timely and relevant feedback from their students. As such, it is natural for 44% of teachers to partially agree that the lack of human contact can be compensated by well-designed distance activities. In contrast, students feel the impact of online education as negative (50%), mainly due to lack of human contact (49%).

The educational effort is increased, on both sides, and students admit that they receive more tasks and homework than in the case of face-to-face education (53%), despite the fact that, in principle, they like to learn by using digital tools and resources (62% of teachers and 47% of students expressed partial agreement). An interesting result was whether the suspension of face-to-face courses allows teachers and students to focus on the essentials, the quality, the skills, and the competencies: while there were no significant differences in the case of teachers, between the percentage of those who expressed a total disagreement (43%) and those who partially agreed (42%), the majority of students (50%) considered that the efforts of teachers do not focus on the quality of the educational process.

Furthermore, teachers consider that digital skills acquired during this period are useful (53%) and want to use them in the future (50%). For the students, the percentage of those who want to use such skills in the future and the percentage of those who are insecure about the issue is the same (43%).

At the same time, the perception of teachers and students regarding the presence and activity/actual participation of students in courses and seminars, as presented in Tables 13–15, does not show significant differences.

**Table 13.** The perception of university teachers regarding the presence and activity of students at courses/seminars.

| To What Extent the Following Statements APPLY to You? | | | | |
|---|---|---|---|---|
| | | **Total Disagreement** | **Partial Agreement** | **Total Agreement** |
| **The presence of students in courses/seminars is better than in face-to-face education** | Number | 68 | 120 | 70 |
| | Percent | 26% | 47% | 27% |
| **The activity of students in courses/seminars is better than in face-to-face education** | Number | 151 | 93 | 14 |
| | Percent | 59% | 36% | 5% |

**Table 14.** Students' perception of their attendance at courses/seminars.

| During This Time, to What Extent Did You Attend the Teaching Activities within Your Study Program? | | | | |
|---|---|---|---|---|
| | **0–25%** | **25–50%** | **50–75%** | **75–100%** |
| Number | 56 | 133 | 349 | 1.031 |
| Percent | 4% | 8% | 22% | 66% |

**Table 15.** Students' perception of their participation in courses/seminars.

| How Much Do You Appreciate That the Participation in ONLINE Teaching Activities Has Increased in Comparison with Face-to-Face Teaching Activities? | | | | | |
|---|---|---|---|---|---|
| | **Participation Decreased** | **0–25%** | **25–50%** | **50–75%** | **75–100%** |
| Number | 679 | 260 | 228 | 240 | 162 |
| Percent | 43% | 17% | 15% | 15% | 10% |

Thus, 47% of teachers and 66% of students showed that their presence in online teaching activities is better compared to face-to-face teaching activities. At the same time, however, the actual participation in online teaching activities decreased compared to face-to-face teaching activities: 59% of teachers and 43% of students said so.

The decrease in the effective participation of students in teaching activities led teachers to look for new ways to 'interest' them, as shown in Table 16.

As such, pedagogical elements (e.g., managing the learning situation, the didactic communication, choosing the right methods and tools for interactions and assessment, providing feedback, monitoring progress and the support in learning) are the most important skills in relation to the elements related to the content of the discipline or to technical elements typical to the use of new technologies: 67% of teachers and 59% of students responded in this respect, while the share of those who gave more significance to other types of skills is significantly lower: 20% of teachers and 26% of students considered more

important the technical elements typical to the use of new technologies, while 13% of teachers and 15% of students gave more importance to elements related to the content of the discipline.

