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Impact of Entrepreneurial Activity and ICT Development on Sustainable Development: Evidence from High-Income Countries

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Abstract: Sustainable development has become a vital issue in the globalizing world given the food insecurity, climate change, significant degradation of the environment and depletion of natural resources, and biodiversity loss. Therefore, the identification of the key factors behind sustainable development is important for the planning and application of the proper policies by countries. In this context, the institutional, demographic, social, and economic determinants of overall sustainable development have been extensively explored, but the interplay among sustainable development, entrepreneurial activity, and ICT development has stayed relatively untouched. This article investigates the effect of entrepreneurial activity, proxied by total early-stage entrepreneurial activity and ICT development, on the overall sustainable development of 15 high-income countries over the 2002–2018 period; it uses the Westerlund and Edgerton cointegration test with a structural break, taking notice of the gap in the empirical literature regarding the determinants of sustainable development. The cointegration analysis shows that entrepreneurial activity and ICT development have a positive influence on sustainable development in the long run, but that the effect of ICT on overall sustainable development is shown to be stronger in comparison to entrepreneurial activity. ICT penetration and entrepreneurial activity should be encouraged through institutional, educational, and fiscal incentives to make progress in sustainable development.

Keywords: entrepreneurial activity; ICT development; sustainable development; cointegration analysis

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1. Introduction

Significant environmental degradation, climate change, natural disasters, income inequality within and between countries, and considerable differences in life conditions, poverty, access to basic needs and education among countries, and gender and education inequality have meant that the concept of sustainable development has become one of the topics of top priority in the world as of 1970s. However, the concept of sustainable development was globally recognized as a whole at the 1972 UN Conference on the Human Environment in Stockholm [1]. The environmental pillar of sustainable development came to the fore relatively early on, although social, economic, and environmental sustainability are the main dimensions of sustainable development. It is of significance to harmonize social inclusion, environmental protection, and sustainable economic growth in order to achieve overall sustainable development.

In this context, many national, regional, and international initiatives have been launched to make progress in three main dimensions of sustainable development. The 17 Sustainable Development Goals (SDGs) perceptibly emerged as a result of the efforts made in the conferences, summits, and meetings of the United Nations (UN) held since the 1970s, and were accepted by 193 UN Members in 2015 to come into force on 1 January 2016 [2]. The SDGs include 17 goals and 169 targets to achieve the following: eliminate hunger and poverty; decrease inequalities; achieve proper work and economic growth; develop innovation and infrastructure; promote responsible production and consumption,

good health and well-being, quality education, gender equality, sustainable cities and communities, peace, justice, and strong institutions; increase the access to clean water and sanitation, and affordable and clean energy; and make improvements to the climate, life on land and life below water [3]. The worldwide SDG index, which measures the improvement in 17 SDGs, indicates that the worldwide SDG index increased to 66.03 in 2019 from 59.36 in 2000, but that the index remained flat for the 2019–2021 period, probably owing to the COVID-19 pandemic [4]. However, the sustainable development level is very heterogeneous among countries. For example, the 2022 SDG index in the top five countries (Finland, Denmark, Sweden, Norway, and Austria) is, respectively, 86.5, 85.6, 85.2, 82.3, 82.3, but the index in the bottom five countries (South Sudan, Central African Republic, Chad, Somalia, and Sudan) is 39.0, 39.3, 41.3, 45.6, and 49.6 [4]. The SDG index considerably changes depending on countries' income levels. In this context, the SDG index for high-income, upper-middle-income, lower-middle-income, and low-income countries in 2022 is, respectively, 77.5, 71.5, 61.8, and 51.6 [4].

The significant heterogeneity among the sustainable development levels of countries has attracted the attention of researchers aiming to explore the driving forces behind sustainable development. Researchers have broadly investigated the factors underlying environmental sustainability and have documented many institutional, economic, and social factors, such as institutional quality, economic growth, human capital, population, innovation, energy use, financial sector development, financial and trade openness, FDI inflows, as the determinants of environmental sustainability [5–9]. However, determinants of overall sustainable development have been researched by relatively few researchers, and institutional and economic factors, and education, have been revealed as the determinants of sustainable development [10–14]. This study empirically examines the effect of entrepreneurial activity and ICT development on overall sustainable development while taking notice of the related empirical literature, because both variables can influence sustainable development through different channels, as explained below. Furthermore, the UN General Assembly emphasized the importance of entrepreneurship for sustainable development through innovation, economic growth and job creation in its resolution 73/225 in 2018 [15]. The UN's strong emphasis on the impact of entrepreneurial activity on sustainable development and the gap in the empirical literature motivates us to investigate the influence of entrepreneurial activity together with ICT development on overall sustainable development.

