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WHAT IS THE IMPACT OF COUNTRY'S VENTURE CAPITAL INVESTMENT ON ITS LABOUR PRODUCTIVITY?

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Abstract

Purpose: The aim of the research is to answer the question of what the impact of venture capital investment is on the labour productivity of countries.

Methodology: This study aims to analyse whether the effect of venture capital investment on countries' labour productivity may occur when, in addition to the traditional linear specification, a non-linear and delayed impact is considered. The proposed method is based on multiple regression models.

Findings: Despite the fact that EU countries allocate much support to develop the venture capital sector, the research results reveal that the impact of venture capital investment on labour productivity in EU-25 countries is insignificant.

Originality: Much of the literature investigates the impact of venture capital investment at the company or sectoral levels. However, researchers emphasise the need to expand the scope and analyse this impact not only at the company or sectoral level, but also at the country level. The analysis of research works on the impact of venture capital investment on economic development indicators of countries demonstrates that empirical research on the impact of venture capital investment on labour productivity of countries is underdeveloped. The study contributes to the scientific literature with one of the first attempts to investigate this topic. The empirical analysis is based on the European Union's (EU) 25 countries.

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Keywords: venture capital investment, labour productivity, innovation, European Union countries.

JEL Classification: G24, J24, O30.

Introduction

Venture capital investment, as a measure of business financing, is closely linked to innovation (Felix et al., 2022; Khan et al., 2021; Pradhan et al., 2018, 2019). Venture capital investment plays a catalyst role in integrating factor resources among invested enterprises (Ma, Zhu, 2025). According to Pradhan et al. (2017), a reliable financial system, along with rapid economic growth, eventually leads to the development of the capital sector. Venture capital investment enhances national capacities in the field of innovation, ultimately driving economic development. Venture capital investments have been shown to play a crucial role in fostering economic well-being and prosperity (Pradhan et al., 2019). Countries that stimulated the development of the venture capital sector were in the lead in developing new start-ups, becoming a channel for high technology. Global practice demonstrates that most venture capital investments are devoted to technology development and new companies operating in the technology sector. Current research focuses on the impact of venture capital investment on artificial intelligence or the digital economy (Montanaro, et al., 2024; Li, et al., 2024) and is associated with the need for these investments.

Venture capital investments are necessary for innovative companies that are excluded from traditional financing. Assurance of funding for innovative companies has a positive external impact on the economy, which makes it possible for governments to take measures that lead to an increase in venture capital investment (Lerner, et al., 2013). Innovation is often associated with high risk, and traditional banks frequently refuse to fund it; therefore, a significant role must be given to venture capital investment. A continuously increasing demand for venture capital investment inevitably has an impact on economic development indicators. This is particularly caused by presently relevant and increasingly emerging processes: high-risk but potentially high-profitability projects, which lead to a great need to borrow. This analysis enabled the recognition of the effects of venture capital investment at the country level, grounded in theoretical arguments and declaring the purposefulness of such assessment, as it was found that the impact of venture capital investment on labour productivity at the macro-level had not been assessed. This substantiates the theoretical and practical value of this study.

The connectedness between venture capital investment and labour productivity, as discussed in the present article, is based on theories of economic growth (endogenous, neoclassical, Schumpeterian, and institutional environment) and the aspects that identify this relationship. In the context of these theories, venture capital investments are linked to labour productivity in the aspects of innovations, knowledge, R&D, and technology

dynamics (Padgureckienė, 2024). Mačiulytė-Šniukienė (2015) emphasises that one of the most important indicators reflecting a country's competitiveness is labour productivity. Labour productivity is considered a key form of productivity and is ultimately assessed by the volume of production per employee. The country's higher labour productivity indicates the ability to obtain better results from the same resources. Naveed, Wang (2023) underline the significance of innovations for labour productivity. Researchers emphasise that innovations determine labour productivity depending on the dominating sectors in the country and the distribution of resources for them. To increase labour productivity, it is necessary to employ innovative solutions. Innovative companies have a significant economic impact and are crucial to the country's economy. Therefore, much attention was paid to them. Countries assume long-term obligations to promote innovation by employing various methods to achieve this goal (Samargandi, 2018). Research on the impact of an innovative environment on labour productivity shows that this area is interesting to researchers and is important. Kurt, Kurt (2015) emphasise the significance of innovation as a production factor as well as its connection with R&D results. This production factor is important for the country's economic growth, development, and productivity. Innovations and technological progress stimulate the improvement of production processes, which makes them more efficient. They also directly and significantly influence productivity. The most common factors in empirical research are innovation, financial development, financial openness, inflation, foreign trade, development of information and communication technologies, human capital and labour supply with capital (Kacou, 2022, Shahnazi, 2021, Dua, Garg, 2019, Samargandi, 2018, Coccia, 2018, Relich, 2017, Dritsaki, 2016, Kurt, Kurt, 2015, Mačiulytė-Šniukienė, 2015, Tang, 2014).

Depending on the novelty of the problem under investigation, it is quite challenging to assess how and through which channels countries can achieve the highest impact of venture capital investment on labour productivity. It was decided to extend the scope of the investigation and, in addition to the traditional linear specification, to investigate the delayed and non-linear impact. A detailed explanation is presented in the methodology section, with a focus on the hypotheses. This study is one of the first empirical investigations to assess the delayed and non-linear impact of venture capital investment on labour productivity growth in the EU-25 countries. The assessment of the effect of venture capital investment on labour productivity employed multiple regression analysis using panel data from 25 European Union countries, covering the period from 2007 to 2019. We employed the least squares dummy variables method to calculate estimates as an alternative to the fixed effects method, assessing the impact of venture capital investment volume on a country's labour productivity.

The article is structured as follows: Section 2 is a literature review. Section 3 presents the applied methodology; Section 4 discusses the results; and the final section concludes the article.