**Table 16.** Skills enhanced by online university education.

| In Your Experience, for the Design and Development of Effective Distance Learning Activities (with Digital Support), the Most Important in These Times Are: | | | |
|---|---|---|---|
| **Category** | **Status** | | |
| | | **University Teachers** | **Students** |
| **Technical elements, typical to the use of new technologies (e.g., creating accounts, installing software, initiating synchronous sessions—videoconference/webinar)** | Number<br>Percent | 52<br>20% | 410<br>26% |
| **Elements related to the content of the discipline (e.g., extensive knowledge in the field of specialisation, through command of the discipline)** | Number<br>Percent | 33<br>13% | 227<br>15% |
| **Pedagogical elements (e.g., managing the learning situation, the didactic communication, choosing the right methods and tools for interactions and assessment, providing feedback, monitoring progress and support in learning)** | Number<br>Percent | 173<br>67% | 932<br>59% |

The respondents to our study were also asked to rate the negative impact of an online university education on learning, as shown in Table 17.

**Table 17.** The negative impact of online university education.

| In Your Opinion, Considering the Usual Teaching Activity (Face-To-Face), What Could Not Be Done Online, thus Having a Negative Impact on the Training? | | | |
|---|---|---|---|
| **Category** | **Status** | | |
| | | **University Teachers** | **Students** |
| **Lectures (course)** | Number<br>Percent | 18<br>3% | 294<br>8% |
| **Explanations for understanding the concepts, relationships, phenomena (course/seminar)** | Number<br>Percent | 56<br>11% | 758<br>20% |
| **Monitoring progress** | Number<br>Percent | 94<br>18% | 588<br>16% |
| **Personalised support/individual counselling** | Number<br>Percent | 133<br>25% | 833<br>22% |
| **Authentic communication (human relationship)** | Number<br>Percent | 229<br>43% | 1.245<br>34% |

Regarding teachers, 43% of them considered that the authentic communication (human relationship) suffered the most, followed by individual counselling (25%), monitoring progress (18%), explanations for understanding the concepts/relationships/phenomena (11%) and lectures (3%).

Regarding students, the figures are alike, monitoring progress having slightly different values than those of the teachers: human relationships (an authentic communication) came first (34%), then individual counselling (22%), explanations for understanding the concepts/relationships/phenomena (20%), monitoring progress (16%) and lectures (8%).

### *3.4. The Qualitative Hypotheses*

The qualitative hypotheses materialised, on the one hand, in open questions, addressed to both categories of respondents, regarding the advantages and disadvantages of online university education, as well as in two questions regarding the real possibility of continuing this type of education, on the other hand, presented in Tables 18 and 19.

**Table 18.** Respondents' option regarding the continuity of online university education.

| After Overcoming This Time in Which It Was Required to Organise Online Courses, Do You Think That They Should Be Kept as Part of Future Online Teaching Activities? | | | | |
|---|---|---|---|---|
| **Status** | | **YES** | **NO** | **I Don't Know** |
| University teachers | Number | 150 | 80 | 28 |
| | Percent | 58% | 31% | 11% |
| Students | Number | 537 | 724 | 308 |
| | Percent | 34% | 46% | 20% |

**Table 19.** Respondents' choice of evaluation system.

| Which Students' Assessment System Do You Consider to Be Most Effective and Objective? | | | | |
|---|---|---|---|---|
| **Status** | | **Exclusively Online** | **Hybrid System** | **Face-to-Face** |
| University teachers | Number | 13 | 109 | 136 |
| | Percent | 5% | 42% | 53% |
| Students | Number | 297 | 453 | 819 |
| | Percent | 19% | 29% | 52% |

Surprisingly we could say, the students are those who do not want a continuation of online teaching activities. Hence, 58% of teachers commented on the continuation of online learning (at least partially), 31% were against and 11% could not express themselves in one way or another.

Regarding students, 46% did not agree with continuing online teaching activities, while 34% of them answered in the affirmative and 20% were not able to decide.

At the same time, drawing a parallel with traditional education, both students (52%) and teachers (53%) considered that face-to-face assessment is more efficient and objective than the exclusively online assessment system (for which opted 19% of students and 5% of teachers) or the hybrid one (for which 29% of students and 42% of teachers opted).

