UNIVERSITY OF DEBRECEN

FACULTY OF ECONOMICS AND BUSINESS

KÁROLY IHRIG DOCTORAL SCHOOL OF MANAGEMENT AND BUSINESS ADMINISTRATION

Head of the Doctoral School: **Prof. Dr. Balogh, Péter professor, DSc**

THE EFFECTS OF TECHNOLOGY AND INSTITUTIONS ON PRODUCTIVITY GROWTH, A SECTORAL APPROACH IN THE CASE OF SOME OF THE OECD COUNTRIES

Prepared by:

Vahid Zeynvand Lorestani

Supervisor:

Dr. habil. László Erdey

DEBRECEN

2025

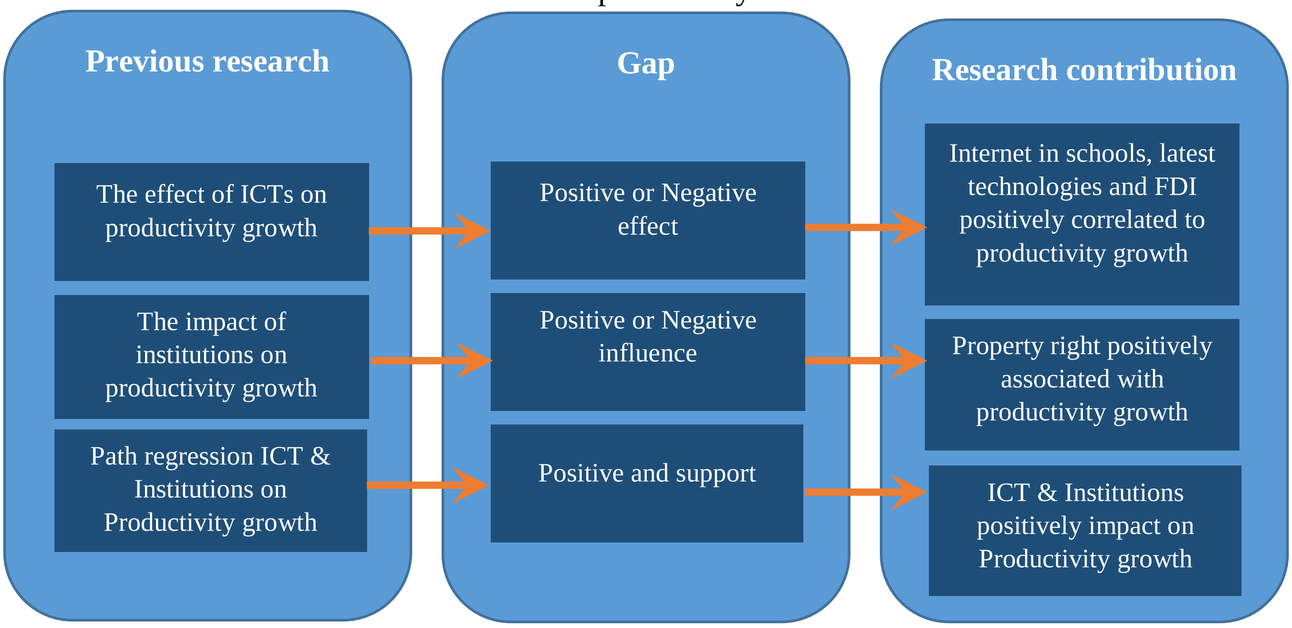
TABLE OF CONTENTS

INTRODUCTION

Today, "Economic Growth" is considered the most essential aim, and every nation is working toward that end. The answer to the issue of why the expansion of an economy is of the biggest significance to a country is, ultimately, connected to the standard of living of its population. Improved quality of life for the general population is one of the goals of economic development. If economic growth does not increase the general living standard, then the concept of "development" cannot be said to have occurred. According to sociologists, economists, and politicians, the improvement of everyone's quality of life should be the overarching goal of economic policy (Firebaugh & Beck, 1994).

This study aims to contribute to the empirical research by evaluating the influence of technology (ICT) and institutions on the increase of productivity in a sectoral approach in OECD nations between 2007 and 2017. This study concentrates on the direct question of how the availability of information and communications technology (ICT), such as internet access in schools, availability of the latest technology, and foreign direct investment, as well as institutional concerns such as property rights, are connected to the rate of enhance in productivity. The data sets compiled by the World Bank and the World Economic Forum were used as the basis for the study, and specific variables were taken from those sets. The empirical data from the dynamic GMM (Generalized Method of Moments) regressions support the assertion that the interplay between access to the internet in schools and the availability of the latest technologies affects economic development.

Research Gap and Study Contribution



Source: Author's compilation (2022)

1. TOPICS AND OBJECTIVES

1.1.Aim of the research

The thesis aims to highlight the interactions between GDP per capita (productivity), Information Communication Technology (ICT), and Institutions.

1.2.Objectives of the research

1. The first objective of this research is to investigate the influence of technology on productivity in OECD countries' sectors in a sectoral approach.

2. The second objective is to identify the influence of institutions on productivity in different sectors in the case of OECD countries in a sectoral approach.

3. Also, to find the proper methodologies and adapt models suitable for analyzing longitudinal and cross-country differences in this research.

1.3.Research questions

Based on the research objectives, the below research questions have been made:

1. How can technology (ICT) influence productivity in different branches?

2. How do institutions affect productivity in different country groups and sectors?

1.4.Research approach

This research started by reviewing the previous studies that examine the direction of the internet in schools, the latest technology adoption, and FDI, as well as property rights.

1.5.Hypotheses development

After summarizing the previous research, this study proposed to develop the six hypotheses as follows.

The hypotheses suggested studying the influence of ICT and institutions on productivity growth.

In proposing a novelty as the theoretical framework of this research, this study argued that Internet access in schools would affect productivity growth. Then, the availability of the latest technology would increase productivity growth, and FDI and technology transfer have the same effect on productivity growth. This research proposed the effect of ICT on productivity growth in the three hypotheses below.

Hypothesis 1: ICT is positively associated with productivity growth in the OECD countries and sectors.

Hypothesis 1a.: Internet access in schools positively affects productivity growth in the OECD countries and sectors.

Hypothesis 1b: Availability of the latest technologies positively correlated with productivity growth in the OECD countries and sectors.

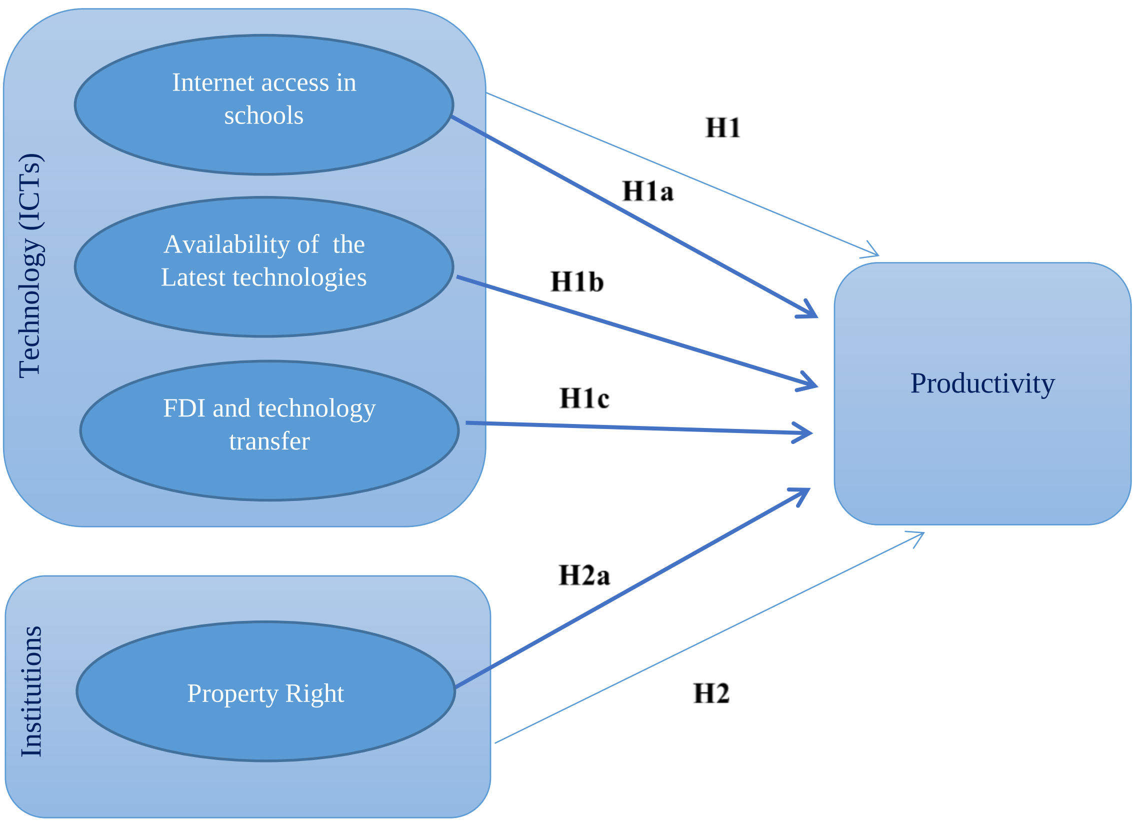
Hypothesis 1c: FDI and technology transfer positively influence productivity growth in the OECD countries and sectors.

