ISSN 2392-1641
e-ISSN 2450-0097

Economics and Business Review

Volume 11 (2) 2025

CONTENTS

Poznań University of Economics and Business Press

Paper based publication

https://doi.org/10.18559/ebr.2025.2

ISSN 2392-1641
e-ISSN 2450-0097

POZNAŃ UNIVERSITY OF ECONOMICS AND BUSINESS PRESS
ul. Powstańców Wielkopolskich 16, 61-895 Poznań, Poland
phone +48 61 854 31 54, +48 61 854 31 55
https://wydawnictwo.ue.poznan.pl, e-mail: wydawnictwo@ue.poznan.pl
postal address: al. Niepodległości 10, 61-875 Poznań, Poland

Printed and bound in Poland by:
Poznań University of Economics and Business Print Shop

Circulation: 80 copies

sciendo

Economics and Business Review

Volume 11 (2) 2025

CONTENTS

sciendo

Economics and Business Review
https://www.ebr.edu.pl

Vol. 11 (2), 2025: 91–117
https://doi.org/10.18559/ebr.2025.2.1917

Economic growth in the European Union: Exploring the role of innovation and gender

Vicente J. Coronel[1]   Carmen Díaz-Roldán[2]

Abstract

This paper aims to investigate the linkages between human capital and employment in high-tech sectors and their impacts on economic growth, considering the overall level of innovation in both the public and private sectors and exploring the role of gender. The analysis employs dynamic ordinary least squares (DOLS) to estimate a model for the EU-27 across the period 2008–2021. The results indicate that employment in high-tech sectors is the variable that most contributes to economic growth in those countries that are leaders in innovation. However, in these countries, a positive and significant effect of the gender gap in employment is observed.

Keywords

- human capital
- innovation
- economic growth

JEL codes: J24, O32, O47

Article received 4 December 2024, accepted 26 May 2025.

Suggested citation: Coronel, V. J., & Díaz-Roldán, C. (2025). Economic growth in the European Union: Exploring the role of innovation and gender. *Economics and Business Review*, *11*(2), 91–117. https://doi.org/10.18559/ebr.2025.2.1917

[1] Universidad de Castilla-La Mancha, Departamento de Análisis Económico y Finanzas, Facultad de Derecho y Ciencias Sociales, 13071 Ciudad Real, Spain, VicenteJose.Coronel@uclm.es, https://orcid.org/0000-0002-3286-8635.

[2] Universidad de Castilla-La Mancha, Departamento de Análisis Económico y Finanzas, Facultad de Derecho y Ciencias Sociales, 13071 Ciudad Real, Spain, corresponding autor: carmen.diazroldan@uclm.es, https://orcid.org/0000-0002-1932-6487.

Introduction

The relationship between innovation and socio-economic factors has become a key area of academic study, driven by the understanding that innovation is not only a result of technological progress but is also deeply intertwined with the socio-economic context in which it occurs. The rapid pace of technological change further highlights the need for detailed studies that explore these dynamic relationships.

The literature on economic growth underscores the importance of innovation processes in driving productivity (Bongers et al., 2022). Griliches (1992) and Jones (1995) argue that growth is generated endogenously through R&D spillovers, with productivity depending on the discovery of novel designs by agents capable of using new technologies. Additionally, human capital externalities have been a key area of interest (Acemoglu & Angrist, 2000; Iranzo & Peri, 2009; Moretti, 2004).

Recently, there has been a body of research examining the role of firms' innovative strategies in enhancing workers' technological capabilities (AlQershi et al., 2021; Capozza & Divella, 2019; Chabbouh & Boujelbene, 2020; Kahn & Candi, 2021; Yue, 2024). However, there is still a lack of empirical studies that jointly examine how innovation-related factors, such as R&D expenditure and employment in high-technology sectors, interact with gender-related dynamics and human capital characteristics in shaping economic performance.

To fill these gaps, this paper aims to investigate the linkages between human capital and employment in high-tech sectors and their impacts on economic growth, considering both the overall level of innovation—including public and private sector efforts—and the role of gender. The key novelty of this paper is twofold: first, we consider the degree of innovation performed by companies and, second, we incorporate a gender perspective.

To analyse the impact of gender, the study incorporates the gender gap in employment as a variable, estimating the model for both total employment and employment by gender. Regarding innovation, the impact is assessed by estimating the model for three groups of countries based on their innovation performance: "highly innovative," "intermediate innovative," and "scarcely innovative," as classified by the European Innovation Scoreboard (European Commission, 2023a). This classification allows for a more nuanced understanding of how innovation impacts human capital and employment across different levels of innovation dissemination, while also contextualising the role of gender in these dynamics.

The empirical analysis uses dynamic ordinary least squares (DOLS), which addresses endogeneity issues, eliminates serial correlation and minimises biases associated with small sample sizes, to estimate cointegrated panel data for the 27 European Union member states (EU-27). The period covered spans 2008–2021 and Eurostat is the data source. GDP growth is the dependent variable used to capture the economic performance of the countries, and the independent variables are grouped into two categories: those related to R&D expenditure and those associated with education and the labour market.