## 4. Discussion

The possession by university teachers and students of at minimum one smartphone with a web subscription was undoubtedly a defining element for participating in online teaching activities during these times. This also allowed for a much better participation of students in online education, given the chance of connecting to courses and seminars from practically anywhere with no physical presence whatsoever.

Online platforms are another essential tool for both online university education and hybrid education, as they let courses to be held, access to material resources needed for courses and seminars, fulfilling the tasks given to students by the teachers and successful testing/examination of students [52]. However, if in the case of teachers, they require a nonstop adaptation of teaching methods, in the case of students the impact is negative, as a reasonably high degree of non-attendance is allowed; consequently, they will go online to the platform during courses and seminars to 'check' the correlated attendance, without opening their video cameras, thus making it difficult to co-opt them for teaching activities.

Of course, as Weiler points out [53], the actual attendance of students in courses and seminars, as well as, implicitly, the impact and success or failure of online education, depend to a great extent on the teaching variety of the teacher. At one end are people who teach mainly on the idea of lectures, with only a few questions addressed to the audience in the least, possibly some questions towards the top of the time allocated thereto course. At the opposite end are those that teach exclusively on the premise of questions and answers or exercises, which involve a previous review of the topic and its rendering during the course/seminar 'through the eyes' of the student who answers these questions/cases/practical situations. Of course, between the two styles mentioned above there is a large number of other variants.

The online education for the courses is closest to the first version, within which the teacher uploads a PowerPoint presentation on the platform, based on which he gives his lecture; the student is not very involved and his feedback is minimal, unlike traditional education, where the expression of the student's face could be a good indicator of his interest in the subject presented. At seminars, where the number of participating students is lower than at courses, where they are usually divided into groups of 25–30 people, it is slightly different; it is a matter of principle that a successful seminar is based primarily on questions and answers, as well as on exercises in which it is desirable for all students to be involved. Very often, however, in online education it happens that the teacher asks a question, and those who answer are always the same 5–10 students always eager to participate. A possible 'exit' may be asking a selected student to answer, this being also an excellent opportunity to see if that student, having the camera closed for the 'protection of private data within the context of GDPR', is truly present at the seminar. The tactic is not without risks: few students are active and those who are nominated and do not know/do not want to answer are resentful and anxious.

Given all of the above, could we conclude that online education has only a negative impact and, as such, that it is imperative to resume traditional education? Should we continue or not to educate online in our universities? Following the results of our study, we prepared a SWOT analysis of online university education (Figure 1), which is a good indicator on whether it may be continued within the future, once the COVID-19 pandemic is overcome.