Literature review

Innovation and digital entrepreneurship are deeply interconnected, forming a synergistic relationship that fuels both technological advancement and economic development. Essentially, innovation serves as the cornerstone of digital entrepreneurship. Innovative ideas give rise to entrepreneurial initiatives, which subsequently stimulate additional innovation through competition, cooperation and ongoing enhancement (Markovic, 2025). Sklavos et al. (2024) investigate how digitalisation and innovations impact the ability of small and medium-sized enterprises to develop environmentally sustainable business models in the agricultural and food sector in Greece. They emphasise that innovations are a major factor allowing competition in the market, as well as an increase in productivity and protection of the environment. In this instance, we can highlight the role of venture capital investment, which closes the funding gaps and provides not only capital. Venture capital investors give reasonable recommendations on how to stimulate the growth of the enterprise's portfolio. They have an enviable reputation; therefore, entrepreneurs regard their suggestions and solutions.

Cincera, Santos (2015) found that investigations assessing the impact of venture capital investment can be divided into four levels (company, sector, region, and country). Empirical studies have been conducted to assess the impact of venture capital investment: at the company level (Ma, Zhu, 2025; Sergi, et al., 2022; Jansma, et al., 2018; Croce, et al., 2013; Bertoni, et al., 2011), at the industry or sector level (Edeh, Prevot, 2024; Frimpong, et al., 2022; Demou et al., 2019; Colombo, Murtinu, 2014), at the region level (Yang, 2018) and at the country level (Khan, Qu et al., 2021; Pradhan et al., 2019, 2018, 2017; Karahan, 2016; Faria, Barbosa, 2014; Popov, Roosenboom, 2013; Pottelsberghe, Romain, 2004). The aim of the present investigation is to assess the impact of venture capital investment on labour productivity at the country level. Therefore, Table 1 provides a review of investigations on the impact of venture capital investment on the economic development of countries.

Table 1. Results of investigations on the impact of venture capital on the economic development of countries

Source	Research sample	Research period, methods	Dependent variable	Results
Sergi, et al., (2022)	33 OECD countries	2019–2020, regression analysis	Innovation, economic growth, competitiveness and sustainable development	A significant impact of venture capital investment on innovation and competitiveness, although its impact on sustainable development remains limited.

Khan, Qu et al. (2021)	41 countries	2006–2016, OLS, PCA	Number of patents	A significant positive impact of venture capital investment on innovation was found
Pradhan et al. (2019)	25 European countries	1989–2016, VECM, Granger causality analysis	Economic growth, ICT infrastructure*	Venture capital investment is related to economic growth and ICT
Pradhan et al. (2018)	23 European countries	1989–2015, VECM, Granger causality analysis	Growth of innovation, financial market, and economy*	A positive correlation between venture capital investment and innovation, financial markets, and economic growth
Pradhan et al. (2017)	20 European countries	1989–2015, VECM, Granger causality analysis	Financial development and economic growth *	Venture capital investment is related to financial development and economic growth
Karahan (2016)	12 European countries	2000–2013, GMM, using panel data	Number of patents	An insignificant impact on innovation was found
Faria, Barbosa (2014)	17 European Union countries	2000–2009, OLS, GMM-SYS	Number of patents	A positive impact of venture capital investment on innovation was found
Popov, Rosenboom (2013)	21 European countries	1998–2008, OLS	Establishment of a new business	A positive impact of venture capital investment on the establishment of a new business was found
Geronikolaou, Papachristou (2008)	15 European countries	1995–2004, analysis of panel data	Number of patents*	An insignificant impact of venture capital investment on innovation was found; a significant negative impact, depending on venture capital investment during earlier periods, was found
Pottels-berghe, Romain (2004)	16 OECD countries	1990–2001, RE, analysis of panel data	Total production factor	A positive impact of venture capital investment on economic growth was found

** The method used in the study provides that a dependent variable that has been included in the model can also be a model variable at the same time.*

The analysed results of other studies reveal that scholars value not only the impact of venture capital investment on economic development. Often, the correlations between venture capital investment and innovation, financial markets, financial development, the number of patents, ICT infrastructure, and economic growth are also analysed (Pradhan et al., 2019, 2018, 2017; Geronikolaou & Papachristou, 2008). Sergi et al. (2022) conducted an econometric analysis across 33 OECD countries and found that venture capital significantly contributed to innovation, as well as global and digital competitiveness; however, its impact on sustainable development and human potential remained limited. The study's findings are more applicable to developed countries and may only be partially applicable to developing countries. The impact of venture capital investment is stronger in developed countries and weaker in developing countries. The study by Khan, Qu et al. (2021) makes a significant contribution to the literature, assessing the direct impact of venture capital investment on innovations in 41 developing and developed countries. The results of the empirical investigation show the strengthening effect of venture capital investment on innovation. It has been found that the development of innovation in the country requires increasing the volume of venture capital investment. For this reason, assessing the impact of venture capital investment on the economy should be taken into account at the political level, as this is a key way to promote innovation.

Empirical research investigates correlations between venture capital investment and different economic development indicators (Pradhan et al., 2019; Pradhan et al., 2018; Pradhan et al., 2017). According to Pradhan et al. (2019), accelerating economic growth necessitates an increase in venture capital investment. To determine the causal relationship between venture capital investment and economic growth, an econometric analysis was conducted within the context of the digital economy. The study is based on the following statements: 1) ICT-oriented companies developing ICT infrastructure or providing ICT services are often funded by venture capital; 2) rapid dissemination of ICT and the demand for services, which has taken place in the world over the last three decades, has led to the development of the venture capital market. These causes also enhance R&D activities and promote the emergence of new ICT companies.