This research proposed that property rights as an institutional indicator might affect the level of productivity growth.

Hypothesis 2: Institutions are positively associated with productivity growth in OECD countries and different sectors.

Hypothesis 2a: Property rights positively influence productivity growth in OECD countries and different sectors.

Summary of the hypothesis



Source: Author's compilation (2022)

2. INDUSTRY CLASSIFICATION

The primary aim of my research is to investigate the relationship between technology and institutions on productivity growth, and the second purpose is to study this relationship in the sectoral approach; therefore, in my research, I followed three taxonomies of industries to identify the performance of productivity growth and employment tendency in different labor-skilled branches, the relationship between productivity growth and innovation taxonomy, and finally the relationship between R&D intensities and economic growth.

2.1.Skill taxonomy

A variety of different methodologies have been used in the process of building the skills taxonomy. The advantage of these data is that the breakdown over qualification levels enables a more detailed analysis than much of the data available for larger groups of countries that categorize individuals as being high-skilled or low-skilled (or blue-collar/white-collar or production and non-production workers). Especially for the strategy that goes into great depth, data from Eurostat covering all of the nations in the EU in terms of skills were utilized to develop an extra taxonomy. These statistics include several years and workers with high, medium, and low levels of expertise. The International Standard Classification of Education - 1976 (ISCED) was used to determine the skill levels for the Eurostat (LFS).

The skill taxonomy of industries

1. High-skilled (HS): Mineral oil refining, coke, and nuclear fuel (23); Chemicals (24); Of-fice machinery (30); Radio, television and communications equipment (32); Electronic valves and tubes (321); Telecommunication equipment (322); Radio and television receivers (323); Financial intermediation, except insurance and pension funding (65); Insurance and pension funding, except compulsory social security (66); Activities auxiliary to financial intermediation (67); Real estate activities (70); Computer and related activities (72); Research & development (73); Other business services (74); Public administration and defense; compulsory social security (75); Education (80).
2. High-intermediate skilled (HIS): Medical, precision & optical instruments (33); Scientific instruments (331); Other instruments (33-331); Other transport equipment (35); Building and repairing of ships and boats (351); Aircraft and spacecraft (353); Railroad equipment and transport equipment (352+359); Electricity, gas, and water supply (40-41); Air transport (62); Supporting and auxiliary transport activities; activities of travel agencies (63); Communications (64); Renting of machinery & equipment (71); Health and social work (85).

3. Low-intermediate skilled (LIS): Wood & products of wood and cork (20); Pulp, paper & paper products (21); Printing & Publishing (22); Fabricated metal products (28); Mechanical engineering (29); Electrical machinery and apparatus (31); Insulated wire (313); Other electrical machinery & apparatus (31-313); Construction (45); Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel (50); Wholesale trade and commission trade, except motor vehicles and motorcycles (51); Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods (52); Inland transport (60); Water transport (61).
4. Low-skilled (LS): Agriculture (01); Forestry (02); Fishing (05); Mining and quarrying (10-14); Food, drink & tobacco (15-16); Textiles (17); Clothing (18); Leather and footwear (19); Rubber & plastics (25); Non-metallic mineral products (26); Basic metals (27); Motor vehicles (34); Furniture, miscellaneous manufacturing; recycling (36-37); Hotels & catering (55); Other community, social and personal services (90-93).

Source: (Mahony & Ark, 2003)

2.2. Innovation taxonomy

This taxonomy emphasizes the significant role that innovation plays as a driver of increased levels of productivity. According to substantial evidence gleaned from research carried out at the firm level as well as case studies, complementary innovation activities, such as organizational changes and other non-technological innovations, are of utmost importance in exploiting the productivity potential from investments in technology (ICT) and human capital. This is the case, although technological innovations themselves are of great importance. The construction of the innovation taxonomy that will take place in this section will have the gathering of information on a wide variety of sources of innovation as its primary objective. This taxonomy defines industrial sectors into nine classes as follows:

The Innovation taxonomy of industries

1. Supplier Dominated Goods (SDG): Agriculture (01); Forestry (02); Fishing (05); Textiles (17); Clothing (18); Leather and footwear (19); Wood & products of wood and cork (20); Pulp, paper & paper products (21); Printing & publishing (22); Furniture, miscellaneous manufacturing; recycling (36-37); Construction (45).
2. Scale Intensive industry (SII):

Mining and quarrying (10-14); Food, drink & tobacco (15-16); Mineral oil refining, coke & nuclear fuel (23); Rubber & plastics (25); Non-metallic mineral products (26); Basic metals (27); Fabricated metal products (28); Motor vehicles (34); Building and repairing of ships and boats (351); Aircraft and spacecraft (353); Railroad equipment and transport equipment (352+359); Electricity, gas and water supply (40-41).
3. Specialized Goods Suppliers (SGS): Mechanical engineering (29); Office machinery (30); Insulated wire (313); Electronic valves and tubes (321); Telecommunication equipment (322); Scientific instruments (331); Other instruments (33-331).
4. Science-Based Innovator (SBI): Chemicals (24); Other electrical machinery & apparatus (31-313); Radio and television receivers (323).
5. Supplier Dominated Services (SDS): Retail trade, except for motor vehicles and motorcycles; repair of personal and household goods (52); Water transport (61); Communications (64).
6. Specialized Services Suppliers (SSS): Computer and related activities (72); Research & development (73); Legal, technical, and advertising (741-3).
7. Organizational Service Innovators (OSI): Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of automotive fuel (50); Inland transport (60); Air transport (62); Financial intermediation, except insurance and pension funding (65); Insurance and pension funding, except compulsory social security (66) Real estate activities (70); Renting of machinery & equipment (71).
8. Client-Led Services (CLS): Wholesale trade and commission trade, except motor vehicles and motorcycles (51); Hotels and catering (55); Supporting and auxiliary transport activities; activities of travel agencies (63); Activities auxiliary to financial intermediation (67); Other business services (749); Other Community, social, and personal services (90-93); Private households with employed persons (95);
9. Non-Market Services (NMS): Public administration (75); Education (80); Health (85).

Source: (Mahony & Ark, 2003)

2.3.R&D intensities taxonomy

In this sector, I followed a unique taxonomy initially presented by Hatzichronoglou (1997) to determine the primary characteristics of production per capita growth tendencies. This taxonomy was designed to categorize different types of economic growth. This strategy emphasizes technology and classifies industries into four distinct groups, ranging from those with a high to a low level of technological intensity.

This taxonomy strongly emphasises the R&D intensities that play in its capacity as a driver of improved levels of productivity.

Classification of manufacturing industries into categories based on R&D intensities

1. High Technology Industries (HT): Aircraft and spacecraft; Pharmaceuticals; Office, accounting, and computing machinery; Radio, TV, and communications equipment; Medical, precision, and optical instruments
2. Medium-High Technology Industries (MHT): Electrical machinery and apparatus, n.e.c.; Motor vehicles, trailers, and semi-trailers; Chemicals excluding pharmaceuticals; Railroad equipment and transport equipment, n.e.c.; Machinery and equipment, n.e.c.
3. Medium-Low Technology Industries (MLT): Building and repairing ships and boats; Rubber and plastic products; Coke, refined petroleum products, and nuclear fuel; Other non-metallic mineral products
4. Low Technology Industries (LT): Manufacturing, n.e.c.; Recycling; Wood, pulp, paper, paper products, printing, and publishing; Food products, beverages, and tobacco; Textiles, textile products, leather, and footwear

Source: (Hatzichronoglou, 1997)

3. MATERIAL AND METHODS

3.1.Data Collection

Economies are classified into many groups, such as developed versus developing nations with certain socio-economic characteristics. A high level of export diversification, a high degree of financial system integration, a large level of industrialization, and a high gross domestic product per capita are frequently the hallmarks of a developed market (Mody, 2004). In the meantime, a developing nation is making strides toward becoming an advanced country. This nation already has a physical, financial infrastructure comprising banks, a stock exchange, and unified currencies. However, this nation's market efficiency, accounting standards, and securities regulations are not yet on par with those of developed nations.

However, institutions evaluate the growth of a nation in many different ways to serve the demands of investors with an objective and consistent approach to the categorization of markets, and there is no precise agreement on how these markets should be categorized.

In this research, I used the „OECD 2022 list" provided and reported by the OECD organization, as mentioned in the Introduction section. The data was collected from the years 2007 to 2017 from OECD countries. This was done so that the findings obtained for each category would be more reliable.

A database known as the World Development Indicators (WDI) has been developed by the World Bank to facilitate the collection of pertinent statistics of high quality and global comparability about global development and the struggle to eradicate poverty. This Databank (The World Bank, 2019) strives to construct a balanced panel by including measurements of factors like production per capita, employment, capital formation, and other such things at the level of individual countries beginning in 1960 and continuing forward. The database maintained by the World Economic Forum is the source of information on access to Internet technologies and infrastructure characteristics (World Economic Forum, 2019).

Internet connectivity in schools is used to measure the overall quality of education and is included in the fifth pillar of the Global Competitiveness Index (GCI), which is connected to higher education. As a variable, the individual use of the internet (as a percentage of the total population) and adoption of the most recent technology are both measured by the ninth pillar of technological preparedness.