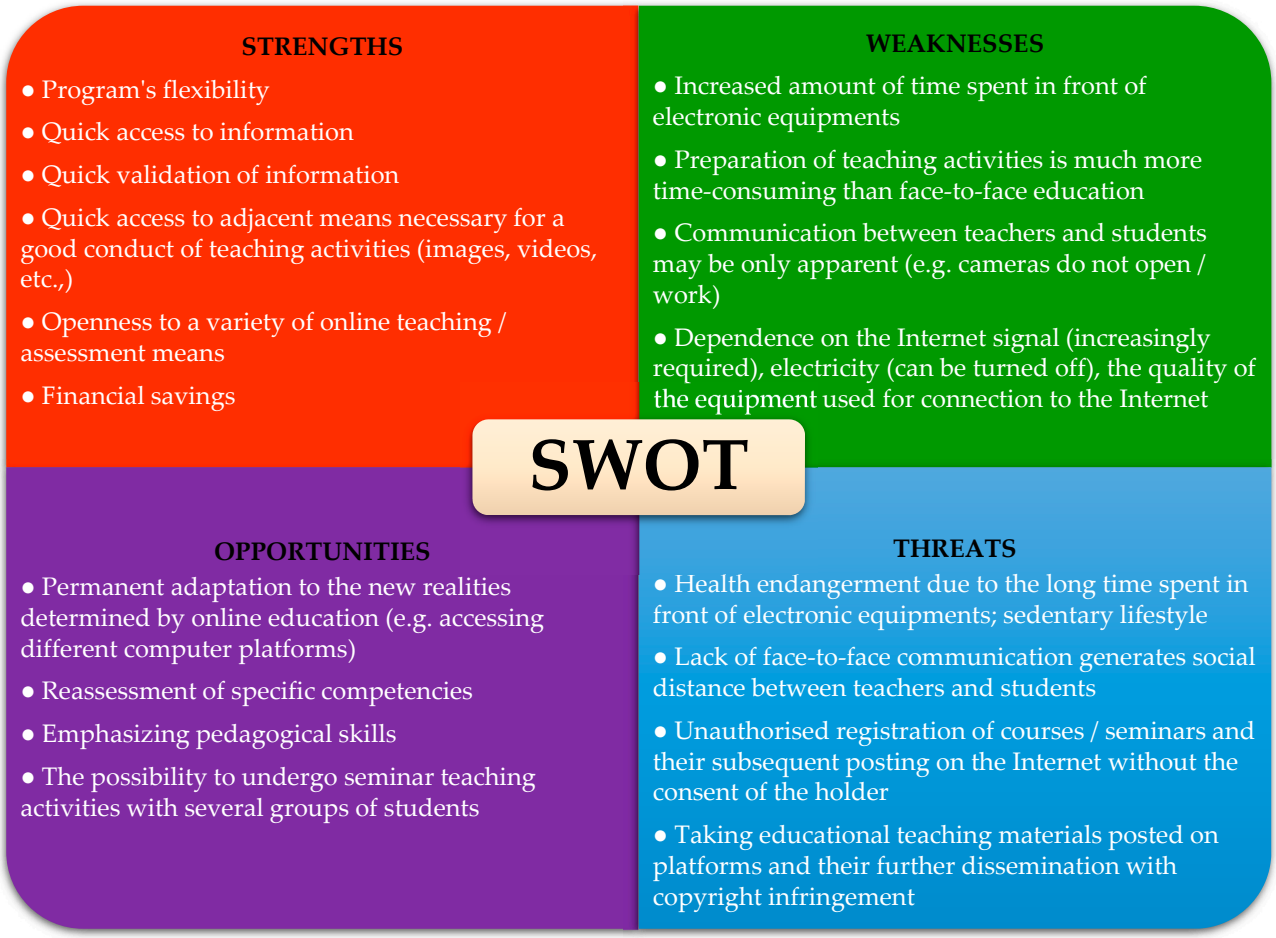


**Figure 1.** SWOT analysis on the continuation of online teaching activities in universities, following the COVID-19 pandemic.

Most certainly, online university education has certain strengths, among which in the first place is a greater flexibility of courses and seminars. Teachers and students no

longer depend on the physical existence of a free classroom for the course/seminar which, in traditional education, can be a problem given the large number of students and the constant need to improve university spaces which may render useless some buildings owned by the universities for the duration of the works. Another advantage is the time which is usually allotted for travel to/from university centres, is better re-allocated to activities complementary to online education, such as academic research or rest.

Access to and validation of information are also quick, as both teachers and students are connected to the Internet via electronic equipment, so that the information presented in the course/seminar can be easily corroborated and supplemented with other information and disseminated via the Internet. The teaching resources, such as PowerPoint presentations or the presentation of documents, respectively are the adjacent means necessary for a good development of the didactic activities (images, videos, etc.,) and are also simplified by the fact that all students have access to them at the same time, thus enjoying a better visibility and a higher understanding than in traditional education, where it could happen that the teacher communicates the information 'faster' than the student's ability to retain it.