On the one hand, entrepreneurial activity can make a positive direct contribution to SDG-4 (quality education including increasing the share of persons with technical and vocational skills for employment, decent jobs and entrepreneurship) and SDG-8 (decent work and economic growth), and can thus positively influence sustainable development and also foster the other SDGs related to climate change, food security, health, gender equality, sanitation and water, and reliable energy sources [16]. On the other hand, entrepreneurial activity can negatively influence sustainable development through harming the environment [17]. Therefore, the net impact of entrepreneurial activity on sustainable development hinges upon the content of entrepreneurial activity.

Information and communication technologies (ICTs) are of vital importance to achieve each of the 17 SDGs, because ICTs can enhance economic, social, and environmental sustainability. Firstly, in this context, ICT can affect economic growth through enhancing productivity, efficiency, competition, and entrepreneurial activity, and making access to and the dissemination of information more easy [18–20]. Secondly, ICTs can affect social development positively through improvements in education, health, innovation, and government services; however, the negative effects of ICTs include hacking, e-fraud, the dissemination of offensive videos and images, and the potential of unemployment [21]. Thirdly, ICTs can contribute to environmental protection through an increase in productivity, the employment of energy-saving and energy-efficient technologies, the development of smart and remote observation, detection, measurement instruments for the control of

environmental degradation, and resource savings via the applications of e-government, e-banking, e-commerce, and virtual learning and meetings [22–24].

The goal of this research is to analyze the effect of entrepreneurial activity and ICT development on sustainable development in the high-income countries. The main objectives of this research is to specify whether entrepreneurial activity and ICT development make a contribution to sustainable development in the short and long-term. The following research questions are discussed in the article in line with this purpose:

What is the role of entrepreneurial activity in achieving sustainable development goals?
What is the role of ICT development in achieving sustainable development goals?
How does the ICT influence sustainable development through entrepreneurial activity?

This research analyzes the effect of entrepreneurial activity and ICT development on sustainable development in a sample of 15 high-income countries (Chile, Croatia, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the United States), because the other high-income countries are missing a significant quantity of data related to entrepreneurial activity.

This study is thought to contribute to the empirical literature in two ways. First, the role of entrepreneurial activity and ICTs in the attainment of sustainable development has been empirically investigated by few researchers when compared with the other potential institutional, demographic, social, and economic determinants of overall sustainable development. Therefore, our article is evaluated to contribute to the empirical literature. Secondly, the existing studies have usually conducted a regression analysis to examine the influence of entrepreneurial activity and ICT development on sustainable development. In this study, a second-generation cointegration with a structural break is utilized to ascertain the long-term influence of entrepreneurial activity and ICT development on sustainable development. Furthermore, the employment of the AMG (augmented mean group) enables us to conduct both panel and country-level analyses. The other sections of the article proceed as follows. Section 2 evaluates the empirical studies that focus on the influence of entrepreneurial activity and ICT development on sustainable development. Section 3 identifies the variables and method, and Section 4 introduces the findings of the cointegration analysis and discussion. Section 5 concludes the article.

2. Literature Review

Entrepreneurial activity can simultaneously help to achieve multiple sustainable development goals through innovation, technological progress, economic growth, and job creation [15]. However, the interplay between entrepreneurial activity and sustainable development has been empirically analyzed only by Huđek and Bradač Hojnik [17], Ibeenwo [25], Venâncio and Pinto [26], Pansera and Sarkar [27], Youssef et al. [28], Dhahri and Omri [29], and Omri [30], despite its significant influence on overall sustainable development.