In this study, the KLEMS Database has been used as well. This database contains information on value-added and employment rates for OECD for 56 different sectors between 1980 and 2021. The new OECD STAN Database of national accounts has served as the point of departure for the majority of the world's countries. The STAN Database includes information on the most significant national account variables from 1970 onwards based on standard industry classification.

The data series available from STAN is the value added in current and constant prices (at basic prices), numbers of persons engaged (including self-employed), number of employees, total labor compensation, and, in a limited number of cases, working hours. Similar variables were available from survey statistics.

3.2.Methodology

Those who disagree with the initial version of Solow's model, which did not account for human capital, point out the inconsistencies between the facts and the model's predictions. A significant overestimation of the rate at which economies will converge to a steady-state level, in contrast to a significant underestimation of the rate at which economies save money and increase their populations. Both of these empirical flaws are amenable to having their severity reduced by increasing the amount of human capital.

As a direct consequence of this, the first point of view is a classical Cobb-Douglas production function. If we assume that human capital is employed to create technology, which then translates into the accumulation of physical capital, then the level of their stock will determine the growth rate of the economies (Romer, 1990). In this method, the amount of human capital is what influences the growth rate, and this is done via the parameter for the neutral total factor productivity. In less developed and rising nations, the connection that predominates is consistent with the technique outlined by (Lucas, 1988). Therefore, the accumulation of human capital that affects economic growth can be better modeled as a factor of production (van Leeuwen & Foldvari, 2008).

The consideration of endogenous growth theories has been expanded across the empirical study via the use of dynamic techniques for a limited number of periods and cross-sectional analyses (Arellano & Bond, 1991). The economy tends to move toward long-term equilibrium when this dynamic strategy is used. In most cases, the lagged levels of the dependent and predefined variables among the repressors are used in these kinds of methodologies. Extraordinary instrumentation of these lagged endogenous variables is necessary for a dynamic specification, and GMM estimators must be reflected such that they can account for covariates. As a result, internal instruments are used since some of the lagging explanatory factors may affect the variable that is being investigated to rule out biases. The number of instruments has been restricted to prevent the issue of overestimation (Roodman, 2009).

In the case of developing markets, the following formula is evaluated after calculating the logarithm of the initial differences of the dependent productivity variable:

$$\Delta lny_{i,t} *= \beta_o + \beta_1 lny_{i,t-1} + \beta_2 lns_{k_{i,t}} - \beta_3 ln(n + \delta + g)_{i,t} +$$
$$\beta_4 lnInternet\_Access_{i,t_{i,t}} + \beta_5 lnAvailability_{i,t} + \beta_6 lnFDI_{i,t} + \beta_7 lnProperty_{i,t} + \beta_8 \varepsilon_{i,t}$$

The dependent variable is the first log of GDP per capita of the country [i] for the period [t] at a constant value. The lagged form of the dependent variable, the investment ratio in physical capital, the growth of employment, the internet access in education, the latest available technologies, FDI and technology transfer, and property rights are the independent variables, respectively.

The following table is presented in the order in which the independent variables appear.

3.3.Model's validity

According to Wooldridge (2001), GMM has significant advantages over maximum likelihood in this context because GMM allows estimation under the restrictions implied by the theory; there is no need to add distributional assumptions that are not implied by the theory.

The GMM model, mostly used for panel data, provides consistent results in the presence of different sources of endogeneity, namely "unobserved heterogeneity, simultaneity, and dynamic endogeneity" (Wintoki et al., 2012).

It was found that the two-step GMM analysis method is suitable to handle the assumption of biased standard errors and to prove the validity of comparisons.

In all the models, the Sragan-Hansen tests illustrate the results of over-identifying limitations. The Sargan-Hansen test is used to avoid instrument proliferation where there is a correlation between the instruments and the errors; to avoid that, the Sargan-Hansen test has been used; otherwise, it leads to misleading results. Also, Autocorrelation can be considered as the Arellano–Bond test (AR2). The p-value of the Arellano–Bond test should be higher than 0.05 (Arellano & Bond, 1991). Based on the results shown in the next section, the two-step GMM analysis method is used to estimate and predict the model used in this study.

Description, Abbreviations, and Sources of Main Variables

Variable	Abbreviation	Description	Source
GDP per person employed	y	GDP per person employed is gross domestic production (GDP) divided by total employment in the economy.	EU KLEMS And STAN database
Capital stock at a current price	Sk	Share of investment within sectoral output	Penn World Table
Human capital	hc	Based on the years of schooling and returns to education.	Penn World Table
Total employment (ages 15+)	$n + \delta + g$	Total employment shows the total number employed ages 15 and over.	EU KLEMS And STAN database
Quality of education	ias	Internet access in schools, 1-7 (best)	GCI data series
Technology adoption	alt	Availability of the latest technologies	GCI data series
FDI and technology transfer	Fdi_tt	FDI and technology transfer	GCI data series
Property rights	pr	Security of property rights Patents, Trademarks, Industrial designs	GCI data series

Source: Author's compilation (2022)

4. RESEARCH FINDINGS, EVALUATION, AND DISCUSSION

4.1.Results of regression – Skill taxonomy of industries

Dependent variable: Productivity Growth $\Delta \ln(y)_{i,t}$

Independent	Model 1				Model 2			
	HS	HIS	LIS	LS	HS	HIS	LIS	LS
Constant	-1.2414	-0.1172	-2.9354	-1.3604	-0.7573	0.8702	-2.0132	-1.2863
	(-2.59)**	(-0.29)	(-6.49)***	(-5.08)***	(-1.51)	(0.80)	(-1.38)	(-2.22)**
GDP per person employed	0.7518	0.7084	0.5689	0.8191	0.4764	0.3661	0.6760	0.8445
	(13.05)***	(11.07)***	(17.02)***	(21.73)***	(6.30)***	(3.13)***	(9.52)***	(10.30)***
Physical capital	0.1470	0.0645	0.2860	0.1316	0.1726	0.1132	0.1747	0.1217
	(3.72)***	(2.01)**	(7.81)***	(6.14)***	(4.35)***	(2.37)**	(2.37)**	(2.95)***
Employment growth	-0.5059	-0.4341	-0.1513	-0.5506	-0.5164	-0.5706	-0.0862	-0.3641
	(-2.64)***	(-6.86)***	(-1.85)*	(-7.37)***	(-3.68)***	(-1.88)**	(-0.82)	(-0.81)
Human capital	0.0702	0.0984	0.1279	0.0404	0.1882	0.1008	0.0445	0.0103
	(1.55)	(2.49)**	(4.32)***	(3.26)***	(3.90)***	(2.07)**	(0.52)	(0.19)
Internet access in schools	#	#	#	#	-0.1171	-0.1561	-0.1289	-0.0160
	#	#	#	#	(2.67)***	(1.62)	(-0.84)	(-0.30)
Availability of the latest technologies	#	#	#	#	0.0148	0.0518	0.4800	0.0789
	#	#	#	#	(0.42)	(0.26)	(3.59)***	(0.89)
FDI and technology transfer	#	#	#	#	0.1033	-0.0452	0.1890	-0.0181
	#	#	#	#	(3.41)***	(0.25)	(0.33)	(0.19)
Property rights	#	#	#	#	-0.0178	-0.0793	-0.2314	-0.0092
	#	#	#	#	(-0.36)	(0.36)	(-1.52)	(-0.09)
Observations	153	153	153	153	153	153	153	153
Countries	17	17	17	17	17	17	17	17
Instruments	13	49	49	49	17	53	53	53
Wald test	(1737.10)***	(1035.43)***	(3665.86)***	(9690.66)***	(1035.04)***	(269.84)***	(5270.41)***	(6622.49)***
AR(2) test	(-1.0552)	(-1.3643)	(-1.1669)	(-2.1897)**	(0.6324)	(-1.0178)	(-1.3482)	(-2.1757)**
Sargan test	(-1.3860)	(-1.9867)**	(-1.3911)	(-1.2684)	(-0.8658)	(-2.2233)**	(-1.5452)	(-1.1111)

Source: Author's compilation (2022)