A study by Pradhan et al. (2018) was conducted in 23 European countries between 1989 and 2015. The research approved the impact of venture capital investment, innovation, and financial development, as well as their relationship with economic growth. In the study, innovation is expressed through various indicators, including the number of patents per 1,000 residents and non-residents; researchers engaged in R&D activities per 1,000 residents; R&D costs as a percentage of GDP; high-tech exports as a percentage of GDP; and others. In the short term, a strong endogenous relationship has been found between venture capital investment and four types of innovation indicators. Pradhan et al. (2017) analysed the relationship of venture capital investment, financial development, and economic growth in 20 European countries over the period of 1989–2015. The causal link between the indicators depends on the methods of measurement of the selected factors and the period under investigation. Thus, the study's results demonstrate the varying impacts of

venture capital investment on other model variables included in the investigation. Karahan (2016) investigated the direct impact of venture capital investment on innovation in European countries. The results of the empirical research indicate that the number of patents has a significant impact on the level of venture capital investment. Thus, innovation creates a demand for venture capital investment. Most European countries do not lack funds to finance new ideas, but rather lack innovative ideas and entrepreneurship. The investigation found that the direct and delayed effects of venture capital investment on patent applications are insignificant. Referring to theoretical statements of other scholars, the delayed impact of venture capital investment may occur after five years, as venture capital investors withdraw from the company and sell their shares when the company's performance becomes successful (Pradhan et al., 2019). According to Jurevičienė and Martinkutė (2013), this effect can last from three to five years.

Faria, Barbosa (2014) carried out a study on the impact of venture capital investment on innovation in EU countries for the period 2000–2009. The results indicate that the impact of venture capital investment depends on the stage of the venture capital investment, as only later-stage venture capital investment promotes the growth of innovation. This means that venture capital investment helps to commercialise innovation rather than to promote their start-up. Popov and Rosenboom (2013) assessed the impact of venture capital investment on the initiation of a new business, taking into account its correlation with other factors. The impact of venture capital investment, influenced by other factors, on starting a new business is higher in countries with higher entry costs and stronger intellectual property rights protection, as well as lower capital gains taxes. The results of the investigation thus show that the effect of venture capital investment on starting a new business is positive in 21 European countries. It has been found that the intensity of starting new businesses is increasing in countries and industry branches with a quite large scope of venture capital investment. The study includes the volume of delayed venture capital investments. The results show that the impact is dynamic.

Geronikolaou, Papachristou (2008) investigated the relationship between venture capital investment and innovation in European countries for the period 1995–2004. To assess the impact of venture capital investment on innovation and technology development, the study is conducted in several stages. First, the direct impact of venture capital investment on innovation is investigated, and the mutual relationship between venture capital investment and innovation is analysed, including the delayed values of venture capital investment over two to three years. The empirical study is based on panel data analysis and the application of relevant methods. The correlations identified for the analysed period have revealed that the number of patents increases venture capital investment in European countries. It can be argued that innovation creates a demand for venture capital, rather than that venture capital creates an offer of innovations. Both models have found that the indicator of venture capital investment in the latter period significantly negatively determines innovation.

Pottelsberghe, Romain (2004) conducted a study assessing the impact of venture capital investment on total production factor productivity in the OECD countries over the

period 1990–2001. It can be argued that this is the only study in the area conducted at a macro-level. The results of their investigation show that venture capital investment affects the total factor productivity (TFP) level, as determined by innovations and R&D.

It was found that the relationship between venture capital investment and macroeconomic indicators (economic growth, financial development, innovation, technology development, TFP), as well as its significance to a specific area (innovation, ICT, start of a new business, knowledge, R&D), was investigated. The analysed impact of venture capital investment on economic development and innovation involves various assessments: direct, delayed, and relating to other factors. The results of the conducted empirical research show that the impact of venture capital investment on economic development indicators is uneven. To sum up, the studies conducted to investigate the impact of venture capital investment on economic development did not assess the impact of venture capital investment on the countries' labour productivity. Therefore, this study draws attention to the empirical investigations on the impact of venture capital investment on other indicators of economic development, their relationship to labour productivity, and the methods used in the studies. Economic insights from the literature review section will be beneficial in discussing the results of this study. It is challenging to compare with the results of previous studies due to the limited number of investigations at the country level. The next section of the article contains the research methodology.

Methodology

The article aims to answer the question of what impact venture capital investment has on the labour productivity of countries. It employs the originally designed theoretical development model to assess the impact of venture capital investment on labour productivity and empirically tests it in the EU-25 countries. This research extends the work by Padgureckienė, Cibulskienė (2024). The results indicate that the macroeconomic impact is statistically insignificant and suggest bidirectional dynamics: innovation and higher labour productivity in EU countries tend to attract venture capital investment, rather than venture capital investment directly driving the growth of labour productivity. This study employs methods that enable the investigation of the delayed and conditional marginal effects of venture capital investment on labour productivity growth (Padgureckienė, 2024). The first hypothesis is raised:

H1. The impact of venture capital investment on the labour productivity of EU countries is delayed.

The first hypothesis is based on both the economic approach, emphasising that the effects of venture capital investment may be delayed (Pradhan et al., 2019; Jurevičienė, Martinkutė, 2013) and the empirical studies, which include delay values of venture capital investment (Karahan, 2016; Popov, Rosenboom, 2013; Geronikalou, Peper, 2008). The article aims to assess whether the delayed impact of venture capital investment enhances the

impact on labour productivity.

H2. With the increase in venture capital investment, its marginal effect on the labour productivity of EU countries is decreasing.

The second hypothesis is based on the neoclassical economics theory, which posits that the marginal effect of capital (in this case, venture capital investment) is initially positive; however, as capital increases, its marginal effect decreases and becomes negative if the capital is not large enough. One of the methods of the neoclassical theory is the theory of marginal utility, which is used to study economic processes and patterns. It is based on the assumption that when the volume of capital increases, its marginal effect is manifested by an increasing or decreasing effect (Solow, 1956). Recent studies analysing the impact of capital on economic growth have identified the non-linear impact of the total capital formation indicator on economic growth (Mačiulytė-Šniukienė & Butkus, 2022). The results obtained in this study support the assumption drawn from this theory, which posits that the total capital formation indicator is characteristic of a declining marginal effect on economic growth. As already mentioned in the introduction section, venture capital investment is closely linked to R&D. Coccia (2018) conducted a study across 35 OECD countries between 1992 and 2014. Statistical evidence reveals a correlation between the labour productivity ratio and the intensity of R&D, as indicated by the curve's downward slope, which identifies their marginal effect. It has been shown that (very) high intensity of R&D does not increase labour productivity of the country. The results of the study reveal that the value, which is approximately 2.5 per cent of R&D in the GDP, increases labour productivity in countries. However, if crossing this threshold, labour productivity starts decreasing. As mentioned earlier, these results can be explained by a non-linear correlation between labour productivity and R&D. The researcher emphasises that every country has its specific structural indicators, such as public debt, inflation, real GDP growth, geopolitical position, employment, and other indicators measuring individuality. Therefore, a similar level of investment in R&D may have various impacts on the labour productivity of different countries. The obtained negative and significant impact can be interpreted as indicating that the impact is possible through other channels, and at a micro-level, for example, the implementation of innovations in companies can lead to labour productivity growth. The implementation of innovations and the application of innovative technologies, but not the cost of R&D, lead to increased labour productivity.