Huđek and Bradač Hojnik [17] investigated the interaction between entrepreneurial activity and social development in 46 countries through correlation and regression analyses, and uncovered the positive influence of innovative and opportunity-driven entrepreneurial activity on the overall sustainable development performance. On the other hand, Ibeenwo [25] investigated the interaction between sustainable development and entrepreneurship based upon the Dangote phenomenon, and discovered a positive interaction between entrepreneurship and sustainable development. However, Venâncio and Pinto [26] also analyzed the influence of entrepreneurial activity on sustainable development and its main dimensions in 67 countries in 2019 through the regression method, and discovered the negative influence of entrepreneurial activity on sustainable development and its components of people, posterity, and partnership.

Pansera and Sarkar [27] explored the influence of entrepreneurship on sustainable development through four cases of grassroot entrepreneurship from India and Bangladesh, and found that grassroots entrepreneurs can make a positive contribution to the attainment of SDGs. Youssef et al. [28] analyzed the influence of entrepreneurship on sustainability in

17 African states for the 2001–2014 period, using a modified environmental Kuznets curve model through cointegration and regression analyses. Their findings revealed that formal and informal entrepreneurial activity increase environmental degradation, but that both entrepreneurship forms improve sustainability when innovation and institutional variables are included in the econometric analysis.

Dhahri and Omri [29] investigated the influence of entrepreneurship on human development, sustainable growth, and environment in 20 developing states over the 2001–2012 term using the Pedroni cointegration test and the Granger causality test; they reached the conclusion that entrepreneurship positively influences human development and economic growth, but negatively affects the environment. Omri [30] also analyzed the influence of sectoral output and entrepreneurship on environmental sustainability in 69 countries with different income levels for the 2001–2011 term through the Pedroni cointegration test; they discovered that the negative influence of entrepreneurship on the environment is lower in high-income countries than other countries, and that there exists an inverted U-shaped interplay between environmental degradation and entrepreneurship in high-income countries.

Based on our literature research, the first hypothesis of the research is as follows:

Hypothesis 1. *There is a relationship between entrepreneurial activity and sustainable development.*

The influence of ICT development on sustainable development has been empirically analyzed by several researchers. In this context, Nchofoung and Asongu [31] analyzed the effect of ICTs on sustainable development in 140 countries over the 2000–2019 period using the regression method and uncovered the positive effect of ICTs on sustainable development.

On the other hand, Jayaprakash and Pillai [32] researched the effect of ICTs on the economic, environmental, and social dimensions of sustainable development in 80 countries over the 2000–2016 term using regression, and revealed the positive impact of ICTs on three main dimensions of sustainable development; however mediation analysis indicates that ICTs led to a strong effect on economic growth and that the spillover effects from economic growth caused the improvement in the social and environmental dimensions of sustainable development. Onuoha et al. [33] also analyzed the interplay among ICT development and sustainable development in ECOWAS countries over the 1995–2020 period using the cointegration and causality tests, and uncovered that the EKC nexus between ICT and CO_2 emissions was valid for low-income countries, but invalid for low-middle income countries. However, ICT had a negative influence on human development in low-income ECOWAS countries, but a positive impact on human development in low-middle-income countries, and an insignificant influence on economic growth in all countries.

ICTs can also contribute to sustainable development via enhancing entrepreneurial activity. Gomes and Lopes [34] analyzed the influence of diverse ICT indicators on entrepreneurial activity in OECD economies over the 2000–2019 period through regression analysis, and revealed the positive influence of ICT indicators on entrepreneurial activity; however, the size of the positive impact of ICT indicators on entrepreneurial activity changed based on the ICT indicators. Afawubo and Noglo [35] also investigated the influence of ICTs on entrepreneurial activity in developed, emerging, and developing economies for the 2006–2016 period and uncovered the positive influence of ICTs on entrepreneurial activity for the whole panel; they did not discover a significant difference regarding ICT entrepreneurial activity in the countries with different development levels. Sardar et al. [36] analyzed the influence of ICTs on entrepreneurship in Pakistan during the COVID-19 pandemic and reached the conclusion that ICT can positively foster entrepreneurial activity. As a result, ICTs are also expected to influence sustainable development via the channel of entrepreneurial activity.