Note: P<0.01 ***, P<0.05 **, P<0.1 *

4.2.Evaluation and discussion of the Skill Taxonomy results

In this table, I find that there is a valid dynamic representation of the relationship between the measure of employment, human capital, and productivity growth. The impact of the lagged GVA per capita is robust, and there are significant positive z-statistics. Nevertheless, in the HS branches in Model 2, there is a significant negative (-0.69) coefficient. If an increase happens in the share of investment within the GDP [s_k] variable in both models, as theoretically expected, we could claim that all the models have a positive impact on productivity growth (except LS in model 2). This result matches the scientific work of Stiroh & Tel (2000). According to this research, productivity growth, in particular, is important since it is consistent with the idea that the massive investment in new technology is working to improve the performance of the banking industry. Tangible investment increases output and boosts living standards by providing employees with greater capital and enhancing labor productivity. Because of the importance of investment, there has been a great deal of theoretical and empirical study on the link between investment, productivity, and economic growth. Productivity growth has a significant association with Employment in all sectors. Based on the literature, Melamed et al. (2011) suggest that growth in services is becoming relatively more important in driving employment than manufacturing. The authors looked at research on 24 growth episodes from the 1980s, 1990s, and 2000s, in which there was evidence of the impact of employment in different s. In 18 of these, poverty had fallen. In 15 of these cases, there had been a rise in employment in services, in 10 a rise in industrial employment, and in six cases a rise in employment in agriculture (six saw rises in employment in two of the three sectors, but there was no case of increased employment in all three s). Similarly, Kapsos (2005) found that historical global employment elasticities by economic are highest in services (at 0.61 percent) at the global level; he estimates that between 1991 and 2003, total employment increased by 0.3 to 0.38 percentage points for every one percentage point of extra GDP growth. Kapsos's study mainly focuses on different regions (including the Soviet Union, East Asia, Mexico, the developed world, Argentina, and the Russian Federation) in different periods. As we can see in the results, as indicated in much of the literature, an increase in the level of human capital results in an increase in GDP per capita growth in all sectors. Hence, human capital is controversially correlated with productivity growth in these sectors. Based on the neoclassical growth theories, such as Mankiw G. et al. (1992), there is a positive relationship between human capital and productivity growth. Although scholars have proven, this relationship can be negative in the case of some countries (Máté, 2015). However, in this research, the impact of human capital on productivity growth is significant in most of them. The significance means that more Human capital, ceteris paribus, implies productivity growth. As regards Internet access in schools, it has a positive and significant impact on productivity growth. In other words, for every one-unit increase in internet access in schools, there is an increase in productivity by 0.1219, 0.2382, 0.0711, and 0.1803 for HS, HIS, LIS, and LS, respectively. Therefore, this result matches the scientific work of (Karaçor et al., 2018), who conclude that the Internet in schools positively affects economic growth and enhances the level of quality of education, which is necessary for productivity. Regarding the availability of the latest technology, the results are different. In the HS and LS sectors, this variable has a positive but not significant effect on productivity. However, in the HIS and LIS sectors, their relationship is negative. In this case, some scholars suggested that the positive effect of the latest technological adoptions is robust (Borensztein et al., 1995) and the role of the transfer and diffusion of new technologies on productivity growth is important (Postelnicu & Dabija, 2015). Furthermore, the same scenario happened regarding the FDI and technology transfer variable. There is a positive relationship between FDI & technology transfer and productivity growth in HS and HIS, but this effect is negative in LIS and LS. In the meantime, it is not significant in all the sectors. However, based on the literature, the relationship is positive most of the time, where FDI and technology transfer enhance productivity. A case study of the energy done by Osano & Koine (2015) in Kenya proved that FDI & technology transfer have an important relationship with economic growth. The beneficial impacts of FDI are mostly due to the transfer of technology, knowledge, and other intangible assets, which result in increased productivity and improved resource allocation efficiency (Khawar, 2005). Property rights have a positive relationship and significant effect on productivity growth in a sector. According to the literature, this result matches previous studies where property rights should have a positive effect on productivity. For example, based on the study of Sattar and Mahmood (2011), intellectual property rights contribute to economic growth positively and significantly worldwide. Further, by classifying the entire sample of countries into high-income, upper-middle-income, lower-middle-income, and low-income countries, they have found that the impact is greater in high-income countries than in middle and low-income countries. Moreover, it also concludes that the impact of intellectual property rights on economic growth is more effective in upper-middle countries than lower-middle-income countries, which in turn is stronger compared to low-income countries.

4.3.Results of regression – Innovation taxonomy of industries

Dependent variable: Productivity Growth $\Delta\ln(y)_{i,t}$

(Model 1)

Independent	SDG	SII	SGS	SBI	SDS	SSS	OSI	CLS	NMS
Constant	-1.4947	0.2315	-2.5911	0.3594	0.3554	-2.5656	-3.6948	-4.2410	-0.2532
	(-2.44)**	(1.36)	(-2.65)***	(1.70)*	(0.71)	(-5.12)***	(-6.33)***	(-7.21)***	(-0.92)
GDP per person employed	-0.0875	-0.0288	1.0302	0.3646	0.2579	0.7466	0.6475	0.4038	0.9526
	(-4.01)***	(-0.77)	(12.69)***	(15.53)***	(4.08)***	(17.35)***	(18.71)***	(3.87)***	(20.04)***
Physical capital	0.1395	0.0984	0.1413	0.3352	0.0772	0.2136	0.3776	0.4095	0.0119
	(2.67)***	(4.47)***	(2.29)**	(11.38)***	(2.74)***	(5.05)***	(6.54)***	(8.21)***	(0.55)
Employment growth	-0.2258	-0.4877	-1.0809	-0.2339	-0.6223	-0.7584	-0.4900	-0.3847	-0.0577
	(-1.85)*	(-9.34)***	(-23.22)***	(-4.42)***	(-6.22)***	(-19.04)***	(-8.81)***	(-18.03)***	(-0.58)
Human capital	0.1747	0.2047	0.1416	-0.7005	0.3140	0.1676	0.0238	0.2081	0.0790
	(2.49)**	(4.78)***	(1.51)	(-8.21)***	(7.63)***	(2.40)**	(0.26)	(2.78)***	(2.59)**
Internet access in schools	#	#	#	#	#	#	#	#	#
	#	#	#	#	#	#	#	#	#
Availability of the latest technologies	#	#	#	#	#	#	#	#	#
	#	#	#	#	#	#	#	#	#
FDI and technology transfer	#	#	#	#	#	#	#	#	#
	#	#	#	#	#	#	#	#	#
Property rights	#	#	#	#	#	#	#	#	#
	#	#	#	#	#	#	#	#	#
Observations	136	136	144	153	153	153	153	153	153
Countries	17	17	16	17	17	17	17	17	17
Instruments	20	20	13	21	49	49	49	49	28
Wald test	(4142.78)***	(1658.33)***	(1447.83)***	(2060.14)***	(150.69)***	(3194.65)***	(2595.31)***	(1061.40)***	(47088.59)***
AR(2) test	(-2.7851)***	(-1.7221)*	(-1.9631)**	(-0.9654)	(-1.2073)	(-1.6972)*	(-1.8307)*	(-1.4864)	(-1.9947)**
Sargan test	(-1.2326)	(-1.3642)	(-2.28)**	(-1.7334)*	(-.04682)	(0.7596)	(-0.5406)	(-0.9856)	(-0.7973)

Source: Author's compilation (2022)
Note: P<0.01 ***, P<0.05 **, P<0.1 *

Results of regression – Innovation taxonomy of industries

Dependent variable: Productivity Growth $\Delta \ln(y)_{i,t}$

(Model 2)

Independent	SDG	SII	SGS	SBI	SDS	SSS	OSI	CLS	NMS
Constant	-1.7521	-0.8287	-4.0593	15.7253	-0.0289	-0.4442	-2.1226	-3.1536	-0.2052
	(-1.25)	(-0.94)	(-4.12)***	(3.36)***	(-0.03)	(-0.36)	(-1.73)*	(-2.70)***	(-0.55)
GDP per person employed	0.0443	0.0373	1.0639	0.0722	0.4337	0.5842	0.4060	0.4683	0.8137
	(0.45)	(-0.77)	(6.42)***	(1.03)	(4.87)***	(2.91)***	(3.54)***	(4.36)***	(7.37)***
Physical capital	0.2027	0.1565	0.2124	-0.4211	0.0011	0.1485	0.3202	0.3550	0.0694
	(2.16)**	(2.61)***	(3.16)***	(-2.40)**	(0.02)	(2.80)***	(6.19)***	(3.55)***	(2.00)**
Employment growth	1.0007	-0.3674	-1.0366	-0.1717	-0.7087	-0.7259	-0.5114	-0.3832	-0.1126
	(2.38)**	(-2.67)***	(-9.94)***	(-0.94)	(-4.45)***	(-5.81)***	(-6.28)***	(-7.33)***	(-0.21)
Human capital	0.0558	0.1659	0.1796	-0.3279	0.3755	0.2727	0.0511	0.1709	0.0260
	(0.47)	(2.93)***	(1.64)	(-1.27)	(6.79)***	(2.28)**	(0.84)	(1.74)*	(0.57)
Internet access in schools	-0.2135	0.0704	0.0018	0.9222	-0.2243	-0.2696	-0.2091	-0.1473	-0.1042
	(-4.93)***	(0.98)	(0.01)	(-3.25)***	(-1.15)	(-1.90)*	(-1.80)*	(-0.85)	(-3.21)***
Availability of the latest technologies	-0.0794	-0.1913	-0.2317	0.9495	0.7185	-0.1312	0.1965	0.3069	-0.1071
	(-0.45)	(-0.95)	(-0.91)	(1.46)	(2.86)***	(-0.67)	(1.09)	(1.01)	(-1.14)
FDI and technology transfer	0.3733	0.1676	0.1602	-0.0644	-0.0867	0.1126	0.0608	-0.3257	0.1910
	(0.96)	(2.16)**	(2.03)**	(-0.08)	(-0.63)	(0.35)	(2.44)**	(-0.53)	1.32
Property rights	0.1232	0.1528	0.2068	-2.6856	-0.0540	0.2853	0.8680	-0.1159	-0.0810
	(0.69)	(1.74)*	(2.04)**	(-5.30)***	(-0.18)	(-1.18)	(-2.29)**	(-0.51)	(-0.96)
Observations	136	136	144	153	153	153	153	153	153
Countries	17	17	16	17	17	17	17	17	17
Instruments	24	24	17	25	53	53	53	53	32
Wald test	(847.83)***	(533.79)***	(7542.44)***	(327.30)***	(141.32)***	(2130.58)***	(1546.67)***	(1950.37)***	(1876.90)***
AR(2) test	(-2.4285)**	(-2.5545)**	(-2.0834)**	(-0.6840)	(-1.5857)	(-1.1894)	(-0.2748)	(-1.5504)	(-1.6297)
Sargan test	(-0.1904)	(-1.398)	(-2.1973)**	(-1.9826)**	(0.4790)	(0.6211)	(-0.0042)	(-0.9336)	(-0.5250)

Source: Author's compilation (2022)
Note: P<0.01 ***, P<0.05 **, P<0.1 *

4.4.Evaluation and discussion of the innovation taxonomy results

This table represents the regression results of the two-step GMM estimators for innovation taxonomy.