A regression equation is presented in the context of panel data, where the delayed impact of venture capital investment on labour productivity in countries is investigated.

$$\Delta \ln(LP_{i,t}) = \alpha + \beta_{1,0} \cdot \ln(VCI_{i,t}) + \beta_{1,1} \cdot \ln(VCI_{i,t-1}) + \beta_{1,2} \cdot \ln(VCI_{i,t-2}) + c_1 \cdot \ln(LP_{i,t-1}) + c_2 \cdot \Delta(FDI_{i,t}) + c_3 \cdot INF_{i,t} + c_4 \cdot \ln(OPENN_{i,t}) + c_5 \cdot \ln(EDUC_{i,t}) + c_6 \cdot \ln(KL_{i,t}) + c_7 \cdot LMR_{i,t} + \theta_t + \mu_1 + \varepsilon_{i,t}, \quad (1)$$

where i – country, t – time period, α – constant, θ_t – the represented time effects, μ_i – specific effects which do not change in relation to time for each country, $\varepsilon_{i,t}$ – bias of the regression

equation, Δ – change over one period, ln – natural logarithm, $\Delta\ln(LP_{i,t})$ – average two-year labour productivity growth over time period t in the country i, $\ln(VCI_{i,t})$ – volumes of venture capital investment over time period t in the country i, $\ln(VCI_{i,t-1})$ – delayed for one venture capital investment in the country i, $\ln(VCI_{i,t-2})$ – delayed for two years venture capital investment in the country i, $\ln(LP_{i,t-1})$ – labour productivity level for the earlier (i.e. initial) years over time period t in country i, $\Delta(FDI_{i,t})$ – a foreign direct investment flow over time period t in country i, $INF_{i,t}$ – the rate of inflation over time period t in the country i ($\Delta\ln CPI\times100$), $\ln(OPENN_{i,t})$ – the rate of openness of trade over time period t in the country i, $\ln(EDUC_{i,t})$ – the rate of higher education over time period t in the country i, $\ln(KL_{i,t})$ – the rate of provision with capital over time period t in the country i, $LMR_{i,t}$ – the rate of provision with capital over time period t in the country i.

Impact of the marginal effect of venture capital investment on labour productivity of the countries (equation 2).

$$\Delta\ln(LP_{i,t}) = \alpha + \boldsymbol{\beta}_1 \cdot \mathbf{ln\ VCI}_{i,t} + \boldsymbol{\beta}_2 \cdot [\mathbf{ln(VCI}_{i,t})]^2 + c_1 \cdot \ln(LP_{i,t-1}) + c_2 \cdot \Delta(FDI_{i,t}) + c_3 \cdot INF_{i,t} + c_4 \cdot \ln(OPENN_{i,t}) + c_5 \cdot \ln(EDUC_{i,t}) + c_6 \cdot \ln(KL_{i,t}) + c_7 \cdot LMR_{i,t} + \theta_t + \mu_1 + \varepsilon_{i,t}, \quad (2)$$

where $[\ln(VCI_{i,t})]^2$ is the logarithmic square indicator for venture capital investment.

The assessment of the impact of venture capital investment on labour productivity in EU-25 countries was performed using an open-source software package, GRETL, for the analysis of panel data. The results of the Breusch-Pagan and Hausman tests for total significance showed that the most appropriate method is the fixed effects method. The least squares dummy variables (LSDV) method, a substitute for the fixed effects method, was used in this study to analyse the data. When plotting the equation, time dummies were included to absorb the effect of time on research results (Wooldridge, 2003).

The assessments are based on the EU-25 data covering the period 2007–2019. It should be noted that the data on venture capital investment in the OECD database has been collected in the European Union since 2007. The study presents data up to 2019, as more recent data were not fully available at the beginning of the study period. The research sample does not include all member states of the EU, as the Organisation for Economic Cooperation and Development does not provide data for the period under investigation on venture capital investment in Cyprus, Croatia, and Malta. The data used for the study were obtained from the specified databases. The descriptive statistics of the variables are provided in Appendix A.

Our empirical strategy – a two-way fixed-effects (LSDV) panel model with country and year dummies, growth-rate outcomes, and economically motivated lags and nonlinearities - is well suited to the research question and data structure. First, country fixed effects control for time-invariant heterogeneity across EU economies (institutions, legal origins, geography, and long-run technological and sectoral composition) that would otherwise confound the venture-capital–productivity link, while year dummies absorb common shocks

(financial crisis, sovereign debt turmoil, and EU-wide policy shifts) that jointly affect all countries. Second, specifying the dependent variable as medium-run productivity growth and conditioning on the initial level operationalises the standard convergence framework, reducing risks of spurious correlations in macro panels and aligning the parameter of interest with incremental changes rather than levels. Third, allowing for distributed lags of VCI reflects realistic diffusion and gestation of investment-to-productivity effects, and the quadratic term captures theoretically plausible diminishing marginal returns; both features reduce functional-form misspecification. Fourth, the within estimator remains consistent under general forms of omitted time-invariant heterogeneity and is preferred to random effects when, as here, Hausman/Breusch–Pagan diagnostics indicate a correlation between unobservable and regressors. Inference is made robust to heteroskedasticity, serial correlation, and cross-sectional dependence using standard corrections. Finally, the approach is transparent and parsimonious relative to the sample size (EU-25, 2007–2019), and is complemented by robustness checks (alternative VCI measures and an alternative productivity proxy), which together strengthen the credibility and interpretability of the estimated macro-level relationship.