Online education also involves a variety of online teaching/assessment formulas. The assessment is interesting because, from the experience of the authors of the present study, the most common method of evaluation, whether we are talking about seminar assessment during the semester, or we are talking about exams, is the one based on the multiple choice test: either it is a statement where, based on the materials presented beforehand, students must decide whether it is true or false, or whether it is a statement where a number of answers/choices are given, at least one of them is considered correct. Of course, there is also the possibility of formulating a set of short-answer or detailed-answer questions, but this option presents the best chance of a mere replication of the information in a book/PDF file without its prior processing.

Last but not least, online university education results in financial savings, as students no longer pay rents for accommodation in large cities, which are also university centres, and no longer pay for transportation to/from that university centre and at/from college/university.

All the above determine ways to adapt to the new reality determined by online education (which turns into opportunities). Pedagogical skills come to the fore, as they need to be re-evaluated to meet the new challenges posed by the need to maintain students' attention during courses/seminars. In general, students prefer to participate in didactic activities with a closed camera, arguing there is a lack of comfort in using this teaching method.

Of course, online education does not have only advantages; there are at least some weaknesses, which are emphasised by the increase in the time required for online education. First, it increases the length of the time spent in front of electronic equipment to the disadvantage of physical activities, for example, which can become a danger, endangering health, and leading to a sedentary lifestyle. In Romanian universities, as a rule, in the first two years of study, precisely to battle the potential negative effects of sedentarism, the university curriculum establishes mandatory physical education classes, on a weekly basis; this also changed in COVID-19 times, since it is significantly difficult to conduct such activities 'from the safety of one's home'. A recent study on the impact of isolation from the COVID-19 pandemic on physical activity [54] showed that the lockdown significantly enhanced the reduction of physical activity, which had a substantial impact on the quality of life of young people [55]. In the same study, it is estimated that an inadequate level of physical activity has a negative impact on the human body, causing an increased risk of chronic diseases, including cancer [56]. Moreover, Kumari et al. showed that a high percentage of people acknowledged that bodyweight increased during the pandemic by an average of 32.0%, and 75% of participants in the questionnaire confirmed an increase in food consumption during the lockdown [57].

A high percentage of the answers to our questionnaire (53% of the students) showed that students receive more tasks and homework than in the case of face-to-face education, which makes the preparation of teaching activities by the teachers much more

time-consuming compared to the classical education. It is only natural, because, as shown in a recent study [58], online education has forced teachers to focus on a type of student-centred education, which is favoured by online education platforms [59]. The same study emphasises that in online environment, the quality of the educational process depends on several factors, including the level of training that teachers have in using technology, their teaching style, interaction with students, the strategies used to capture students' attention, the need to encourage the contact between students and colleagues, a quick feedback, active learning, encouraging students to spend more time on performing tasks, having high expectations—that is the teacher should communicate his expectations to encourage and motivate his students, diversified learning, and the application of technology [60–62].

An exclusively online education highlights, on the long-term, its disadvantages and dangers, to the loss of its strengths. Thus, the communication between teachers and students can only be apparent, considering there are frequent situations in which, citing various reasons, students refuse to open the cameras during teaching activities. Consequently, teachers end up communicating with only a part of the students, usually with those who are normally active in each course/seminar.

The good development of online teaching activities depends on Internet access. However, along with the benefits of technology, there are also problems such as the lack/poor quality of the Internet signal, which is increasingly in demand, respectively increasing the dependence on the electricity required for the proper functioning of the electronic equipment. These raise new issues regarding the effective participation in teaching activities. The teacher has no choice but to rely on the good faith of the student if, during the course/seminar, such issues are reported. At the same time, however, what would be the solution if the students claim it is impossible to connect to the Internet during exams? The solutions envisaged so far refer, on one hand, to allow the resumption of the exam during its allotted time, despite the obvious disadvantage of the student who has less time to solve the same number of problems/multiple choice question as his colleagues, and, on the other hand, to consider the respective student as being absent at the respective exam with the possibility of subsequent examination.