In this table, I find that there is a valid dynamic representation of the relationship between the measure of employment, human capital, and productivity growth. The impact of the lagged GVA per capita is significant and positive z-statistics. As observed in the above tables, there is a highly significant relationship between investment and productivity growth in all the models. Based on the empirical research of Wilson & Smith (2019), although GDP growth does not impact investors' decision-making in the United States in the near term, it does provide a decent indicator of how the economy is performing; long-term investors should be informed of what is going on in the economy in terms of policy, technological innovation, and GDP growth potential. Strong GDP growth might contribute to long-term increases in the fundamentals of stock returns.

In the Sources of the Productivity Rebound and the Manufacturing Employment Puzzle (Nordhaus, 2005), Nordhaus examines extensive industrial productivity and employment statistics dating back over 60 years, with a particular focus on the United States' productivity resurgence from 1995. Nordhaus examines the link between productivity shocks and changes in manufacturing employment using specific data on productivity and employment. Nordhaus examines the link between productivity and employment using a variety of datasets on industrial production and productivity, as well as a variety of econometric tests. He shows that faster productivity growth leads to higher rather than lower employment in manufacturing by examining the key "elasticities" between employment and productivity growth, which has been significant since 1998. Higher productivity growth may result in job losses for specific firms or industries, according to Nordhaus, who cites the drop in employment in the typewriter manufacturing industry following the introduction of the personal computer as an example.

However, the lower prices that follow from increasing productivity have enhanced demand growth and more than offset the employment-lowering effect of higher productivity. According to Nordhaus, the explanation for decreasing manufacturing employment over the previous decade does not appear to be stronger productivity growth in the United States. Instead, stronger productivity growth and more severe price drops among overseas manufacturers competing with US firms will likely be the source. Also, Capital investment can have reasonably drastic effects on productivity levels. For example, the oil industry's initial boom in the United States came partially because of the amount of capital invested in new drilling equipment. Investing in new technology companies or physical plants tends to make it easier for workers to produce goods and services more quickly due to improved productivity.

Nevertheless, when it comes to causing unemployment for workers, large investments can strain a country's labor market because they often lead to layoffs that are not compensated with high wages. This is why some believe large capital investments are good for employment but do not necessarily increase overall production levels. This fact supports the result of this research that there is a negative relationship between employment and productivity growth. As shown in the results, in much of the literature, the effect of human capital on productivity growth is positive and significant. This matches the results of the scholar who has proven that labor, physical, and human capital are positively related to economic growth and that the coefficients are statistically significant (Qadri & Waheed, 2013). Nevertheless, in the SGS branches, there is a significant negative coefficient. Hence, human capital is controversially correlated with productivity growth.

Furthermore, the result shows that there is a positive influence on productivity growth when there is a one-unit increase in Internet access in schools in SDG, SII, SDS, SSS, OSI, and GLS sectors, and this relationship is negative in SGS, SBI and NMS sectors. Scholars also have different points of view in this regard. Some studies have proven that Internet access in schools and economic growth are positively related in OECD countries (Devarajan et al., 1996; Eriçok & Yılancı, 2013; Psacharopoulos & Patrinos, 2018), but in many cases, these impacts could take place in long-run. In addition, Kho et al. (2011) conducted a study on the impacts of internet access in schools in Peru between 2007 and 2017, comparing schools with internet access with those that either had no access or had obtained it later. In the first 18 months, they found that schools with internet access reported only moderately higher performance of students on standardized math tests with standard deviations between 0.04 and 0.08. However, the divergence between students with and without internet access grew increasingly pronounced each subsequent year. The growing impact of school connectivity was attributed to several factors. Among these, one of the main drivers was the hiring of teachers over time who were trained in using computers and the internet and could, therefore, more effectively integrate digital tools into their teaching over time. It was found that schools were more likely to have a computer-trained teacher by 2.1 percentage points up to one year after connecting to the internet and by 9.6 percentage points up to five years later. The same results have shown a positive and negative relationship between the latest technology and productivity growth in the case of OECD countries. Some scholars have supported the positive results. For example, Caselli & Coleman (2001) focused on computer adoption in a large number of OECD countries from 1970 to 1990. They found that worker aptitude (measured as educational level), openness to manufacturing trade, and the overall investment rate in the country are among the important determinants of the level of investment in computers. As the authors point out, trade openness is significant not because computers comprise a large share of manufacturing imports; computers are usually a small fraction of total manufacturing imports. At the household level within the United States, Kennickell & Kwast (1997) also find evidence for the role of education, consumer skills, and learning in their study of the consumer adoption of electronic banking. 70% of all American households used some form of electronic banking in 1995, but only a small fraction of households used the more recent and advanced forms of electronic banking such as bill paying. The most common use of electronic banking was for making direct deposits, which is a relatively well-established and old technology, one that is widely used throughout the world, indirectly confirming the existence of a learning effect. As technology develops and improves, more people become familiar with it and comfortable using it, and this accelerates the speed of adoption.

All these findings prove the important role of technology adaptation in increasing productivity from a macroeconomic perspective. In addition, FDI and technology transfer variables, like the previously selected variables, positively and negatively correlated with productivity growth in different sectors. Fujimori & Sato (2015) examined the relationship between the level of TFP and the level of FDI in each industry. Researchers found a positive relationship between FDI & and technology transfer variables and economic growth (Lensink & Morrissey, 2001); Blomström et al., 1992; Borensztein et al., 1995; Campos & Kinoshita, 2002). Property rights are mostly positively related to productivity growth (except in the SII and SBI sectors). These results match research where property rights should have a positive effect on productivity. According to Mate (2014), a 1% increase in the level of patents increases (0.28%) productivity. Furthermore, trademarks are also positively correlated with productivity growth with existing significant z-statistics. These results imply the existence of a positive relationship between IPRs and productivity among the examined OECD countries.

4.5.Results of regression – R&D intensities taxonomy of industries

Dependent variable: Productivity Growth $\Delta \ln(y)_{i,t}$

Independent	Model 1				Model 2			
	HT	MHT	MLT	LT	HT	MHT	MLT	LT
Constant	-2.3072	-6.2515	-5.1405	-1.3416	4.3347	-2.2733	1.0501	1.7469
	(-1.61)	(-5.39)***	-4.86	(-1.89)	(2.37)**	(-0.89)	(1.19)	(1.06)
GDP per person employed	-0.1101	0.5546	-0.0833	0.4307	-0.3011	0.4716	0.0201	0.4168
	(-1.16)	(11.14)***	-0.73	(3.70)	(-2.31)**	(3.64)***	(0.12)	(2.21)**
Physical capital	0.3994	0.5414	0.5018	0.1820	0.2591	0.1604	0.1158	0.0454
	(3.06)***	(5.88)***	5.13	(2.91)	(1.57)	(0.93)	(1.64)	(0.57)
Employment growth	-0.4661	-0.0118	-0.3570	-0.0059	-0.3494	0.0065	-0.4834	-0.0867
	(-5.08)***	(-0.17)	-2.15	(-0.05)	(-5.58)***	(0.02)	(-2.59)***	(-0.74)
Human capital	0.4962	0.0503	0.6514	0.2641	0.2396	0.4523	0.7213	0.3134
	(3.17)***	(0.51)	6.70	(2.45)	(0.94)	(1.65)*	(3.57)***	(2.46)**
Internet access in schools	#	#	#	#	-0.0694	0.6596	0.0240	-0.0673
	#	#	#	#	(-0.24)	(4.37)***	(0.09)	(-0.62)
Availability of the latest technologies	#	#	#	#	0.0871	0.1456	-0.2801	-0.2054
	#	#	#	#	(0.13)	(0.48)	(-0.65)	(-1.07)
FDI and technology transfer	#	#	#	#	-1.0869	-0.6367	0.4483	-0.1128
	#	#	#	#	(-1.64)	(-1.88)*	(1.15)	(-0.40)
Property rights	#	#	#	#	-0.7671	0.1812	-0.9155	-0.3717
	#	#	#	#	(-1.81)*	(0.41)	(-5.39)***	(-1.01)
Observations	132	132	133	132	132	132	133	132
Countries	15	15	15	15	15	15	15	15
Instruments	13	49	13	49	17	53	17	53
Wald test	(428.66)***	(808.19)***	(293.51)***	(937.79)***	(909.42)***	(500.70)***	(656.88)***	(688.20)***
AR(2) test	(0.8650)	(-1.2265)	(0.1655)	(-2.2757)**	(0.2229)	(-1.0593)	(0.5785)	(-1.9075)*
Sargan test	(0.0262)	(-0.9688)	(-1.1954)	(-1.539)	(0.7404)	(-0.6974)	(1.1568)	(-1.3452)

Source: Author's compilation (2022)
Note: P<0.01 ***, P<0.05 **, P<0.1 *

4.6. Evaluation and discussion of the R&D intensities taxonomy

This table includes the R&D intensities taxonomy regression results.