However, the effects of ICT indicators on economic growth and CO_2 emissions have been explored widely. The impact of ICT development on CO_2 emissions is not clear in theoretical terms, because ICTs have two opposite effects on CO_2 emissions. On the one hand, ICTs are accepted as the sources of CO_2 emissions considering the production of ICTs, energy use, and electronic waste recycling. On the other hand, ICTs are expected to reduce CO_2 emissions via the development of energy-efficient devices, smarter cities, transportation and industrial production systems [37]. Thus, empirical studies about the nexus between ICTs and the environment for different countries and country groups have stayed inconclusive in parallel with these theoretical considerations [37–42]. Añón Higon et al. [37] also analyzed the interplay between ICTs and CO_2 emissions, and uncovered an inverted U-shaped interplay between ICTs and CO_2 emissions in 142 countries with different economic development levels for the 1995–2010 term.

On the other hand, the effect of ICT development on economic growth is one of the most researched issues in the empirical literature about the economic effects of ICTs. Researchers have generally uncovered a positive growth effect of diverse ICT indicators, because ICT is expected to positively influence economic growth through productivity and innovation [43,44]. Many researches have reached the findings in line with the theoretical expectations [20,45–47]. In context, Fernández-Portillo et al. [48] investigated the influence of ICT investments on sustainable economic development in the EU states for the 2014–2017 term through regression analysis, and uncovered the positive influence of ICT investments on sustainable economic growth.

ICTs can also foster the SDG of quality education using a supportive education tool and facilitating access to educational materials [12,13]. In this context, Samari and Atashak [49] and Aristovnik [50] discovered the positive influence of ICTs on educational output, and Nisar et al. [51] revealed the positive influence of ICTs on educational efficiency.

ICTs in the health sector can also can make a positive contribution to the SDG of good health and well-being through enhancing healthcare quality, focusing on patient-centred health and educating healthcare workers and patients [52]. Shao et al. [53] revealed the positive influence of ICTs on health outcomes for a panel of 141 countries.

Based on our review of the literature, the second hypothesis of the research is as follows:

Hypothesis 2. *There is a relationship between ICT development and sustainable development.*

3. Data and Methods

This research investigates the effect of entrepreneurship and ICTs on overall sustainable development in a sample of 15 high-income countries through second-generation cointegration analysis. In the cointegration analysis, sustainable development is represented by an overall sustainable development score (SUSDEV) proposed by Sachs et al. [4]; the score denotes the achievement degree of overall sustainable development as a percentage of the 17 SDGs (for example, a score of 70 shows that 70% of the 17 SDGs have been achieved). The entrepreneurial activity is proxied by the total early-stage entrepreneurial activity (ENTREP) using the Global Entrepreneurship Monitor [54], and the variable denotes the rate of nascent entrepreneurs or owner–managers of a new business as a percentage of the population aged 18–64. Lastly, ICT is proxied by the ICT index of UNCTADSTAT [55], and the index is calculated based on fixed line and mobile phones users, internet accessibility and server security. The variables of SUSDEV, ENTREP, and ICT are on an annual basis and the period of study is specified as 2002–2018; this is because the ENTREP variable is available for most of the high-income countries during this period.

High-income countries usually have a higher level of entrepreneurial activity [12]. Therefore, the entrepreneurship data for all the high-income countries when considering the World Bank's [56] income classification are checked; then, the uninterrupted data of 15 high-income countries (Chile, Croatia, France, Germany, Greece, Ireland, Italy, Japan, the Netherlands, Slovenia, Spain, Sweden, Switzerland, the United Kingdom, and the

United States) can be obtained from the database of Global Entrepreneurship Monitor and these countries form the sample of the study. During the 2002–2018 period, all countries in Table 1 made progress in sustainable development; however, Chile, Croatia, and Italy, respectively, made the largest improvements in sustainable development, while the United States, Switzerland, and Japan, respectively, made the smallest improvements in sustainable development. EViews 12.0, Stata 15.0, and Gauss 11.0 were employed to conduct the econometric applications.

Table 1. SDG index in study sample.