The results indicate that employment in high-tech sectors is the most significant contributor to economic growth in highly innovative countries. In this group, a positive and significant effect of the gender gap in employment on economic growth is observed which may reflect the current male-dominated composition of high-tech sectors rather than differences in productivity. Additionally, in all countries except for the low-innovation group, women with higher levels of education contribute more than their male counterparts with the same degree, although women's contributions in high-tech sectors remain lower overall.

The paper is organised as follows: Section 1 reviews the relevant literature, Section 2 presents the data and research method, Section 3 discusses the results, and the last Section offers concluding remarks.

1. Literature review

1.1. Human capital and innovation

The connection between human capital and innovation has been widely acknowledged as a fundamental driver of long-term economic growth. Pioneering works by Uzawa (1965) and Lucas (1988) highlighted human capital as a critical factor in endogenous growth models. This idea was further supported by Jones (2002, 2005) and Álvarez et al. (2008), suggesting that innovation is not merely about access to education, but also concerns the ability of a skilled workforce to contribute to technological progress.

In addition, a substantial body of literature has examined the population's level of education and its externalities. For instance, Acemoglu and Angrist (2000) attempted to quantify the external effects of human capital, while Moretti (2004) explored the link between educational externalities and firm productivity. More recently, Capozza and Divella (2019) analysed the relationship between human capital and firm-level innovation, highlighting the efforts made by companies to pursue a path of innovative development.

Chabbouh and Boujelbene (2020) consider both the resource-based approach and the open innovation approach to study the effects of human resources on open innovation and on firm performance. They suggest that human capital has positive effects on innovation and performance via the indirect channel of openness. Kahn and Candi (2021) analyse the effects of firm size on innovation strategy and performance, finding that managerial and research characteristics are relevant. Furthermore, AlQershi et al. (2021) study the relationship between human capital and firm size, finding that the former plays an important role as a moderating variable in the relationship between strategic innovation and firm performance.

From a different perspective, Bongers et al. (2022) investigate the international migration of highly skilled labour, developing a dynamic stochastic general equilibrium (DSGE) model in which aggregate productivity is a function of innovations produced exclusively by STEM workers (i.e. science, technology, engineering and mathematics graduates). The results predict the existence of a wage premium for STEM workers, increasing with positive technological shocks. More recently, Yue (2024) uses the Chinese university enrolment expansion policy, to analyse the effect of human capital development on firm innovation. Yue's results prove that an increase in human capital improves firm innovation, thus providing new arguments related to the microeconomic effects of human capital on innovation.

In summary, the interaction between business innovations, human capital, and economic policies creates socio-economic conditions that enhance productivity and economic growth. However, in most studies, the role of women has rarely been captured by existing innovation data and indicators. Nevertheless, the consensus is that measuring and including the gender dimension will help change attitudes and outcomes in innovation (European Commission, 2020). Based on this foundation, our focus will now shift to analyse how gender dynamics within corporate environments shape innovation processes and outcomes.

1.2. Innovation from a gender perspective

Although the field of innovation has been widely studied, the role of gender within it has received comparatively little attention. This is partly because much of the existing research tends to concentrate on the outcomes of innovation—such as new products, processes, or organisational changes—rather than on the characteristics and contributions of the individuals involved in generating these innovations. Moreover, the commonly used indicators of innovation are often not disaggregated by gender, which makes it difficult to analyse potential differences. In recent years, however, a growing number of studies have begun to explore innovation from a gender perspective, offering new insights into how gender dynamics may shape innovative activity.

According to Alsos et al. (2013), the dominant approach views gender as a variable and innovation as an outcome. This approach is evident in studies examining innovation in businesses owned by men and women, as well as in the literature exploring gender differences in patenting and commercialisation. Beyond these context, Cropley and Cropley (2017) examine gender diversity's impact on an Australian manufacturing firm. They find a negative relationship between the proportion of females in functional areas and innovation potential attributable to an unfavourable organisational climate. Their study highlights how simply increasing the number of female employees does not necessarily enhance innovation, unless the organisational climate supports such diversity. This suggests that organisational culture and climate play crucial roles in harnessing the benefits of gender diversity. Ritter-Hayashi et al. (2019) find that gender diversity among firms' human resources enhances innovation in developing countries. Similarly, Xie et al. (2020) analyse how gender diversity within R&D teams influences firms' innovation efficiency by offering informational and social benefits. Furthermore, Griffin et al. (2021) find that boards are more likely to include women in countries with narrower gender gaps and higher female labour market participation, given that gender-diverse boards have more patents and higher innovative efficiency.