Logic of the regression analysis of the investigation: 1) assessment of the delayed effect of venture capital investment on labour productivity. After analysing empirical studies, it has been found that a delay of two years is sufficient to assess whether the impact of venture capital investment on labour productivity is delayed; 2) in the context of the neoclassical theory, venture capital investment is understood as a form of capital whose effect manifests by a decreasing marginal effect. The non-linear effect means that as the X factor volume increases, the marginal effect either increases or decreases, and is graphically illustrated by an inverted U-shaped curve (Coccia, 2018). To assess the non-linear impact of venture capital investment on labour productivity, the regression equation includes a logarithmic square indicator. Section four examines the impact of venture capital investment on labour productivity in twenty-five European Union countries.

Results

4.1. Assessment of venture capital investment and delayed impact on labour productivity of EU countries

The analysis of the results starts with the dynamic analysis of venture capital investment in EU-25 countries for the period 2007–2019. Figure 1 illustrates the average venture capital investment in EU-25 countries as a percentage of their GDP.

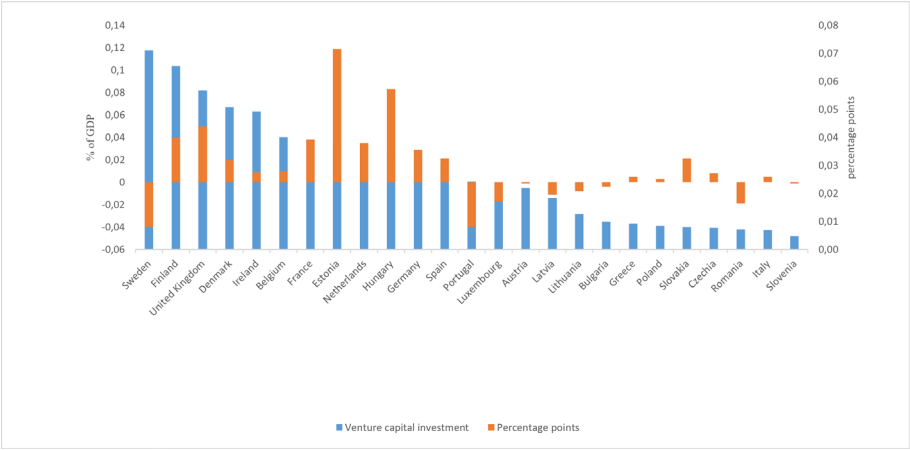

Figure 1. Average venture capital investment in EU-25 countries in 2007–2019, percentage of GDP, and its dynamics

As Figure 1 demonstrates, over the period under analysis, the largest average venture capital investment was recorded in Sweden, reaching 0.07% of the country's GDP. Whereas the smallest was in Slovenia, reaching only 0.004%. Comparing the data from 2019 and 2007, a significant growth in venture capital investment is found in Estonia (0.11 percentage points); the biggest negative dynamics are observed in Portugal and Sweden (-0.04 percentage points). Appendix B presents statistical data on venture capital investment per 1,000 residents and venture capital investment as a percentage of gross fixed capital (GFC). Essentially, the same trends in venture capital investment, calculated in both ways, are observed in the EU-25 countries. During the period under investigation, the largest portion of venture capital investment per 1,000 residents was allocated in Sweden, Finland, and Ireland, while the smallest portion was allocated in Slovenia, Bulgaria, and Romania, on average. The calculated percentage of a venture capital investment from GFC was the largest in the United Kingdom, at 0.32%; the least was in Slovakia, at 0.02%. An analysis of scientific literature and statistical data on venture capital investment leads to the conclusion that this investment is closely connected to a country's economic development; i.e., the volume of venture capital investment in economically stronger states is usually larger.

Table 2 presents the results of the delayed impact of venture capital investment on labour productivity growth in the countries. The estimation is based on equation 1.

Table 2. Delayed impact of venture capital investment on labour productivity in EU-25 countries

Dependent variable: average growth rate for two years of labour productivity		
Constant	1.491***	1.522***
	(0.3444)	(0.5301)
Venture capital investment	-0.0008	-1.576e-07
	(0.0013)	(0.0015)
Venture capital investment (ln VCI-1)	0.0011	0.0007
	(0.001)	(0.0014)
Venture capital investment (ln VCI-2)		0.0007
		(0.0009)
Level of labour productivity (ln LP-1)	-0.1430***	-0.1363**
	(0.0315)	(0.0528)
Foreign direct investment (d FDI)	-4.897e-05	-5.491e-05
	(5.815e-05)	(6.370e-05)
Inflation (INFL)	-0.0003	0.0017
	(0.0009)	(0.0017)
Openness of trade (ln OPENN)	0.0156	0.007
	(0.0201)	(0.0296)
Higher education (ln EDUC)	0.0012	0.0024
	(0.019)	(0.0266)
Supply of labour with capital (ln KL)	0.0103	0.0043
	(0.0105)	(0.0165)
Labour market regulation (LMR)	-0.0058*	-0.0077**
	(0.0032)	(0.0036)
n	324	325
Corrected R^2	0.6765	0.659
Data diagnostics:		
White test	p<0.05	
Wooldridge test	p<0.05	
Pesaran test	p>0.05	

** p<0.10, **p<0.05, ***p<0.01.*

The delayed (t_0, t_{-1}, t_{-2}) impact of venture capital investment on labour productivity, investigated in three modifications, is statistically insignificant. Karahan (2016), Popov and Rosenboom (2013), and Geronikalou and Peper (2008), who conducted investigations, have included the values of delayed venture capital investment at the country level. The conclusions drawn by Karahan (2016) and Geronikalou and Peper (2008) coincide with the findings of the carried-out study, where, after investigating the delayed impact of venture capital investment on innovations, it was found that a delay of two or three periods is insignificant. After modelling different situations with a delayed impact of venture capital investment and comparing the results with those of the previous models, it has been found that the impact of other variables on labour productivity growth remains unchanged. Thus, as the level of labour productivity increases by 1%, the growth of labour productivity will decrease in different periods of venture capital investment, respectively, by 0.14% and 0.13%. This model identifies the negative impact of the labour market regulation on the growth of labour productivity, where venture capital investments are delayed for 2 years. The results of the marginal effect of venture capital investment on the growth of labour productivity of the countries are presented in Table 3.