Countries	Years	SDG
Chile	2002	70.65
	2018	77.24
Croatia	2002	72.23
	2018	78.08
France	2002	74.92
	2018	80.75
Germany	2002	76.18
	2018	81.87
Greece	2002	69.82
	2018	76.14
Ireland	2002	75.99
	2018	80.29
Italy	2002	71.98
	2018	78.07
Japan	2002	76.12
	2018	79.15
Netherlands	2002	76.83
	2018	79.68
Slovenia	2002	73.91
	2018	79.59
Spain	2002	73.51
	2018	78.92
Sweden	2002	83.60
	2018	85.06
Switzerland	2002	77.23
	2018	80.27
United Kingdom	2002	76.67
	2018	80.97
United States	2002	71.39
	2018	74.11

Source: Sachs et al. [4].

The descriptive statistics of the SUSDEV, ENTREP, and ICT are presented in Table 2. The mean value of SUSDEV, ENTREP, and ICT are, respectively, 77.041, 7.177%, and 18.754. Therefore, this indicates that the high-income economies in the sample recorded significant progress in achieving the 17 SDGs. However, there exist remarkable changes among the countries in terms of entrepreneurial activity.

Table 2. Descriptive figures of SUSDEC, ENTREP, and ICT.

	SUSDEV	ENTREP	ICT
Mean	77.041	7.177	18.754
Median	77.250	6.130	18.794
Maximum	85.300	26.830	31.035
Minimum	69.820	1.480	7.493
Std. Dev.	3.385	4.184	4.880
Skewness	0.267	2.469	0.085
Kurtosis	3.027	10.471	2.626
Observations	255	255	255

The cointegration relationship among entrepreneurial activity, ICT development, and sustainable development is investigated with the Westerlund and Edgerton [57] cointegration test, with structural breaks in deference to the economic crises, cross-sectional dependence, and heterogeneity.

The Westerlund and Edgerton [57] cointegration test counts in the structural breaks at level, trend and cross-sectional dependence, and tests the existence of cointegration subsistence by eliminating the problems of heteroscedasticity and autocorrelation; as such, it enables the structural dates to differ among cross-sections. The test statistic is derived from Equations (1) and (2):

$$y_{i,t} = \alpha_i + \eta_i t + \delta_i D_{i,t} + x'_{i,t}\beta_i + (D_{i,t}x_{i,t})'\gamma_i + z_{i,t} \quad (1)$$

$$x_{i,t} = x_{i,t-1} + w_{i,t} \quad (2)$$

In Equations (1) and (2), i and t are, respectively, the cross-section and time dimensions of the dataset. D_{it} is the dummy variable, β_i and α_i are the slope coefficients and constant before the structural break, δ_i and γ_i are the constant and slope coefficients after the structural break, and $w_{i,t}$ is the disturbance term. Two LM-based test statistics for the test [57] are figured out as Equations (3) and (4):

$$\overline{LM}_{\varnothing}(N) = \frac{1}{N}\sum_{i=1}^{N} LM_{\varnothing}(i) \quad (3)$$

$$\overline{LM}_{\tau}(N) = \frac{1}{N}\sum_{i=1}^{N} LM_{\tau}(i) \quad (4)$$

Last, the normalized test statistics calculated by considering the asymptotic properties of $\overline{LM}_{\varnothing}(i)$ and $\overline{LM}_{\tau}(i)$ are as follows:

$$Z_{\varnothing}(N) = \sqrt{N}\left(\overline{LM}_{\varnothing}(N) - E(B_{\varnothing})\right) \quad (5)$$

$$Z_{\tau}(N) = \sqrt{N}\left(\overline{LM}_{\tau}(N) - E(B_{\tau})\right) \quad (6)$$

The cointegration coefficients are estimated via the method of FMOLS (Fully Modified Ordinary Least Squares). The FMOLS method is based on Phillips and Hansen [58]. The FMOLS method resolves the second-degree deviations through taking into account the simultaneous relationships between the disturbance terms of the equations, regards the endogeneity and autocorrelation, and produces consistent estimates for the small samples [58].

4. Results

In the analyses, the presence of cross-sectional dependency and heterogeneity among entrepreneurial activity, ICT development, and sustainable development is examined with LM_{adj}., LM, and LM CD tests and delta tilde tests. The test statistics and their probability values are shown in Table 3. The probability values of all cross-sectional dependency

tests were found to be less than 1%. As a result of this finding, H0 (nonexistence of cross-sectional dependence) is rejected and an entity of cross-sectional dependence is discovered among entrepreneurial activity, ICT, and sustainable development. Consequently, the level of entrepreneurial activity, ICT, and sustainable development in one country of the high-income economies can impress the other high-income countries in the sample thanks to the current highly globalized world. The probability values of two homogeneity tests are unveiled to be smaller than 1% and H0 (nonexistence of heterogeneity) is rejected in reference to the probability values.