From a different perspective, the gender gap in STEM fields has significant implications for innovation and technological development. This gap (the difference between the number of men and women graduating in STEM fields) is evident across various levels, from education to professional careers, and is influenced by a range of institutional, organisational, and individual factors. Delaney and Devereux (2019) discuss the gender gap in STEM university programmes, which is primarily attributable to subject choices and, to a lesser extent, grades. Equity-focused educational interventions for girls and women in STEM aim to bridge this gap, facilitating women's access to higher education and careers in technologically innovative fields. Women are significantly underrepresented in STEM entrepreneurship due to systemic gender biases and structural disadvantages (Botella et al., 2019; Kuschel et al., 2020), thus demonstrating the need to achieve gender equity and promote education and career advancement for women of all backgrounds (Perez-Felkner et al., 2020).

This growing body of research underscores the nuanced relationship between gender diversity and innovation. Beyond the mere presence of women in leadership or R&D, the broader organisational and social context plays a key role in facilitating their contributions. A supportive environment and equitable opportunities are essential to fully realising the innovative potential of gender diversity. Examining gender dynamics within European firms offers valuable insights into how diversity influences innovation and economic growth. Differences in access to resources, decision-making roles, and organisational climate can significantly shape innovation outcomes across both the public and private sectors.

1.3. Innovation and economic growth

Innovation plays a crucial role in economic growth, as emphasised by numerous studies. Empirical evidence demonstrates that innovation significantly contributes to economic expansion. This impact manifests itself through various measures such as R&D spending, patenting, and innovation counts, alongside technological spillovers between firms, industries, and countries. However, these spillovers tend to be localised, limiting the benefits for foreign economies and slowing the technological "catch-up" process (Cameron, 1996).

However, according to Verspagen (2009), the relationship between innovation and economic growth is complex and varies across theoretical frameworks. While neoclassical endogenous growth models depict growth as a steady-state phenomenon driven by innovation, evolutionary approaches emphasise historical contingencies, intricate causal mechanisms, and turbulent growth patterns.

Many governments have invested in R&D to boost innovation and economic growth in peripheral regions, though the effectiveness of these policies depends on region-specific socio-economic factors (Bilbao-Osorio & Rodriguez-Pose, 2004). Similarly, Ulku (2004) identifies a positive relationship between per capita GDP and innovation, particularly in OECD countries with large markets. However, the study suggests that innovation alone may not guarantee sustained economic growth due to the absence of constant returns to innovation. Pece et al. (2015) highlight that R&D expenditures and technological investments are key drivers of economic competitiveness and sustainability. Maradana (2017) also finds strong evidence of a long-term relationship between innovation and per capita economic growth in 19 European countries.

Beyond traditional measures of innovation, entrepreneurship plays a pivotal role in economic growth. Wong et al. (2005) argue that high-growth potential entrepreneurship—rather than entrepreneurship in general—has a substantial impact on economic performance, as job creation is primarily driven by fast-growing new firms. From the perspective of firm performance and product innovation, remote work and online activity appeared in the literature as indicators of the digital capability of people, even before the obligation to work remotely resulting from COVID-19 confinement, as can be seen in Zhou and Wu (2010), and Heredia et al. (2022). In a broader sense, the ability to deal with technological advances is referred as "technology readiness" and is commonly referred to in the literature on innovation and management (Bowen, 2016; Parasuraman, 2000). Moreover, despite critiques of rapid technological change, historical evidence shows that technological innovation has significantly improved living standards and human well-being (Broughel & Thierer, 2019).

In conclusion, while the link between innovation and economic growth is well established, its effectiveness depends on factors such as market structures, policies, and socio-economic contexts, thus necessitating tailored approaches. Our analysis highlights the role of gender diversity in innovation, particularly in R&D and entrepreneurship. However, its impact varies across countries, especially in the European Union, where gender gaps and policy differences shape innovation dynamics. This is particularly relevant given regional variations in gender-inclusive policies and innovation performance, which influence how diversity affects the efficiency and direction of innovation in firms and industries.

Moreover, this study builds upon the work of researchers like Bilbao-Osorio and Rodriguez-Pose (2004), who emphasise the role of socio-economic factors in shaping innovation policies in peripheral regions. By incorporating gender as a key variable, our analysis contributes to a better understanding of gender dynamics in innovation, highlighting patterns that may be relevant for informing future discussions on how public policies could address gender imbalances and support inclusive innovation. This approach provides a more comprehensive understanding of the mechanisms that drive both technological and organisational innovation and their implications for sustained economic growth in the European Union.

2. Data and research method

2.1. Variables and data set

We will conduct our analysis on an annual balanced panel data set for the EU-27 member states across the period 2008–2021, using Eurostat data. Our choice of start date stems from some of the variables required not being available before 2008. Moreover, starting in 2008 allows us to capture the post-financial crisis period. Fortunately, the DOLS method of estimation possesses satisfactory properties even for small panels. In our case, to ensure a valid number of observations, the sample ends in 2021. The member states included are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

Our dependent variable will be GDP. Using the real GDP growth rate as a dependent variable instead of GDP per capita will better capture output growth as the basic indicator of economic performance and will also be useful for comparing economies at the international market level. Thereby, we will estimate the effects on the GDP growth of variables related to the expenditure on R&D both in the business sector and in the higher education sector, whatever the source of funds. In addition to variables related to the labour market, which may indicate the level of digitalisation of workers (such as working in technology and knowledge-intensive sectors and working from home), we will complement the analysis by exploring the role of higher education level of those employed. Furthermore, in line with the new European Innovation Agenda, we will consider the gender perspective, recognising that such a view has scarcely been adopted in innovation processes or policies (European Commission, 2023b). To do so, we will introduce the gender perspective in two dimensions: firstly, differentiating the variables between male and female; and secondly, exploring the role of the gender gap. In addition, and as way of performing a robustness check, we also consider gross fixed capital formation and the exports of goods and services as additional variables, in order to capture the role of investment and the openness of the economy, respectively. Table 1 presents the names and description of the variables.