In this table, productivity growth has a strong significant association with and is positively related to investment (except HT). This result is similar to the Khan & Reinhart (1990) findings. They estimated the effect of investment on economic growth in 24 countries in the private and public sectors. In the results of both, they found that the coefficient of private investment is positive and significantly different from zero at the 1% level. However, in my result, as the estimated coefficient is significantly different from zero at the 5% level, investment in R&D-intensive sectors directly affects economic growth.

Employment has a strongly significant impact on productivity growth in all sectors (except MLT model 2). This result matches the scientific work of scholars such as Rahman Khan (2007), who found that the employment elasticity of GDP growth is 0.7. A literature review by Basnett & Sen (2013) identifies an extensive body of evidence that suggests that growth in manufacturing and services has happened when there is a particularly positive relationship between employment and economic growth. The impact of employment on GDP growth in agriculture is found to be limited overall, while value-added growth in agriculture has a relatively large impact on employment. The body of evidence for textiles was small, but the studies suggest that growth positively contributed to job creation. For agri-business/food processing, the authors find a positive impact of growth on employment.

In addition, human capital is positively associated with productivity growth at a significant level in most of the models. According to the neoclassical growth theories such as Mankiw G. et al. (1992), there is a highly significant impact on and positive relationship between human capital and productivity growth in all the models. Much of the motivation for human capital policies is the possibility of providing economic growth that will raise income levels in these countries, based on (Hanushek, 2013). In this case, Qadri & Waheed (2013) examined the theoretical relationship between human capital and economic growth in a cross-section of 106 countries. They found that human capital is positively related to economic growth. However, the rate of return on human capital is higher in low-income countries than the overall returns of human capital across the world. The results obtained from the full sample model and the model having low-income countries are robust when including the other growth-related variables.

Regarding internet access in schools, HT and HMT are positively correlated to productivity growth, and MLT and LT are negative. None of the models have a significant impact on productivity growth. According to Hanushek (2013), the rapid expansion of new digital learning technologies– both as blended learning with teachers and technology and as standalone approaches suggest that many of the past decisions on access and quality might rapidly lead to being more productive. Also, the Economist Intelligence Unit (EIU) -funded by Ericsson in support of UNICEF- mentioned that connecting schools to the internet can result in up to 20% GDP growth with a limited broadband connection. Higher internet penetration provides an opportunity to develop the skills of teachers in a cost-effective manner, which is particularly crucial when there is a shortage of qualified teachers. As access to education worldwide grows, there is a risk that the teaching profession could become unmanageable with growing class sizes. In this context, digital technologies can also support teachers by providing them with additional tools and, through blended learning approaches, freeing time for them to focus on teaching rather than on administration. Furthermore, internet access enables teachers to focus attention where needed by providing real-time information on student performance.

Moreover, in the case of the latest technology, it is negatively correlated to productivity (except LT). Bayarçelik & Taşel (2012) examine the relationship between researchers employed in R&D departments, R&D expenditures, patents as innovation indicators, and Gross Domestic Product (GDP) as economic growth. They used a panel regression model to investigate these relations for chemical firms listed on the Istanbul Stock Exchange (ISE) between 1998 and 2010. The results show a strong correlation between the number of R&D employees and GDP. However, there is a weak correlation between R&D investments and GDP.

Furthermore, the FDI and technology transfer variable has not had a strong significant impact on productivity growth. Borensztein et al. (1995) proved a statistically significant negative relationship between the linear term of FDI and economic growth. However, based on some of the literature, the relationship should be positive, where FDI and technology transfer enhance productivity. In this case, Zhang K. (2001) found that FDI and economic growth have a favorable association. Zhang used data from 11 countries in East Asia and Latin America to investigate the causality between FDI and economic growth. Other scholars such as Bengoa & Sanchez-Robles (2003) explore the interplay between economic freedom, foreign direct investment, and economic growth using panel data analysis for a sample of 18 Latin American countries from 1970 to 1999. They found that economic freedom in the host country is a positive determinant of FDI inflows.

Regarding property rights, the result shows a positive relationship between Property rights and productivity growth in HT and MHT, but this effect is negative in MLT and LT. In the meantime, this relationship is not significant in all the sectors. However, based on the literature, the relationship is positive most of the time. According to Novotny (2013), stronger patent rights help secure greater technology transfer in industries, leading to economic growth.

5. CONCLUSIONS

This study contributed to literature combined with a few extents. First, this research established a strong relationship between the effect of ICT as the internet in schools, availability of the latest technology, FDI and technology transfer, and institutions as the property right on productivity growth in OECD countries in the case of the sectoral approach.

The result demonstrated a positive relationship between internet access in schools and productivity growth in Skill taxonomy. This relationship in Innovation taxonomy is mostly significant and positive, and in R&D intensities, taxonomy is partially positive but not significant.

Also, the results prove that in Skill taxonomy, the relationship between the availability of the latest technology and productivity growth is partially positive and significant. This relationship in the innovation taxonomy is negative and partially significant, and the same situation exists in the R&D intensities taxonomy.

Regarding the relationship between FDI and technology transfer and economic growth, the results show that this relationship in the skill taxonomy is partially positive and not significant, and the same results are in the innovation taxonomy. It is mostly positive but not significant in the taxonomy of R&D intensities.

Finally, Property right is strongly significant and positively associated with productivity growth in the Skill taxonomy; it is almost significant and positively related to economic growth in the Innovation taxonomy, in the case of the R&D intensities taxonomy, this relationship is partially positive and not significant.

The finding of this study confirmed previous research on internet access in schools and productivity growth (Devarajan et al., 1996; Eriçok & Yılancı, 2013; Psacharopoulos & Patrinos, 2018). Also, the result related to the correlation between the availability of the latest technology and productivity growth is in harmony with Caselli & Coleman (2001). The result of this study is comparable to the results from Lensink & Morrissey(2001), Borensztein et al., 1995; Campos & Kinoshita (2002) as well as Mate (2014); Sattar & Mahmood (2011), who investigated the FDI & technology transfer, as well as the property right, is mostly positively associated with productivity growth.

5.1 Recommendation and Policy Implications

This research recommends that decision-makers and governments use the Internet in schools in OECD countries for a specific policy. The nature of the internet can be easily accessed, and the information can be easily disseminated. The use of this education technology has diversified the opportunities for individuals to learn, companies to grow, and students, in general, to facilitate their studies. It is common for schools, colleges, and universities to implement internet-based education programs designed specifically for students.

Internet-based educational programs are becoming very popular today as they deal with their advantages in facilitating student engagement and providing educational materials at a reasonable price level where they may not be traditionally offered. Therefore, internet use in educational institutions has been considered remarkably successful compared to traditional school learning methods.

Using the Internet in schools benefits the national economy and gross domestic production. Preventing the global economy from stagnating, broadening access to knowledge and information, and improving the educational opportunities for rural and remote residents are some of the reasons why there is a need to use e-learning.

After reviewing several studies conducted on internet use in schools in OECD countries, this research shows a general trend toward using information technology in educational institutions. In general, using the internet in schools has positive results on student learning.

Research findings indicated that using the Internet in schools may give positive results in furthering learning towards improved academic results, better student engagement, enhanced retention in school, and overall school performance. The findings also showed a need to promote Internet-based Education in OECD countries because it can promote social and economic growth.

Based on this research review, it can be concluded that there should be an increase in efforts to implement the Internet in schools to improve learning outcomes and enhance student engagement in school.

These strategies can include, but are not limited to, continuous and adequate training for teachers, facilities such as broadband internet access, laptop computers for students, and adequate computer equipment or ICT for schools.

In addition, This paper recommends that decision-makers invest in expanding the availability of the latest technologies in OECD countries.

The use of outdated technology increases costs while producing less efficient results, in turn discouraging economic development. Decision-makers must make the right investments to mitigate this trend, which will have implications for policy design and implementation.

Regarding these decisions, we must consider where opportunities lie within existing infrastructures and how we reconcile them with new challenges.

These challenges create gaps in infrastructure development and implementation, which leads to increased costs. To address these challenges and continue development, decision-makers need to be able to choose the most efficient technology and design policies that will encourage them to do so. For example, global communication systems can currently serve as a platform for addressing some of these challenges. The mobile cellular telephone infrastructure is a system designed for mobile communications with a low marginal cost of usage. The wired telephone system is another global communications platform that supports voice calling at a low cost for long distances.

The availability of the latest technologies has a positive effect on economic growth. Therefore, investment in technology development can increase economic growth for the governments and countries in OECD countries.