Table 3. Consequences of cross-sectional dependency and homogeneity tests.

Cross-Sectional Dependence Tests		
Test	**Test Statistic**	***p* Value**
$LM_{adj.}$	38.8	0.00001
LM CD	13.47	0.001
LM	391.5	0.0001
Homogeneity Tests		
Test	**Test Statistic**	***p* Value**
$\widetilde{\Delta}$	10.621	0.004
$\widetilde{\Delta}_{adj.}$	12.146	0.006

The stationarity of entrepreneurial activity, ICT development, and sustainable development is investigated by Pesaran [59] and the CIPS unit root test, taking account of the subsistence of cross-sectional dependence. The test findings displayed in Table 4 show that SUSDEV, ENTREP, and ICT are not stationary at their level values, but SUSDEV, ENTREP, and ICT are stationary at the first-differenced values. As a consequence, SUSDEV, ENTREP, and ICT are discovered to be I (1).

Table 4. Consequences of CIPS unit root test.

Variables	**Constant**	**Constant + Trend**
SUSDEV	−0.237	0.306
D(SUSDEV)	−7.398 ***	−5.814 ***
ENTREP	−0.199	0.973
D(ENTREP)	−11.154 ***	−9.326 ***
ICT	−0.205	1.069
D(ICT)	−6.325 ***	−4.816 ***

*** significant at 5% significance level.

The cointegration interplay among entrepreneurial activity, ICT, and sustainable development is investigated using the Westerlund and Edgerton [57] test, considering the presence of heterogeneity, cross-sectional dependency, and the economic crises in the study term. The test statistics and their probability values are depicted in Table 5. The test results of the cointegration test with no shift indicates that there exists an insignificant cointegration among three variables. However, the test results of the cointegration test level and regime shifts reveal a significant cointegration between entrepreneurial activity, ICT development, and sustainable development. As a result, the utilization of a second-generation cointegration test with structural breaks contributes to our attainment of more reliable results. Furthermore, structural break dates indicate that the global financial crisis and Eurozone debt crisis have had a significant influence on the interaction among entrepreneurial activity, ICTs, and sustainable development.

Table 5. Results of the Westerlund and Edgerton [57] cointegration test.

Model	$Z_{\varphi}(N)$	***p* Value**	$Z_{\tau}(N)$	***p* Value**
No shift	−0.098	0.461	0.734	0.769
Level shift	−5.348	0.000	−4.603	0.000
Regime shift	−4.044	0.003	−4.654	0.001
Countries	**Structural breaks (level shift)**		**Structural breaks (regime shift)**	
Chile	2011		2011	
Croatia	2012		2012	
France	2016		2014	
Germany	2014		2014	
Greece	2011		2011	
Ireland	2014		2014	
Italy	2013		2013	
Japan	2007		2016	
Netherlands	2014		2014	
Slovenia	2012		2012	
Spain	2010		2012	
Sweden	2009		2009	
Switzerland	2013		2013	
United Kingdom	2009		2009	
United States	2008		2008	

The cointegration coefficients are estimated by the FMOLS (Full Modified OLS) method, and the coefficients presented in Table 6 reveal the positive influence of both entrepreneurial activity and ICT development on sustainable development. In this context, a 1% increase in ICT development and entrepreneurial activity, respectively, lead to a 10.8% and 5.1% increase in sustainable development. Therefore, ICT has more effect on sustainable development in the long term when compared with entrepreneurial activity. On the other hand, the same association among entrepreneurial activity, ICTs, and sustainable development is valid for country-level analyses. Furthermore, the influence of ICT on sustainable development is higher in The Netherlands, Switzerland, Sweden, the United Kingdom, Japan, and Ireland, and lower in Spain, France, and Greece. Entrepreneurial activity also positively influences sustainable development and the impact is higher in the United States, Germany, Sweden, France, The Netherlands, France, and Switzerland, but is lower in Italy, Greece, Chile, Japan, Croatia, and Slovenia. The cointegration coefficients are also estimated via the AMG (Augmented Mean Group) estimator of Eberhardt and Bond [60], in order to check the robustness and that similar coefficients are obtained; however, the coefficients produced by the AMG estimator were revealed to be slightly higher. The Newey–West algorithm, which is based on consistent standard errors, is employed to meet the assumptions behind the FMOLS and AMG estimations. Harvey and LM tests are respectively used to check the problems of heteroskedasticity and autocorrelation for both the estimators, and the probability values of both tests are found to be higher than 5%. Therefore, we reach the conclusion that there exist no problems of heteroskedasticity and autocorrelation. Lastly, Jarque–Bera test is applied to check whether the error terms are normally distributed, and the probability value is revealed to be larger than 5%. As a result, we determine that the error terms are normally distributed.