Table 1. Description of variables

Dependent variable	
GDPg	real GDP growth rate, in percent
Independent variables	
ERB	gross domestic expenditure on R&D at the national level, business enterprises sector; whatever the source of funds; in percent of GDP
ERE	gross domestic expenditure on R&D at the national level, higher education sector; whatever the source of funds; in percent of GDP
HTT	employment in technology and knowledge-intensive sectors (high-technology manufacturing and knowledge-intensive high-technology services); in percent of total employment
HTF	high-technology and knowledge employees, female; in percent of total employment
HTM	high-technology and knowledge employees, male; in percent of total employment
TWT	employed persons working from home; in percent of total employment
TWF	employed persons working from home, female; in percent of total employment
TWM	employed persons working from home, male; in percent of total employment
EHT	employment rate with tertiary level of education; in percent of total employment
EHF	employment rate with tertiary level of education, female.; in percent of total employment
EHM	employment rate with tertiary level of education, male; in percent of total employment
GAP	gender employment gap; difference between the employment rates of men and women aged 20–64; in percent of total population of the same age group
INV	gross fixed capital formation; in percent of GDP
EXP	exports of goods and services; chain-linked volumes, percentage change to previous period

Source: own elaboration on the basis of Eurostat data.

Table 2 presents the descriptive statistics. These statistics reveal the heterogeneity of the EU-27 data during the period. Examining the Jarque-Bera (JB) statistic, the null hypothesis of normally distributed data is rejected for most of the variables. However, due to the relatively short time frame of the panel (14 years), we remain cautious in drawing firm conclusions solely based on this test. In our study, the potential problems associated with working with a small sample are overcome when estimating using DOLS (Mark & Sul, 1999, 2001). The correlation matrix is provided in the Appendix to complete the information (see Table A1).

Table 2. Descriptive statistics

	Mean	Median	Max	Min	Standard deviation	Skew-ness	Kurtosis	JB	JB-Prob.
GDPg	1.48	2.00	25.20	–14.80	4.18	–0.24	7.02	257.96	0.00
ERB	0.98	0.75	2.67	0.07	0.69	0.65	2.22	36.34	0.00
ERE	0.41	0.35	1.04	0.04	0.22	0.63	2.87	25.67	0.00
HTT	4.19	4.00	10.10	1.70	1.37	0.91	4.41	84.17	0.00
HTF	3.13	2.90	7.20	1.40	1.02	1.07	4.24	96.64	0.00
HTM	5.10	5.00	12.80	1.90	1.78	0.76	4.00	52.44	0.00
TWT	6.24	4.60	32.00	0.20	5.14	1.67	6.81	404.83	0.00
TWF	4.19	4.00	10.10	1.70	1.37	0.91	4.41	84.17	0.00
TWM	6.01	4.40	31.50	0.10	5.16	1.67	6.60	379.50	0.00
EHT	33.87	34.35	55.20	15.50	8.89	–0.02	2.16	11.09	0.00
EHF	39.46	40.40	61.50	15.70	10.22	–0.15	2.13	13.35	0.00
EHM	28.99	29.60	51.70	11.80	8.33	0.17	2.25	10.65	0.00
GAP	11.05	10.05	39.10	–1.50	6.24	1.15	5.47	179.76	0.00
INV	3.77	3.70	6.60	1.60	1.10	0.31	2.46	10.59	0.00
EXP	3.98	4.50	41.00	–23.20	7.91	–0.32	6.00	146.47	0.00

Note: 378 observations and 27 cross-sections.

Source: own elaboration.

Various panel unit root tests suggest that the variables are I(1), and the Pedroni (1999, 2004) and Kao (1999) panel cointegration test rejects the null hypothesis of no cointegration (please see Tables A2 and A3 in the Appendix). Having determined the cointegration relationship, we could apply the panel DOLS method to estimate our cointegrated panel.

2.2. Research method

We perform our analysis on the sample of the EU-27 member states. In the current paper, dynamic ordinary least squares (DOLS) is implemented. Its preconditions are the same order of integration of the variables, and that there is cointegration between the variables (see Maeso-Fernández et al., 2004, for an overview). This method uses lags and leads of the differences of variables (which are non-stationary) to resolve the problems endogeneity, autocorrelation and, also minimise biases associated with small sample sizes. Following Kao and Chiang (2000), DOLS provides better results than FMOLS estimators in terms of average biases. For this reason, we will apply the DOLS methodology in our study.