In the case of FDI and technology transfer, OECD countries have a complex relationship with FDI, which is why investing the per capita of a foreign investor in OECD countries is complicated. On the other hand, non-OECD countries offer attractive plans and facilities compared with OECD countries (such as low tax and customs tariffs when importing raw materials or re-exporting the goods). Foreign direct investment arises when national businesses invest in subsidiaries or branches in a foreign country. Foreign direct investment can take two forms: greenfield investments, which mean establishing new facilities, or mergers and acquisitions (M&A), which means acquiring an existing company. Investments can be either debt or equity-based but often involve both types of capital at the same time.

Property rights are the degree to which individuals or groups control specific things. If a person owns a particular object with national worth, they do not have the right to destroy it. The idea of property rights remains at the core of societies because everyone agrees that this arrangement is good for them in certain ways. However, some believe property rights are economically harmful because they incentivise people to take advantage of others instead of sharing something.

The early researchers have indicated the importance of property rights and limited government, but if we look at history, we find that the government has begun to take control over property rights.

In recent years, there has been a growing tendency for governments to create more powers to control people's private property. When taking a look at what kind of property governments are controlling. There is one particular item that can be moved from free people control to government control. The land is one kind of property that is being used to feed the planning process and expand the power of governance at a lower cost. This is where zoning laws come in since they are put in place by politicians who want their supporters to get richer and help them get re-elected. That is why we see that, sometimes, the effects of property rights in some countries are negative. The reason can be related to these rules. However, scholars proved that this relationship must be positive. Property rights have an outsized effect in the developing world, where they have been found to account for a sizable share of the difference between rich and poor nations. Ownership makes a fundamental difference in how people approach their work and interact with society. However, what is it that makes property rights so essential? This is the point that decision-makers and governments should consider and create their approach based on it.

5.2 Limitations and future direction of the study

- ✓ The main limitation of this study is the data related to independent variables for some of the countries and times selected. At the beginning of the research, I selected 17 independent variables, but because of this limitation, I had to decrease the number of variables.
- ✓ The literature of this study did not compare the results of OECD countries in some of the taxonomies' sectors.
- ✓ Due to the COVID-19 pandemic, and because my family and I were infected by the Coronavirus 2 times and had to be in hospital, I was not able to focus on this research for some months. Therefore, after recovery, I faced a big problem with lacing the time to do this study.
- ✓ This is also recommended for future studies to investigate the effect of the pandemic on the relationship between ICT as well as institutions on productivity growth in OECD countries.

5.3 Main conclusion and novel findings of the study

1. This research proposes a good model describing the effect of ICT as the internet in schools, availability of the latest technology, FDI & and technology transfer, and institutions as the property right on productivity growth.
2. Based on the literature, there is no comprehensive investigation of the influence of ICT institutions on economic growth in OECD in the three mentioned taxonomies of industries. This research covered this gap.

3. This study used analysis to prove the hypothesis. The findings show a positive relationship between internet access in schools and productivity growth. Also, the results prove that there is a positive correlation between the availability of the latest technology and productivity growth. Regarding the relationship between FDI and technology transfer and productivity growth, the results show it is the same as the result of the availability of the latest technology. Furthermore, property rights are strongly significant and positively associated with productivity growth.
4. After discussing the important role of the Internet in schools for children and teenagers studying in OECD countries, it can be argued that it positively correlates to economic growth worldwide. It can facilitate the tolls of education and enhance the level of the teacher’s knowledge accordingly. Hence, it has an important influence on economic growth.
5. In the case of the availability of the latest technologies, it is evident that nowadays, all industries are directly dependent on the availability of the latest technologies. The analysis of this research proved that this relationship is positive.
6. In the case of FDI and technology transfer and economic growth relationship, most of the studies claimed there is a positive correlation between these two factors; the results of this paper show that there is a positive relationship. However, there is a point in this case: although OECD countries are developed and well-structured in government policies (such as taxes and tariffs), most investors are willing to invest their money in non-OECD countries (where developing countries offer attractive facilities). So, the decision-makers in OECD countries must consider this point.
7. Based on the findings of the previous studies, property rights are positively associated with productivity growth. However, the complicated administrative process of property rights is geared toward individuals and companies. The legal aspects of property rights take a lot of time and energy from individuals and firms.
8. The highlighted results compare the sectoral approaches such as Skill taxonomy, Innovation taxonomy, and R&D intensities taxonomy in the detailed sectors as the novel of this research.

Results of the Hypotheses

No	Code	Hypothesis	Result
1	**H1**	**ICT is positively associated with productivity in the OECD countries and sectors**	**Partially Accepted**
2	H1a	Internet access in schools is positively associated with productivity in the OECD countries and sectors	Partially accepted
3	H1b	Availability of the latest technologies positively correlated with productivity in the OECD countries and sectors	Accepted
4	H1c	FDI and technology transfer positively correlated with productivity in the OECD countries and sectors	Partially Accepted
5	**H2**	**Institutions positively influence productivity in OECD countries and different sectors**	**Partially Accepted**
6	H2a	Property rights positively influence productivity in OECD countries and different sectors	Partially Accepted

Source: Author's compilation based on the results of this research, 2022

6. REFERENCES

1. Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, *58*(2), 277. https://doi.org/10.2307/2297968
2. Basnett, Y., & Sen, R. (2013). What do empirical studies say about economic growth and job creation in developing countries. ? *Overseas Development Institute, September*, 38.
3. Bayarçelik, E. B., & Taşel, F. (2012). Research and Development: Source of Economic Growth. *Procedia - Social and Behavioral Sciences*, *58*, 744–753. https://doi.org/10.1016/j.sbspro.2012.09.1052
4. Bengoa, M., & Sanchez-Robles, B. (2003). Foreign direct investment, economic freedom and growth: New evidence from Latin America. *European Journal of Political Economy*, *19*(3), 529–545. https://doi.org/10.1016/S0176-2680(03)00011-9
5. Blomström, M., Lipsey, R. E., & Zejan, M. (1992). What Explains Developing Country Growth? In *National Bureau of Economic Research Working Paper Series: Vol. No. 4132* (pp. 7–13). http://www.nber.org/papers/w4132
6. Borensztein, E., Gregorio, J., & Lee, J.-W. (1995). *How does foreign direct investment affect on productivity growth*?
7. Campos, N. F., & Kinoshita, Y. (2002). Foreign direct investment as technology transferred: Some panel evidence from the transition economies. *Manchester School*, *70*(3), 398–419. https://doi.org/10.1111/1467-9957.00309
8. Caselli, F., & Coleman, Jw. ohn. (2001). Cross-Country Technology Diffusion: The Case of Computers. *Source: The American Economic Review*, *91*(2), 328–335.
9. Devarajan, S., Swaroop, V., & Zou, H. (1996). The composition of public expenditure and economic growth Cite this paper Moneay ECONOICS The composition of public expenditure and economic growth. In *ESEIER Journal of Monetary Economics* (Vol. 37).
10. Eriçok, R. E., & Yılancı, V. (2013). *Education Expenditures and Economic Growth Relationship. Bounds Test Approach*.
11. Firebaugh, G., & Beck, F. D. (1994). *Does Economic Growth Benefit the Masses ? Growth , Dependence , and Welfare in the Third World*. *59*(5), 631–653.
12. Fujimori, A., & Sato, T. (2015). Productivity and technology diffusion in India: The spillover effects from foreign direct investment. *Journal of Policy Modeling*, *37*(4), 630–651. https://doi.org/10.1016/j.jpolmod.2015.04.002

13. Hanushek, E. A. (2013). Economic growth in developing countries: The role of human capital. *Economics of Education Review*, *37*, 204–212. https://doi.org/10.1016/j.econedurev.2013.04.005
14. Hatzichronoglou, T. (1997). *REVISION OF THE HIGH-TECHNOLOGY SECTOR AND PRODUCT CLASSIFICATION*. *97*.
15. Kapsos, S. (2005). *The employment intensity of growth: Trends and macroeconomic determinants*.
16. Karaçor, Z., Güvenek, B., Ekinci, E., & Konya, S. (2018). Panel estimation for the relationship between education expenditure and economic growth for OECD countries. *Forum Scientiae Oeconomia*, *6*(2), 7–20. https://doi.org/10.23762/FSO_VOL6NO2_18_1
17. Kennickell, A. B., & Kwast, M. L. (1997). Who Uses Electronic Banking? Results from the 1995 Survey of Consumer Finances. *Finance and Economics Discussion Series*, *1997*(35), 1–48. https://doi.org/10.17016/feds.1997.35
18. Khan, M. S., & Reinhart, C. M. (1990). Private investment and economic growth in developing countries. *World Development*, *18*(1), 19–27. https://doi.org/10.1016/0305-750X(90)90100-C
19. Khawar, M. (2005). *Foreign Direct Investment and Economic Growth : A Cross-Country Analysis Foreign Direct Investment and Economic Growth : A Cross-Country Analysis ∗*. *5*(1).
20. Kho, K., Lakdawala, L. K., & Nakasone, E. (2011). *Impact of Internet Access on Student Learning in Peruvian Schools **.
21. Lensink, R., & Morrissey, O. (2001). *Foreign direct investment Flows, volatility and growth in developing countries*.
22. Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3–42. https://doi.org/10.1016/0304-3932(88)90168-7
23. Mahony, M., & Ark, B. Van. (2003). EU Productivity and Competitiveness: An Industry Perspective. In *Can Europe resume the catching-up process*? http://www.enterprise-europe-network.sk/docs/NB5503035ENC_002.pdf
24. Mankiw, N. G., Romer, D., & Weil, D. N. (1992). *A CONTRIBUTION TO THE EMPIRICS OF ECONOMIC GROWTH*.
25. Máté, D. (2014). Can Intellectual Property Rights Impact Directly on Productivity: A Case Study in Manufacturing Industries. *SSRN Electronic Journal*, *2000*, 25–32. https://doi.org/10.2139/ssrn.2526778
26. Máté, D. (2015). Impact of human capital on productivity growth in different labour-

skilled branches. *Acta Oeconomica*, *65*(1), 51–67. https://doi.org/10.1556/AOecon.65.2015.1.3