Table 3. Marginal effect of venture capital investment on labour productivity in EU-25 countries.

Dependent variable: average growth rate for two years of labour productivity	
Constant	1.542***
	(0.3694)
Venture capital investment	-0.0044
	(0.0058)
Venture capital investment (sq. VCI)	-0.0003026
	(0.0004)
Labour productivity level (ln LP-1)	-0.1441***
	(0.0333)
Foreign direct investment (d FDI)	-4.948e-05
	(5.556e-05)
Inflation (INFL)	-0.0003
	(0.0009)
Openness of trade (ln OPENN)	0.0132
	(0.0186)
Higher education (ln EDUC)	-0.0023
	(0.0177)

Supply of labour with capital (ln KL)	0.0075
	(0.0114)
Labour market regulation (LMR)	-0.0062*
	(0.0033)
n	325
Corrected R^2	0.6842
Data diagnostics:	
White test	p<0.05
Wooldridge test	p<0.05
Pesaran test	p>0.05

** p<0.10, **p<0.05, ***p<0.01.*

Based on the neoclassical theory of economic growth, the non-linear effect has been investigated, when venture capital investment is characterised by a decreasing marginal effect of performance, i.e., initially, the marginal effect is positive, but, as the venture capital investment increases, it decreases and becomes negative if the volume of venture capital investment is not high. As can be seen from the data in Table 3, the non-linear effect of venture capital investment on labour productivity growth in EU-25 countries is statistically significant. The results indicate that a 1 per cent increase in labour productivity level decreases labour productivity growth by about 0.14 per cent, with a negative effect at the 99 per cent significance level. The effect of other variables involved in the study is insignificant.

The results show that venture capital investment does not significantly affect labour productivity. To sum up, usually, venture capital investment is oriented towards a very narrow segment of companies – new, high-risk, innovative enterprises. At the national level, the impact of those enterprises on labour productivity may be too low. Even if the effect on labour productivity is not significant, venture capital investments may be important in other aspects, such as enhancing the innovation ecosystem and creating new workplaces in high-value-added sectors. Therefore, policy-makers should promote the development of venture capital investment.

4.2. Robustness check for the study results

This sub-section deals with the robustness check of the research results. To check the model's robustness, modifications of the model are carried out: first, by changing a variable of venture capital investment. Adding to venture capital investment expressed by percentage from GDP, statistical data is collected for the following: 1) venture capital investment per 1,000 residents, 2) venture capital investment by percentage from GFC. The obtained results are presented in Tables 3 and 4.

Table 3. Delayed impact of venture capital investment on labour productivity in EU-25 countries

Dependent variable: average growth rate for two years of labour productivity				
Constant	Venture capital investment, per 1,000 residents		Venture capital investment, percentage from GFC	
	1.488***	1.521***	1.491***	1.519***
	(0.3455)	(0.5293)	(0.3436)	(0.5321)
Venture capital investment	-0.0006900	0.0001128	-0.0007933	-1.209e-05
	(0.001254)	(0.001444)	(0.001294)	(0.001431)
Venture capital investment (ln VCI-1)	0.001082	0.0007111	0.001082	0.0005204
	(0.001048)	(0.001357)	(0.001040)	(0.001351)
Venture capital investment (ln VCI-2)		0.0006405		0.0008946
		(0.0008942)		(0.0008564)
Level of labour productivity (ln LP-1)	-0.1432***	-0.1380**	-0.1430***	-0.1364**
	(0.03162)	(0.05320)	(0.03171)	(0.05403)
Foreign direct investment (d FDI)	-4.827e-05	-5.346e-05	-4.871e-05	-5.588e-05
	(5.775e-05)	(6.288e-05)	(5.822e-05)	(6.444e-05)
Inflation (INFL)	-0.0003104	0.001777	-0.0003219	0.001698
	(0.0009694)	(0.001760)	(0.0009608)	(0.001699)
Openness of trade (ln OPENN)	0.01583	0.007622	0.01504	0.005782
	(0.02023)	(0.02983)	(0.02010)	(0.02951)
Higher education (ln EDUC)	0.001315	0.002560	0.001343	0.002523
	(0.01904)	(0.02680)	(0.01901)	(0.02649)
Supply of labour with capital (ln KL)	0.01029	0.004226	0.01043	0.005066
	(0.01029)	(0.01599)	(0.01140)	(0.01827)
Labour market regulation (LMR)	-0.005876*	-0.007748**	-0.005887*	-0.007718**
	(0.003287)	(0.003710)	(0.003268)	(0.003627)
n	324	325	324	325
Corrected R^2	0.6765	0.6589	0.6765	0.6592
Data diagnostics:				
White test	p<0.05			
Wooldridge test	p<0.05			
Pesaran test	p>0.05			

** p<0.10, **p<0.05, ***p<0.01.*

Table 4 shows the marginal effect of venture capital investment on labour productivity in the EU-25 countries.

Table 4. Marginal effect of venture capital investment on labour productivity in EU-25 countries.