Our specification for the total population is described in equation (1), while the alternative specifications where we introduce the gender perspective (distinguishing between the variables for female and male) are equivalent and are not reported to save space:

$$GDPg_{ti} = \beta_0\, ERB_{ti} + \beta_1\, ERE_{ti} + \beta_2\, HTT_{ti} + \\ + \beta_3\, TWT_{TI} + \beta_4\, EHT_{ti} + \beta_5\, GAP_{ti} + \varepsilon_{ti} \quad (1)$$

The expected signs of the estimates are not unambiguous a priori. Regarding the effects of expenditure on R&D on growth, there is no consensus in the empirical literature. Pradhan (2023) finds a positive relationship, mixed results are found by Gumus and Celikay (2015), and Bassanini et al. (2011) obtain negative effects, while Sylwester (2001) detects a positive but not significant relationship. An interesting discussion on the (non-expected) effects of government expenditure can be found in Arawatari et al. (2023) and the references therein. Concerning the effects of employment in high-tech sectors, the studies suggest that their potential benefits are highly context-dependent and unevenly distributed (Kemeny & Osman, 2018; Lee & Clarke, 2019). As addressed in the literature section, in our study, the telework variable is intended to capture the workers' technological capabilities; as well as a gender effect given, women usually tend to choose the telework option (Althoff et al., 2021; Elsamani & Kajikawa, 2024). In line with the studies outlined in the literature section, our variable of employment with high level of education, tries to record the accumulation of human capital. Finally, including the gender gap allows us to evaluate the impact of the European Gender Equality Strategy 2020–2025 (European Commission, 2020). With regard to the expected result, the sign of the coefficient in the GAP variable is an indirect indicator of the type of work men do. Assuming that men and women are equally productive, if GAP contributes positively to growth, it would probably mean that men are employed in more productive jobs.

For all the estimations, we offer a pooled weighted estimation, which accounts for heterogeneity by using cross-section-specific estimates of the conditional long-term residual variances to reweight the moments for each cross-section when computing the pooled DOLS estimator. As noted by Kao and Chiang (2001), although the DOLS estimator outperforms other procedures for estimating cointegrated panel regressions, DOLS could give different estimates depending on the lags and leads chosen. To overcome this potential drawback, we have employed the Akaike information criterion (AIC) selection. Moreover, as pointed out by Choi and Kurozumi (2012), the model selection criteria perform better than the fixed selection rules. The long-term variance weights are computed by applying the Bartlett kernel and the Newey-West fixed bandwidth.

3. Empirical results and discussion

3.1. Estimations for the entire EU

Table 3 presents estimations for the whole EU. As can be seen, spending on R&D, both in the business sector and in the higher education sector, shows a negative and significant effect. These results are consistent with those of Birdsall and Rhee (1993), Bilbao-Osorio and Rodríguez-Pose (2004), Bassanini et al. (2011) and Kadir et al. (2020), to name a few studies. The reasons are related to the public and private sector's interrelationships, bureaucracy, inefficiency, time horizon, spillover effects and innovation overflow. Our results could be explained by the time period used (2008–2021), which started with a financial and economic crisis, and thus covers years of cuts in expenditure. Moreover, this austerity might have led to difficulties in obtaining the satisfactory return on expenditure on education.

On the other hand, the share of employees in high-tech sectors (both total and men) and with a higher level of education shows a positive and significant effect. These results are in line with those of Chabbouh and Boujelbene (2020) and Yue (2024), who find that human capital improves firms' innovation. By contrast, the result for women employed in high-tech sectors is negative, although not significant, which could be explained using the findings of Cropley and Cropley (2017), who attribute the negative relationship to an unfavourable organisational climate.

The variable telework shows a positive effect, but it is not significant. Furthermore, regarding the gender gap in employment, it reveals a negative effect, although not a significant one when the estimation considers the to-