27. Melamed, C., Hartwig, R., & Grant, U. (2011). Jobs, growth and poverty: what do we know, what don't we know, what should we know? *Growth*, *May*, 1–8. http://www.odi.org.uk/sites/odi.org.uk/files/odi-assets/publications-opinion-files/7121.pdf
28. Mody, A. (2004). *What is An Emerging Market?* (No. 04; Working Paper 177).
29. Nordhaus, W. (2005). *The Sources of the Productivity Rebound and the Manufacturing Employment Puzzle*.
30. Novotny, Á. (2013). Az egyetemi – ipari technológiatranszfer sajátosságai Magyarországon. *Közgazdasági Szemle*, 1119–1139.
31. Osano, H. M., & Koine, P. W. (2015). Role of foreign direct investment on technology transfer and economic growth in Kenya: a case of the energy sector. *Journal of Innovation and Entrepreneurship*, *5*(1). https://doi.org/10.1186/s13731-016-0059-3
32. Postelnicu, C., & Dabija, D.-C. (2015). *Transfer and Diffusion of New Technologies Within the Supply Chain of Multinational Companies with Operations in Romania—A Contemporary Approach* (S. Vaduva & A. R. Thomas (eds.)). Springer International Publishing. https://doi.org/10.1007/978-3-319-12685-2
33. Psacharopoulos, G., & Patrinos, H. A. (2018). Returns to investment in education: a decennial review of the global literature. *Education Economics*, *26*(5), 445–458. https://doi.org/10.1080/09645292.2018.1484426
34. Qadri, F. S., & Waheed, A. (2013). Human capital and economic growth: Cross-country evidence from low-, middle- and high-income countries. *Progress in Development Studies*, *13*(2), 89–104. https://doi.org/10.1177/1464993412466503
35. Rahman Khan, A. (2007). *Growth, employment and poverty: An analysis of the vital nexus based on some recent UNDP and ILO/SIDA studies*. http://www.un.org/esa/desa/papers
36. Romer, P. M. (1990). *Capital, Labor, and Productivity*. *1990*, 337–367.
37. Roodman, D. (2009). Practitioners' corner: A note on the theme of too many instruments. *Oxford Bulletin of Economics and Statistics*, *71*(1), 135–158. https://doi.org/10.1111/j.1468-0084.2008.00542.x
38. Sattar, A., & Mahmood, T. (2011). Intellectual Property Rights and Economic Growth: Evidences from High, Middle and Low Income Countries. *Pakistan Economic and Social Review*, *49*(2), 163–186. http://www.scopus.com/inward/record.url?eid=2-s2.0-

21744457871&partnerID=40&md5=bc5803eb04ae53f12d965bfdacca6d91

39. Stiroh, K. J. (2000). How did bank holding companies prosper in the 1990s? In *Journal of Banking & Finance* (Vol. 24). www.elsevier.com/locate/econbase

40. The World Bank. (2019). *World Development Indicators | DataBank*.

41. van Leeuwen, B., & Foldvari, P. (2008). Human capital and economic growth in Asia 1890-2000: A time-series analysis. *Asian Economic Journal*, *22*(3), 225–240. https://doi.org/10.1111/j.1467-8381.2008.00276.x

42. Wilson, C., & Smith, A. (2019). *GDP and Investment Decisions*.

43. Wintoki, M. B., Linck, J. S., & Netter, J. M. (2012). Endogeneity and the dynamics of internal corporate governance. *Journal of Financial Economics*, *105*(3), 581–606. https://doi.org/10.1016/j.jfineco.2012.03.005

44. Wooldridge, J. M. (2001). Applications of generalized method of moments estimation. *Journal of Economic Perspectives, 15*(4), 87–100. https://doi.org/10.1257/jep.15.4.87

45. World Economic Forum. (2019). *The Global Competitiveness Report 2017-2018 | World Economic Forum*.

46. Zhang, K. H. (2001). How does foreign direct investment effect economic growth in China? *Transition*, *9*(3), 679–693.

7. PUBLICATION

UNIVERSITY of DEBRECEN

UNIVERSITY AND NATIONAL LIBRARY
UNIVERSITY OF DEBRECEN
H-4002 Egyetem tér 1, Debrecen
Phone: +3652/410-443, email: publikaciok@lib.unideb.hu

Registry number: DEENK//2022.PL
Subject: PhD Publication List

Candidate: Vahid Zeynvand Lorestani
Doctoral School: Károly Ihrig Doctoral School of Management and Business
MTMT ID: 10069169

List of publications related to the dissertation

Articles, studies (3)

1. Máté, D., **Zeynvand Lorestani, V.**: The Impact Of Pandemic Downturn Exposure On Economic Growth.
   Cross-Cultural Management Journal. 23 (2), 191-198, 2021. ISSN: 2286-0452.
2. Faid, G., Tariq, M. M., Ishtiaq, A., **Zeynvand Lorestani, V.**, Meyer, D. F., Máté, D.: The nexus of e-government and increased productivity relative to income level comparsion.
   Business, Management and Education. 18 (1), 88-105, 2020. ISSN: 2029-7491.
   DOI: http://dx.doi.org/10.3846/bme.2020.12067
3. **Zeynvand Lorestani, V.**: Trends in the Internet of Things (IoT) and Influence on the Industries' Progress.
   International Journal of Engineering and Management Sciences = Műszaki és Menedzsment Tudományi Közlemények. 5 (1), 182-193, 2020. EISSN: 2498-700X.
   DOI: http://dx.doi.org/10.21791/IJEMS.2020.1.15

List of other publications

Articles, studies (5)

4. Yousuf, A., **Zeynvand Lorestani, V.**, Felföldi, J., Zatonatska, T., Kozlovskyi, S., Dluhopolskyi, O.: Companies performance management: the role of operational flexibility.
   Marketing and Management of Innovations. 1, 30-37, 2021. ISSN: 2218-4511.
   DOI: http://doi.org/10.21272/mmi.2021.1-03
5. Yousuf, A., **Zeynvand Lorestani, V.**, Oláh, J., Felföldi, J.: Does Uncertainty Moderate the Relationship between Strategic Flexibility and Companies' Performance? Evidence from Small and Medium Pharmaceutical Companies in Iran.
   Sustainability. 13 (16), 1-17, 2021. ISSN: 2071-1050.
   DOI: http://dx.doi.org/10.3390/su13169157
   IF: 3.251 (2020)

Address: 1 Egyetem tér, Debrecen 4032, Hungary Postal address: Pf. 39. Debrecen 4010, Hungary
Tel.: +36 52 410 443 Fax: +36 52 512 900/63847 E-mail: publikaciok@lib.unideb.hu, ¤ Web: www.lib.unideb.hu

UNIVERSITY AND NATIONAL LIBRARY
UNIVERSITY OF DEBRECEN
H-4002 Egyetem tér 1, Debrecen
Phone: +3652/410-443, email: publikaciok@lib.unideb.hu

6. Máté, D., Erdei, E., **Zeynvand Lorestani, V.**, Popp, J., Oláh, J.: Can Internet in schools and technology adaption stimulate productivity in emerging markets?
   Economics & Sociology. 13 (1), 182-196, 2020. ISSN: 2071-789X.
   DOI: http://dx.doi.org/10.14254/2071-789X.2020/13-1/12
7. Yousuf, A., Kerekes, V., Felföldi, J., **Zeynvand Lorestani, V.**: The effect of environmental instability on the decision of strategic flexibility implementation in Syrian companies.
   Economics and Working Capital. 1 (2), 28-33, 2020. ISSN: 2398-9491.
8. **Zeynvand Lorestani, V.**, Máté, D.: The Relationship Between Job Satisfaction and Employees' Loyalty: an Iranian Case Study.
   Cross-Cultural Management Journal. 21 (1), 67-72, 2019. ISSN: 2286-0452.

Conference presentations (1)

9. **Zeynvand Lorestani, V.**, Máté, D.: The new trends in IoT and its role in Entrepreneurship.
   In: Absztraktkötet : "Kihívások és tanulságok a menedzsment területén. Fókuszban a folyamatmenedzsment - az Ipar 4.0 kihívásai" = Book of abstracts : "New Trends and Challanges in Management. Special Focus on Process Management and Industry 4.0" / [szerk. Szűcs Edit], University of Debrecen Faculty of Engineering, Debrecen, 10, 2019.

Total IF of journals (all publications): 3,251
Total IF of journals (publications related to the dissertation): 0

The Candidate's publication data submitted to the iDEa Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.

17 June, 2022