Dependent variable: average growth rate for two years of labour productivity		
	Venture capital investment, per 1,000 residents	Venture capital investment, percentage from GFC
Constant	1.541***	1.539***
	(0.3518)	(0.3649)
Venture capital investment	-0.0003	-0.0043
	(0.0054)	(0.0042)
Venture capital investment (sq. VCI)	-4.119e-05	-0.0004108
	(0.0004)	(0.0004)
Labour productivity level (ln LP-1)	-0.1427***	-0.1413***
	(0.0319)	(0.0325)
Foreign direct investment (d FDI)	-4.687e-05	-5.045e-05
	(5.336e-05)	(5.651e-05)
Inflation (INFL)	-0.0003	-0.0003
	(0.0009)	(0.0009)
Openness of trade (ln OPENN)	0.0120	0.0135
	(0.0189)	(0.0188)
Higher education (ln EDUC)	-0.0007	-0.0029
	(0.0188)	(0.0175)
Supply of labour with capital (ln KL)	0.0079	0.0051
	(0.0111)	(0.0123)
Labour market regulation (LMR)	-0.0061*	-0.0061*
	(0.0033)	(0.0033)
n	325	325
Corrected R^2	0.6830	0.6850
Data diagnostics:		
White test	p<0.05	
Wooldridge test	p<0.05	
Pesaran test	p>0.05	

** p<0.10, **p<0.05, ***p<0.01.*

Thus, based on the data and results from Tables 3 and 4, it can be stated that the results of the impact of venture capital investment, expressed by three indicators, on labour productivity are identical. This proves the reliability of the designed model. It can be stated that the modifications to the model did not affect the results, as these modifications yielded identical outcomes in the assessment of the impact of venture capital investment on labour productivity growth.

Additionally, verification is conducted for cases where an alternative measurement method is employed for a dependent variable in the research. It is investigated whether the previously identified statistically insignificant impact of venture capital investment on labour productivity persists when labour productivity is assessed using an alternative method. The statistically insignificant impact of venture capital investment on labour productivity growth may be associated with a more accurate measurement of labour productivity growth. The AMECO database (2023) calculates the total factor productivity labour share (TFP labour share). It is associated with innovation, efficiency and technological progress. This indicator is suitable for assessing the impact of venture capital investment. The check includes modifying a dependent variable to the average growth rate of TFP labour part over two years. The calculations are available in Appendix C, Tables C1 and C2. The obtained results do not contradict those obtained by measuring labour productivity by the gross domestic product per employed person. This confirms the validity of the obtained results, as the use of alternative measurement methods does not alter the economic conclusions drawn during the study.

Discussion and conclusions

Studies examining the impact of venture capital investment on labour productivity have, to date, mostly focused on company (Chemmanur et al., 2011; Marti et al., 2006) or sectoral (Demmou et al., 2019; Crose et al., 2013) levels. The contribution of the present study is that it verifies the possibility of the impact of venture capital investment at the country level. This extends and bridges the research gaps in this field, while also substantiating the practical significance of the study. Based on the theories of economic growth that explain labour productivity and the aspects that identify their relationship, the study presents key aspects of the connection between venture capital investment and labour productivity. It also draws the hypotheses and indicators for the selected empirical model. Moreover, the methodology for assessing the impact of venture capital investment in the EU-25 countries has been designed. The impact of the delayed and marginal effect of venture capital investment on labour productivity in countries has been investigated. The performed investigation has rejected the raised hypotheses, as venture capital investment does not impact labour productivity of the EU-25 countries.

The research has several limitations. In the context of the problem under investigation, the study's results cannot be directly compared to those of earlier studies on labour

productivity indicators, particularly due to the lack of research at the country level. At the macro-level, only one investigation was conducted to assess the impact of venture capital investment on the overall productivity of production factors in OECD countries for the period 1990–2001 (Pottelsberghe, Romain, 2004). Therefore, when analysing the study's results, the possible assumptions and factors that led to this are purposefully presented. It is understandable that the lack of detailed research at the country level weakens its practical applicability. For the period under investigation, aspects of business cycles and economic shocks (post-COVID period), which may influence inconsistencies of venture capital investment in the long run, are not assessed. Other aspects of limitations are the research dataset ending in 2019.

Future research development directions may include grouping countries, for example, taking into account their institutional environment, the level of development of the financial system, or the scope of funding in EU countries, as well as support for the venture capital sector. Classification of EU countries into groups would enable the identification of conditions that lead to venture capital investment, making the biggest impact on labour productivity. The analysis of the development of countries' financial systems would reveal if the impact of venture capital investment differs depending on the orientation of the country's financial system, either towards banks or private capital. The analysis of venture capital investment in specific sectors would help assess whether this investment contributes to labour productivity growth in particular sectors, thereby creating high added value.

The significance of practical results lies in the formation of EU support policy and promoting venture capital investments in the innovation capacity sectors of the economy. Additionally, the results are crucial for informing recommendations to governing and other institutions that make innovation-related policies. Ma, Zhu (2025) assert that policymakers can leverage venture capital investment as a strategic instrument to enhance enterprise innovation and provide industrial guidance, thereby promoting the efficient allocation of social resources, boosting total factor productivity, and developing sustained and healthy socio-economic growth. EU public initiatives in the venture capital sector aim to support the overall development of SMEs, particularly in less developed countries, and to bridge the financing gap for new and innovative enterprises (Matisone, Lace 2019).

In the conclusion, it is necessary to elaborate in more detail on the policy implications related to structuring VC-friendly environments, legal frameworks and innovation ecosystems in order to foster entrepreneurship and resilience. The discussion focuses on policy implications, on how VC-friendly environments, appropriate legal frameworks and well-developed innovation ecosystems can foster entrepreneurship and strengthen economic resilience. First and foremost, it is necessary to create favourable conditions for the development of venture capital by introducing tax incentives for investors, to encourage public–private cooperation. At the same time, it is essential to enhance the legal system by simplifying business formation, bankruptcy, and restructuring procedures, strengthening intellectual property protection, and establishing a stable and transparent regulatory environment that fosters investor confidence. Equally important is the strengthening of

innovation ecosystems, which involves fostering collaboration among academia, business, and the public sector, as well as investing in research, technological development, and innovation infrastructure, such as clusters or technology parks. Altogether, these measures create the foundation for sustainable business growth, innovation to promote entrepreneurship and resilience, thereby promoting labour productivity and economic growth.