Table 3. The DOLS regressions on real GDP growth rate in EU-27, 2008–2021

	TOTAL					FEMALE					MALE				
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
ERB	−0.76* (−0.71	−1.22*** (−3.65)	−0.69*** (−3.38)			−0.59 (−1.22)	−1.28*** (−3.50)	−1.12*** (−4.75)			−0.63 (−1.51)	−0.78** (−2.54)	−0.74*** (−2.59)		
ERE	−3.54*** (−2.92)			−4.94*** (−4.98)	−2.27*** (−3.36)	−2.31* (−1.81)			−2.72* (−2.29)	−2.48*** (−3.08)	−1.93* (−1.68)			−3.04*** (−2.78)	−3.06*** (−4.25)
HTT	0.83*** (3.39)	0.72*** (2.92)	0.59*** (3.42)	0.79*** (2.84)	0.22* (1.96)										
HTF						−0.14 (−0.21)	−0.63 (−0.83)	−1.20* (−2.28)	−0.81 (−0.97)	−1.72** (−2.85)					
HTM											0.62*** (3.37)	0.33* (1.89)	0.46*** (3.17)	0.66*** (3.44)	0.45*** (3.52)
TWT	0.07 (1.35)	0.07 (1.57)	0.04 (1.30)	0.13** (2.87)	0.03 (1.02)										
TWF						0.61 (1.20)	1.08 (1.75)	1.63*** (3.63)	1.01 (1.54)	1.35** (2.76)					
TWM											0.01 (0.18)	0.02 (0.39)	−0.01 (−0.18)	0.06 (1.41)	0.01 (0.45)
EHT	0.05** (2.35)	0.04** (1.95)	−0.01 (−0.72)	0.05* (1.93)	0.02 (1.32)										
EHF						0.04** (2.23)	0.03 (1.11)	−0.03* (−2.03)	0.03 (1.53)	0.01 (0.56)					
EHM											0.03* (1.64)	0.05* (2.18)	−0.01 (−0.42)	0.03 (1.17)	0.01 (0.02)
GAP	−0.02 (−0.60)	−0.04 (−1.36)	−0.04 (−1.70)	−0.09* (−2.20)	0.01 (0.95)	0.09** (2.19)	0.15** (3.12)	0.03* (2.76)	0.13** (2.58)	0.07** (2.18)	−0.01 (−0.16)	0.01 (0.19)	−0.03 (−1.27)	−0.09** (−2.28)	−0.01 (−0.84)
INV		−0.04 (−0.29)		0.13 (0.71)			−0.19 (−1.10)		0.08 (0.44)			0.01 (0.03)		0.05 (0.31)	
EXP			0.29*** (12.69)		0.32*** (9.02)			0.35*** (13.54)		0.39*** (13,21)			0.31*** (11.12)		0.33*** (11.16)
R^2	0.75	0.77	0.88	0.71	0.89	0.70	0.73	0.86	0.68	0.85	0.76	0.78	0.89	0.76	0.90
R^2_{adj}	0.53	0.56	0.78	0.52	0.78	0.44	0.48	0.74	0.40	0.72	0.54	0.58	0.79	0.54	0.81
Periods: 13; Cross-sections: 27; Observations: 351															

Note: t statistics in parentheses. ***, **, *, indicate 1%, 5%, 10% significance levels, respectively.

Source: own elaboration.

tal and the male series. However, when the estimation only includes the female data, the effect of the gender gap on economic growth is positive and significant. This result might also be related to the gender gap in STEM areas addressed in the literature.

As a robustness check[3], we have included additional explanatory variables as the gross fixed capital formation for capturing the role of investment (INV) and the percentage change over the previous period of the exports of goods and services (EXP) to record, in a simple way, a measure of the economy's openness (the rate of growth of exports) as well as, indirectly, the productivity of the firms (Berthou & Dhyne, 2018), given that we are analysing the role of the environment's level of innovation. Adding the additional variables, the results for the variables of interest do not show serious changes. In detail, if we add investment as a variable, the estimate shows a very small and no significant coefficient. The results could be explained by the austerity policies of the post-2008 financial crisis period. If, on the other hand, we add the variable 'exports', the estimate exhibits a moderate positive value and high significance. The only noticeable change is the loss of significance of employment in high-tech sectors and higher education, when the variable 'exports' is added. Additionally, for further exploring the gender perspective, we have estimated the interactions between women's (and men) telework and women's (and men) education[4] (see Table A4 in the Appendix). For the women, the estimates prove to be positive and significant, reinforcing the individual effects of the variables. On the contrary, the estimates of the interactions in the male case are not significant.

3.2. Estimations for countries differentiated by innovation level

Next, we try to delve deeper into the extent to which the level of innovation achieved by firms contributes to economic growth. To this end, we divide the data for the EU-27 into three groups according to how companies disseminate innovation. From a different perspective, this approach can be found in Gasparri et al. (2023) and concerns the role played by foreign subsidiaries and domestic firms regarding R&D and innovation. To distinguish among these three groups of EU countries, we use the information provided by the European Innovation Scoreboard Index (EISI). This index summarises 32 indicators of 12 innovations dimensions, which are grouped into four types of activities: framework, conditions, investments, and innovative activities

[3] We acknowledge this suggestion to an anonymous referee.

[4] We acknowledge this suggestion to an anonymous referee.

(European Commission 2023a). In these ways, the index synthesises the research and innovation performance of the EU-27 countries and characterises the degree of innovation disseminated by their firms. Using the EISI, we can differentiate among: (1) 'Highly innovative' countries, which include both 'innovation leaders' (Denmark, Sweden, Finland, the Netherlands, and Belgium) and 'strongly innovative' countries (Austria, Germany, Luxembourg, Ireland, Cyprus, and France); (2) 'moderately or intermediate innovative' countries (Estonia, Slovenia, Czechia, Italy, Spain, Malta, Portugal, Lithuania, Greece, and Hungary): and (3) 'emerging innovators or scarcely innovative' countries (Croatia, Poland, Latvia, Bulgaria, and Romania).