The access to technology through online education highlights, on the long-term, some threats identified from the open responses at our questionnaire, such as the lack of face-to-face communication generating social distancing between teachers and students or copyright infringement by unauthorised download of teaching materials posted on educational platforms and their subsequent dissemination or unauthorised registration of the courses/seminars. Regarding these disadvantages, our study is in agreement with other research [58,63], which show that students do not have a high level of attention during courses/seminars because teachers have not implemented strategies focused on student attention, as well as due to lack of experience with the new technologies. At the same time, students feel isolated due to lack of interaction, especially with the teachers, because they spend more time at home, in front of the computer, and the pandemic has imposed social distancing. As such, our respondents also believed that the online educational process has a lower value than the traditional one, and teachers and students prefer a hybrid system, respectively to use online platforms in combination with face-to-face education [58,64,65]. It is also possible that e-learning affects students' performance due to poor information assimilation, especially in those courses where teachers have not adapted their teaching methods. In addition, universities were not prepared to implement an exclusively online education [58,66], which generated syncope in the educational process, especially in the second semester of the 2019–2020 academic year.

All of the above entitles us to think that online university education cannot and must not be completely eliminated once the crisis caused by the COVID-19 pandemic ends. An appropriate system would be a hybrid one, highlighting the benefits of online education. As for students, they should want to actively take part in courses and seminars, have clear learning motivations and actively communicate with their teachers and colleagues [67]. In fact, recent studies have ruled the adaptability of students and teachers to online educa-

tion [68]. Thus, it was noted there are studies that showed that students use technology as a portal of knowledge, through which they store and disseminate documents, access materials and courses, and send homework. The availability of online information motivates students to learn new concepts and therefore to use independent and sustainable learning. Teachers share information, collaborate and interact online using chat, messages, video calls and emails. However, irrelevant information on social networks, such as spam, advertising, and negative posts, tend to distract [68,69]. At the same time, the degree of adaptation of teachers is closely related to job-related insecurity: in the online environment, teachers have a higher degree of adaptability and a lower degree of insecurity in relation to the work performed [68,70].

At the same time, in agreement with other studies [68], our research also shows that, if at first it was considered that making the materials available to students was enough for the success of online teaching activities, what in fact matters is the interaction between teachers and students, encouraging and motivating the latter, to obtain real-time feedback and changing/adapting the academic process to allow teachers to focus on students.

Our results are also in line with a recent survey on 'Digitally enhanced learning and teaching in European higher education institutions' from January 2021, published by the European University Association, with responses from 368 higher education institutions from all 48 countries representing the entire European Higher Education Area in 2020 and, in addition, some institutions from Kosovo and Northern Cyprus, showed that practically all institutions managed to pivot to blended (a model combining face-to-face classroom teaching and the -innovative use of ICT technologies) and online learning in COVID-19 times [71]. The survey was open to all higher education institutions in the European Higher Education Area, resulting in a diverse sample with a majority of comprehensive/multidisciplinary universities (62%), in addition to specialised universities (17%), and technical universities (11%) and some universities of applied sciences and university colleges (9%).

## 5. Conclusions

Our study shows the positive effect of digitalisation directly on tertiary education, and indirectly on sustainable development (in GDP per capita, as proxy). The results also suggest the positive long-run effect of the tertiary education (all age groups) on economic sustainable development, with GDP per capita in logarithmic values used as proxy. Our results confirm the necessity of public intervention and better funding of the education on all levels, but most importantly in higher education, being in line with the economic literature that accentuates the positive role of (tertiary) education on economic growth (sustainable development). We believe that public policies in education should also consider strong investments in digitalisation and the implementation of new technologies in (e-)learning, so that the public expenditures should increase in these areas, as a premise for sustainable development. We do not, though, encourage the excessive use of remote teaching, due to major difficulties related to learners' understanding and student evaluation. Another objective of the paper was to identify the response reaction of universities during COVID-19 pandemic. We found that students feel isolated due to lack of interaction, especially with teachers, because they spend more time at home, in front of the computer and the pandemic has imposed social distancing. We believe that regarding teaching, an appropriate system would be a hybrid one, that highlights the benefits of online education, as an important, and also complementary instrument that helps the teacher in on-site (face-to-face) interaction, with the necessity of adaptation of the teaching methods to students' needs.