Table 6. The cointegration coefficients.

Countries	FMOLS Estimator		AMG Estimator	
	ENTREP	ICT	ENTREP	ICT
Chile	0.044 ***	0.106 ***	0.051 ***	0.119 ***
Croatia	0.046 **	0.104 **	0.058 **	0.115 **
France	0.063 **	0.094 ***	0.067 **	0.010 ***
Germany	0.070 ***	0.109 **	0.076 **	0.112 **
Greece	0.042 **	0.097 **	0.049 **	0.103 **
Ireland	0.058 ***	0.111 ***	0.063 ***	0.117 ***
Italy	0.031 ***	0.086 ***	0.024 ***	0.093 ***
Japan	0.045 **	0.112 **	0.054 **	0.126 **
Netherlands	0.063 **	0.119 ***	0.071 **	0.128 ***
Slovenia	0.048 **	0.103 **	0.056 **	0.109 **
Spain	0.055 ***	0.075 **	0.060 ***	0.084 **
Sweden	0.068 ***	0.114 **	0.074 ***	0.127 **
Switzerland	0.061 ***	0.119 ***	0.070 ***	0.129 ***
United Kingdom	0.059 **	0.113 **	0.063 **	0.124 **
United States	0.072	0.108 ***	0.080	0.110 ***
Panel	0.051 **	0.108 **	0.062 **	0.119 **

*** and **, respectively, significant at 1% and 5%.

5. Discussion

Entrepreneurship is expected to simultaneously influence multiple sustainable development goals, consisting of sustainable growth, social development, and environmental sustainability via innovation, technological progress, economic growth, and job creation [15]. However, the impact of entrepreneurship on sustainable development may be changed depending on the innovative nature of entrepreneurial activity and countries' development level. The limited empirical literature has revealed different findings about the influence of entrepreneurship on sustainable development [17,25–30]. On the one hand, Huđek and Bradač Hojnik [17], Ibeenwo [25], Pansera and Sarkar [27] revealed the positive influence of entrepreneurial activity on sustainable development. On the other hand, Venâncio and Pinto [26] discovered a negative influence of entrepreneurial activity on sustainable development. Some researchers have analyzed the influence of entrepreneurial activity on the components of sustainable development. In this context, Youssef et al. [28] and Dhahri and Omri [29] discovered the negative influence of entrepreneurial activity on environmental quality and Omri [30] also reached a conclusion supporting these two studies. Our findings are thought to be compatible with the results of Huđek and Bradač Hojnik [17], Ibeenwo [25], Pansera and Sarkar [27], Youssef et al. [28], Dhahri and Omri [29] and Omri [30], because a low negative effect of entrepreneurial activity on environmental degradation in high-income countries is possible. However, our findings indicate that the effect of entrepreneurial activity on other SDGs, such as economic sustainability, and social and human development, outweighs the negative environmental influence of entrepreneurial activity.