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Appendix A

Table A1. Descriptive statistics

Marking	Data base	Min	Max	Mean	Median	Standard deviation
LP	World Bank, OECD	-0.0553	0.124	0.00870	0.00760	0.0196
VCI_GDP	OECD	0.0000	0.129	0.0288	0.0249	0.0252
VCI_1000	World Bank, OECD	0.000	1.01e+005	12399	6973.8	14652
VCI_GFC	World Bank, OECD	0.000	0.569	0.124	0.0993	0.112
FDI	UNCSTAD	9.09	376	66.6	47.0	64.4
INFL	World Bank	-4.48	15.4	1.97	1.73	2.11
OPENN		45.4	408	120	104	64.4
EDUC	Eurostat	12.0	47.3	29.7	30.2	8.58
KL	World Bank, OECD	2762.8	83713	14991	1316	10254
LMR	Fraser institute	3.89	8.40	6.62	6.77	0.991
L_TFP_LS	AMECO database	-0.0665	0.1242	0.0093	0.0109	0.0195

Appendix B.

Average venture capital investment, per 1,000 residents, and percentage from GFC

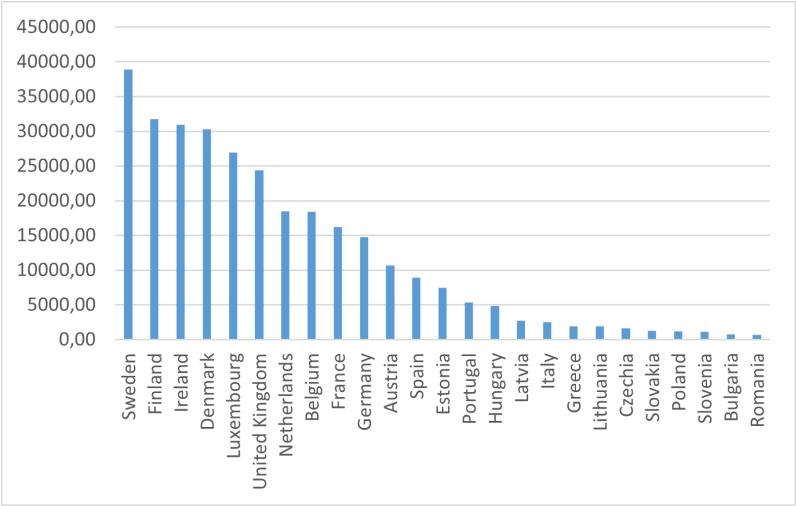

Figure B1. Venture capital investment (per 1,000 residents) in EU-25 countries in 2007–2019, by USD

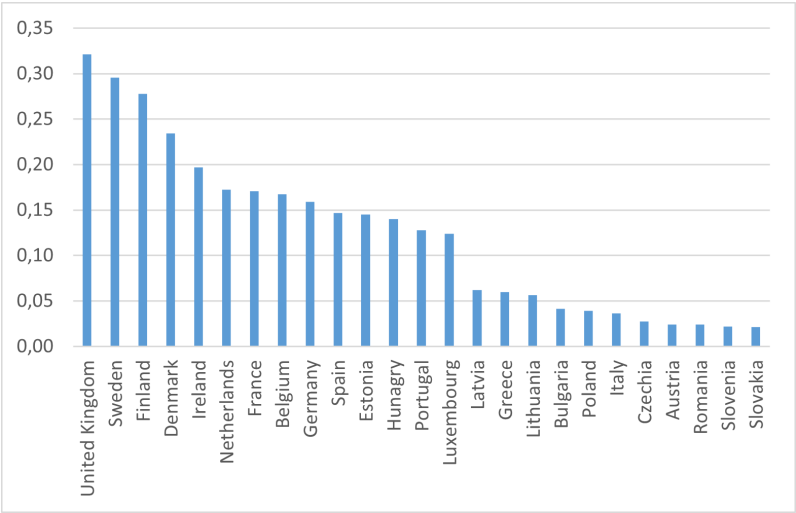

Figure B2. Venture capital investment (percentage from GFC) in EU-25 countries in 2007–2019

Appendix C

Table C1. Robustness check of the study results, assessment of the delayed impact of venture capital investment on labour productivity in EU-25 countries by substituting the dependent variable of the study with the growth of TFP labour part

Dependent variable: average growth rate of TFP labour part for two years		
Constant	0.7122***	0.7666***
	(0.09652)	(0.1244)
Venture capital investment	-0.0006354	-0.0001345
	(0.0009339)	(0.001433)
Venture capital investment (ln VCI-1)	0.002037*	0.0005607
	(0.001012)	(0.0008410)
Venture capital investment (ln VCI-2)		0.001458
		(0.001044)
Level of labour productivity (L_TFP_LS)	-0.1796***	-0.1905***
	(0.04421)	(0.05135)
Foreign direct investment (d FDI)	-5.312e-05	-6.491e-05
	(5.763e-05)	(5.016e-05)
Inflation (INFL)	0.001303	0.001867
	(0.001028)	(0.002002)
Openness of trade (ln OPENN)	0.01500	0.01653
	(0.02775)	(0.02192)
Higher education (ln EDUC)	0.003110	0.004875
	(0.01555)	(0.01498)
Supply of labour with capital (ln KL)	0.007382	0.007760
	(0.01131)	(0.01320)
Labour market regulation (LMG)	-0.001845	-0.004561
	(0.003240)	(0.003266)
n	324	325
Corrected R^2	0.6500	0.6448

Table C2. Robustness check of the study results, assessment of the marginal effect impact of venture capital investment on labour productivity in EU-25 countries by substituting the dependent variable of the study with the growth of TFP labour part

Dependent variable: average growth rate of TFP labour part for two years	
Constant	0.7352***
	(0.1020)
Venture capital investment	0.001597
	(0.005782)
Venture capital investment (sq. VCI)	9.287e-05
	(0.0004867)
Level of labour productivity (L_TFP_LS)	-0.1808***
	(0.04167)
Foreign direct investment (d FDI)	-4.459e-05
	(5.546e-05)
Inflation (INFL)	0.001457
	(0.0009600)
Openness of trade (ln OPENN)	0.01164
	(0.02623)
Higher education (ln EDUC)	0.003461
	(0.01651)
Supply of labour with capital (ln KL)	0.007167
	(0.01105)
Labour market regulation (LMR)	-0.002119
	(0.003256)
n	325
Corrected R^2	0.6366