The results of this study are not exhaustive and have some limitations. First, the respondents are a part of universities/faculties whose disciplines are suitable for online university education, being theoretical ones. No applied universities/faculties, such as medical, pharmacy or chemistry, were considered. As such, no characteristics derived from the diversity of participants in online university education could be found, which would

certainly have had a significant impact on the values of our study. This is a limitation easily found in other studies, too [72], and, from this perspective, a future study should take into account the universality of respondents, both for teachers and students.

Second, our research focused only on Romania, which is only one country out of the 27 Member States of the European Union. At the same time, respondents from only two university centres were selected, even if, as previously mentioned, these are two of the greatest Romanian university centres. Consequently, as other researchers have suggested [72], more EU Member States as well as third countries could be considered in future, to value as many experiences as possible in various areas of online university education.

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**Informed Consent Statement:** The participants received information at the beginning of the questionnaire about the purpose of the online survey. The participation was voluntary and anonymous, and the personal data of the respondents were not stored, in order to respect anonymity and confidentiality. The informed written consents of the participants have not been distinctly conducted and given since the privacy and personal identity information of all participants were protected. The participation in the survey was optional; the waiver of informed consent did not and will not have adverse effect on the rights of the participants.

**Data Availability Statement:** The initial data on the questionnaire method presented in this study, collected separately from teachers and the students, are available on request from the corresponding author.

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**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A. Comprehensive Results Tables

**Table A1.** Panel descriptive statistics.

| Variable | | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Year | Overall | 2012 | 4.327055 | 2005 | 2019 |
| | Between | | 0 | 2012 | 2012 |
| | Within | | 4.327055 | 2005 | 2019 |
| lnTER25 | Overall | 3.577249 | 0.27704 | 2.6554 | 4.0284 |
| | Between | | 0.2337865 | 3.0965 | 3.888567 |
| | Within | | 0.1562718 | 3.041483 | 3.998789 |
| lnTER55 | Overall | 3.008534 | 0.36276 | 1.9821 | 3.7139 |
| | Between | | 0.3399909 | 2.338813 | 3.513367 |
| | Within | | 0.1446372 | 2.621241 | 3.385221 |
| lnIA | Overall | 4.229713 | 0.3215013 | 2.7588 | 4.589 |
| | Between | | 0.177009 | 3.85946 | 4.514007 |
| | Within | | 0.2708582 | 2.965239 | 4.733853 |
| lnGDPc | Overall | 10.47338 | 0.3885937 | 9.538 | 11.7008 |
| | Between | | 0.3530313 | 9.979 | 11.45101 |
| | Within | | 0.1779815 | 9.956348 | 10.97912 |
| lnSEC | Overall | 3.82244 | 0.3415544 | 2.6105 | 4.342 |
| | Between | | 0.3413145 | 2.923493 | 4.293893 |
| | Within | | 0.0715621 | 3.361033 | 4.152847 |