The results of the estimations can be seen in Tables 4, 5 and 6. When analysing the degree of innovation, we established that in the group of highly innovative countries, employment in high-tech sectors is the variable that contributes the most (both in total, and for men), followed by the gender gap variable. However, disaggregating by gender, the variable that contributes the most is the gender gap, followed by the female population that telework and women with higher education. While the spending on R&D allocated to higher education continues to be negative, it is no longer significant. The group of moderate innovators behaves very similarly to that of the whole EU, although the contributions of employees who telework (total) and women with a tertiary level of education are noteworthy. In addition, the gender gap is negative, but highly significant for the total and male cases. Finally, in the group of emerging innovators, the effect of spending on R&D allocated to higher education is negative and highly significant, while the contributions of employees who telework (total) and men with higher education prove to be positive and significant.

If we consider the results offered by gender differentiation, we can observe that for employees in high-tech sectors, the result for men is maintained, except in the case of scarcely innovative countries, where this becomes negative. In the case of intermediate innovative countries, the important contribution of men employed in high-tech sectors merits highlighting. For the population with higher education and employees who telework, the positive signs remain. Both in highly and intermediate innovative countries, women with higher education exhibit a positive and significant contribution to economic growth, while men do not present a significant contribution. The opposite is true in the case of employment in high-tech sectors. These results are in line with those of WIPO (2020), which indicate that in high-income countries women tend to attain higher grades and are more likely to complete master's programmes than men, while in terms of professional development, the outcomes are the other way around. The results may also indicate that although women tend to achieve high levels of education, a gender gap persists in STEM-related employment, as evidenced by the strong and significant contributions to growth observed among men employed in high-tech

Table 4. The DOLS regressions on real GDP growth rate in highly innovative EU countries, 2008–2021

	TOTAL					FEMALE					MALE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
ERB	−0.86 (−1.42)	−0.68 (−1.79)	−0.48** (−2.33)			−0.63 (−1.31)	−0.59 (−1.44)	−0.66** (−3.54)			−0.88 (−1.31)	−0.44 (−1.27)	−0.43 (−1.47)		
ERE	−1.52 (−0.82)			−3.60** (−2.20)	−1.69** (−2.24)	−1.23 (−0.93)			−2.09 (−1.63)	−1.29 (−1.61)	−0.29 (−0.13)			−1.82 (−1.08)	−2.38** (−2.95)
HTT	0.65** (2.02)	0.36 (1.30)	0.31 (1.77)	0.47 (1.20)	0.11 (0.57)										
HTF						0.38 (1.18)	0.24 (0.72)	0.81** (3.88)	0.18 (0.41)	0.33 (1.27)					
HTM											0.49** (1.89)	−0.07 (−0.35)	0.19 (1.11)	0.16 (0.51)	0.31* (2.03)
TWT	0.06 (1.01)	0.02 (0.39)	0.01 (0.48)	0.06 (0.89)	0.02 (0.64)										
TWF						0.07* (1.77)	0.07 (1.41)	0.03 (1.07)	0.06 (1.03)	0.01 (0.22)					
TWM											0.01 (0.19)	0.02 (0.31)	0.01 (0.01)	0.04 (0.69)	−0.02 (−0.66)
EHT	0.01 (0.44)	0.04 (1.64)	−0.01 (−0.46)	−0.01 (−0.24)	0.01 (0.28)										
EHF						0.04** (2.22)	0.06** (2.84)	−0.02 (−1.43)	0.01 (0.64)	0.01 (0.34)					
EHM											−0.01 (−0.17)	0.09** (2.49)	−0.01 (−0.08)	−0.01 (−0.06)	−0.01 (−0.11)
GAP	0.11** (1.76)	0.05 (1.04)	0.03 (0.99)	0.12 (1.85)	0.06 (1.50)	0.11*** (2.44)	0.13** (2.52)	−0.02 (−0.61)	0.17** (2.79)	0.02 (0.35)	0.16** (2.15)	−0.03 (−0.53)	0.03 (0.73)	0.12 (1.38)	0.07 (1.46)
INV		−0.07 (−0.26)		0.41 (0.98)			−0.47 (−1.71)		0.26 (0.71)			0.11 (0.37)		0.38 (0.97)	
EXP			0.33*** (10.55)		0.36*** (9.02)			0.32 (12.44)		0.33*** (8.01)			0.32*** (7.95)		0.31*** (7.48)
R^2	0.79	0.76	0.93	0.75	0.93	0.82	0.78	0.93	0.77	0.93	0.79	0.78	0.92	0.77	0.93
R^2_{adj}	0.58	0.53	0.87	0.52	0.86	0.64	0.56	0.87	0.55	0.86	0.59	0.56	0.84	0.54	0.86
Periods: 13; Cross–sections: 11; Observations: 143															

Note: see note in Table 3.

Source: own elaboration.