On the other hand, ICTs also can influence multiple SDGs via diverse channels such as education, innovation, productivity, efficiency, competition, entrepreneurial activity, knowledge transfer, and the environment. Therefore, the net effect of ICTs on sustainable development can be different depending on country-specific characteristics, such as human development and economic development levels. In the empirical literature, Nchofoung and Asongu [31], and Jayaprakash and Pillai [32], respectively, analyzed the effect of ICTs

on sustainable development in terms of the panels of 140 and 80 countries, and revealed the positive influence of ICTs on sustainable development. However, Onuoha et al. [33] revealed the negative influence of ICTs on human development and environmental quality in low-income ECOWAS countries. Therefore, our findings for selected high-income countries are consistent with the results of Nchofoung and Asongu [31], and Jayaprakash and Pillai [32]. However, the impact of ICTs on entrepreneurial activity, economic growth, the environment, education, and health has been widely investigated. In this context, Gomes and Lopes [34], Afawubo and Noglo [35], and Sardar et al. [36] revealed the positive influence of ICTs on entrepreneurial activity. On the other hand, the empirical literature focusing on the nexus between ICTs and environmental quality for different countries and country groups has remained inconclusive [37–42], but researchers have generally revealed the positive growth effect of ICTs [20,43–48]. Lastly, researchers have empirically revealed the positive influence of ICTs on the SDGs of quality education and health [12–23,52–56]. As a result, we can say that ICTs can foster sustainable development through these channels, but the negative environmental influence of ICTs is possible depending on a country's current development level. Therefore, our findings are also indirectly consistent with the results of the aforementioned researchers who analyze the influence of ICTs on entrepreneurial activity, economic growth, the environment, education, and health.

6. Conclusions

The industrial and knowledge revolutions have led many countries to achieve significant economic expansion, but many problems, such as climate change, the loss of biodiversity, natural disasters and globally increasing levels of poverty and inequality, have accompanied the considerable economic expansion taking place in the world. As a result of these developments, the future of the world has been extensively discussed and the concept of sustainable development has become one of the priorities of the globalized world.

The significant differences in the sustainable development levels of the countries analyzed have led researchers to explore the determinants of sustainable development; in turn, many demographic, institutional, economic, and social factors have been suggested as the determinants of sustainable development and its main dimensions. However, the gap in the empirical literature about the influence of entrepreneurial activity and ICT development on overall sustainable development attracts our attention because entrepreneurship and ICTs can simultaneously foster multiple SDGs. Therefore, the influence of entrepreneurial activity and ICT development on overall sustainable development is analyzed in a sample of high-income countries, using a second-generation cointegration test for the 2002–2018 period. However, the absence of entrepreneurial activity data for all high-income countries means that the empirical analyses are limited to using 15 high-income countries. Furthermore, the availability of entrepreneurship data for the sample restricts us to carrying out the empirical analyses for the 2002–2018 period.

The cointegration analysis reveals that both entrepreneurial activity and ICT development have a positive effect on overall sustainable development in the long run, but that the influence of ICTs on overall sustainable development at both the panel and country level is higher when compared with that of entrepreneurial activity. The influence of entrepreneurial activity and ICT development on overall sustainable development can be changed depending on country-specific characteristics, because both variables can influence sustainable development through channels. However, our findings are compatible with the results of a limited number of empirical studies investigating the influence of both entrepreneurial activity and ICT development on overall sustainable development. Furthermore, the results of the empirical studies on the effect of entrepreneurial activity and ICT development on the main dimensions of sustainable development for high-income countries support our findings.

The previous studies have predominantly used the regression approach to analyze the interplay among sustainable development, entrepreneurial activity, and ICTs. Therefore,

their results are valid for the whole panel. However, this article employs the AMG estimator to make evaluations at both the country level and panel level, unlike the related literature. Secondly, the use of the cointegration test with a structural break points out that economic and financial crises have significant influence on the interplay among sustainable development, entrepreneurial activity, and ICTs. Thirdly, our findings support that country-specific characteristics, such as the current level of economic development and human capital, influence the interplay among sustainable development, entrepreneurial activity, and ICTs. Therefore, the different findings regarding the influence of entrepreneurial activity and ICTs on sustainable development result from these country-specific socio-economic features.

Consequently, policies for increasing the use of ICTs and sustainable entrepreneurial activity, together with environmental measures, should be encouraged; in addition, country-specific characteristics should also be taken into account when designing these policies. This study has raised many research questions on the subject for possible future studies. Within this scope, whether or not the influence of entrepreneurial activity and ICT on sustainable development changes depending on the type of entrepreneurial activity and type of ICT can be explored. Furthermore, the influence of entrepreneurial activity and ICTs on sustainable development, taking notice of the human capital and economic development levels of the countries, can be studied.

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