**Table A2.** The adaptation degree of respondents to online university education.

| To What Extent the Following Statements Apply to You? | | | | | |
|---|---|---|---|---|---|
| | **Status** | | **Total Disagreement** | **Partial Agreement** | **Total Agreement** |
| **The suspension of face-to-face teaching activities negatively affects the lectures and activities of the course/seminar** | University teachers | Number | 39 | 154 | 55 |
| | | Percent | 16% | 62% | 22% |
| | Students | Number | 277 | 498 | 794 |
| | | Percent | 18% | 32% | 50% |
| **Students receive more assignments and homework than in face-to-face education** | University teachers | Number | 99 | 117 | 42 |
| | | Percent | 39% | 45% | 16% |
| | Students | Number | 264 | 476 | 829 |
| | | Percent | 17% | 30 | 53% |
| **Teachers have difficulties with the efficient organisation/structuring of learning activities to facilitate interaction between students** | University teachers | Number | 73 | 147 | 38 |
| | | Percent | 28% | 57% | 15% |
| | Students | Number | 319 | 795 | 455 |
| | | Percent | 20% | 51% | 29% |
| **Teachers have problems in providing/receiving timely and relevant feedback (from) students** | University teachers | Number | 73 | 127 | 58 |
| | | Percent | 28% | 49% | 23% |
| | Students | Number | 386 | 689 | 494 |
| | | Percent | 25% | 44% | 31% |
| **Students enjoy learning by using digital tools and resources** | University teachers | Number | 51 | 160 | 47 |
| | | Percent | 20% | 62% | 18% |
| | Students | Number | 384 | 743 | 442 |
| | | Percent | 25% | 47% | 28% |
| **The lack of human contact can be compensated by well-designed remote activities** | University teachers | Number | 97 | 114 | 47 |
| | | Percent | 38% | 44% | 18% |
| | Students | Number | 766 | 512 | 291 |
| | | Percent | 49% | 33% | 18% |
| **The suspension of face-to-face teaching activities allows teachers and students to focus on the essential, the qualitative, the skills and competences** | University teachers | Number | 111 | 108 | 39 |
| | | Percent | 43% | 42% | 15% |
| | Students | Number | 780 | 539 | 250 |
| | | Percent | 50% | 34% | 16% |
| **The digital skills acquired during this time will prove useful for future teaching** | University teachers | Number | 13 | 108 | 137 |
| | | Percent | 5% | 42% | 53% |
| | Students | Number | 267 | 709 | 593 |
| | | Percent | 17% | 45% | 38% |
| **I will continue to use in face-to-face teaching activity (some of) the digital tools and resources that I started to use during this time** | University teachers | Number | 20 | 108 | 130 |
| | | Percent | 8% | 42% | 50% |
| | Students | Number | 215 | 678 | 676 |
| | | Percent | 14% | 43% | 43% |
| **It is difficult for me to use the tools necessary for online education** | University teachers | Number | 189 | 64 | 5 |
| | | Percent | 73% | 25% | 2% |
| | Students | Number | 834 | 557 | 178 |
| | | Percent | 53% | 36% | 11% |
| **Online education is easy to implement** | University teachers | Number | 72 | 145 | 41 |
| | | Percent | 28% | 56% | 16% |
| | Students | Number | 571 | 599 | 399 |
| | | Percent | 36% | 38% | 26% |
| **The way in which online education is carried out is clear and easy to explain/understand** | University teachers | Number | 31 | 157 | 70 |
| | | Percent | 12% | 61% | 27% |
| | Students | Number | 459 | 744 | 366 |
| | | Percent | 29% | 48% | 23% |

**Table A2.** *Cont.*

| To What Extent the Following Statements Apply to You? | | | | | |
|---|---|---|---|---|---|
| | **Status** | | **Total Disagreement** | **Partial Agreement** | **Total Agreement** |
| **The tools/instruments for implementing online education seem rigid and inflexible to me** | University teachers | Number<br>Percent | 126<br>49% | 108<br>42% | 24<br>24% |
| | Students | Number<br>Percent | 579<br>37% | 690<br>44% | 300<br>19% |
| **Online education makes teaching tasks easier to complete** | University teachers | Number<br>Percent | 133<br>52% | 102<br>39% | 23<br>9% |
| | Students | Number<br>Percent | 732<br>47% | 572<br>36% | 265<br>17% |
| **Online education is useful for enabling student learning** | University teachers | Number<br>Percent | 59<br>23% | 144<br>56% | 55<br>21% |
| | Students | Number<br>Percent | 705<br>45% | 579<br>37% | 285<br>18% |

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