Table 5. The DOLS regressions on real GDP growth rate in intermediate innovative EU countries, 2008–2021

	TOTAL					FEMALE					MALE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
ERB	−2.17* (−1.68)	−1.26 (−1.22)	−2.37** (−2.19)			−0.29 (−0.20)	−0.93 (−0.78)	−0.57 (−0.51)			−0.25 (−0.16)	−1.26 (−1.22)	−2.37** (−2.19)		
ERE	−6.42** (−2.38)			−6.26** (−2.36)	−4.21** (−1.61)	−8.06** (−2.64)			−5.71* (−2.06)	−5.96** (−2.46)	−6.54*** (−2.93)			−5.69* (−2.17)	−5.41** (−2.86)
HTT	1.80*** (3.53)	1.95*** (4.53)	1.41** (2.98)	1.07** (2.79)	0.42 (1.04)										
HTF						0.03 (0.04)	1.30* (1.99)	0.01 (0.01)	−0.02 (−0.04)	−1.06* (−2.35)					
HTM											1.54*** (4.56)	1.80*** (5.26)	1.31*** (4.52)	1.41*** (4.45)	1.05*** (3.81)
TWT	0.27*** (2.52)	0.17 (1.51)	0.22* (1.81)	0.33** (4.00)	0.18* (1.78)										
TWF						0.21 (1.45)	0.24 (1.71)	0.16 (1.47)	0.35** (2.86)	0.17* (2.29)					
TWM											0.17 (1.05)	0.06 (0.40)	0.16 (1.11)	0.28* (1.81)	0.19 (1.32)
EHT	0.03 (0.59)	−0.01 (−0.13)	−0.06 (−1.53)	0.07 (1.89)	0.05 (1.19)										
EHF						0.14*** (3.03)	0.05 (1.33)	0.03 (0.96)	0.08* (2.17)	0.14*** (3.97)					
EHM											0.02 (0.43)	−0.02 (−0.72)	−0.07* (−2.05)	0.02 (0.32)	−0.01 (0.11)
GAP	−0.24*** (−4.44)	−0.13*** (−2.93)	−0.11** (−2.29)	−0.14** (−2.75)	−0.07 (−1.35)	−0.06 (−0.90)	−0.05 (−0.89)	−0.02 (−0.52)	−0.05 (−0.07)	0.03 (0.90)	−0.26*** (−4.72)	−0.18** (−3.88)	−0.14** (−3.01)	−0.22** (−4.06)	−0.15** (−3.42)
INV		−0.74 (−0.33)		−0.34 (−1.21)			−0.77* (−2.41)		0.10 (0.32)			−0.51* (−2.43)		−0.15 (−0.55)	
EXP			0.28*** (5.47)		0.23** (4.04)			0.25*** (6.87)		0.23*** (5.76)			0.27*** (5.61)		0.25*** (4.62)
R^2	0.80	0.92	0.87	0.79	0.87	0.78	0.81	0.87	0.78	0.89	0.82	0.84	0.88	0.81	0.89
R^2_{adj}	0.60	0.62	0.74	0.59	0.75	0.57	0.61	0.74	0.57	0.78	0.64	0.84	0.77	0.62	0.78
Periods: 13; Cross-sections: 10; Observations: 130															

Note: see note in Table 3.

Source: own elaboration.

Table 6. The DOLS regressions on real GDP growth rate in low innovative EU countries, 2008–2021

	TOTAL					FEMALE					MALE				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
ERB	−3.58 (−1.47)	−5.24 (−1.79)	−0.05** (−0.02)				−1.80 (−0.74)	0.80 (0.43)				−10.53** (−2.35)	2.16 (0.95)		
ERE	−12.18** (−2.77)			−9.56 (−1.34)	−3.62 (−0.76)				−0.47 (−0.06)	−4.56 (−0.95)				−6.18 (−0.81)	−1.43 (−0.73)
HTT	0.61 (0.70)	0.77 (0.89)	0.20 (0.26)	1.05 (1.23)	0.29 (0.40)										
HTF							0.72 (0.92)	−0.16 (−0.26)	0.33 (0.34)	−0.19 (−0.26)					
HTM												−0.71 (−0.87)	0.25 (0.41)	−0.07 (−0.07)	0.44 (0.52)
TWT	0.64*** (1.81)	0.42 (1.35)	0.34 (1.43)	0.49 (1.15)	0.38 (1.23)										
TWF							0.02 (0.09)	0.22 (1.07)	−0.18 (−0.49)	0.25 (0.97)					
TWM												0.71* (1.96)	0.38 (1.50)	0.40 (0.84)	0.40 (1.43)
EHT	0.09 (1.10)	0.14 (1.46)	0.02 (0.29)	0.09 (0.96)	0.01 (0.06)										
EHF							0.07 (1.16)	0.04 (1.02)	0.10 (1.29)	0.03 (0.61)					
EHM												0.54** (3.54)	−0.08 (−0.84)	0.26 (1.63)	−0.10 (−0.90)
GAP	0.18 (1.38)	0.16 (1.24)	−0.04 (−0.38)	0.05 (0.44)	−0.04 (−0.35)		0.20 (1.83))	−0.04 (−0.41)	0.31*** (2.84)	0.03 (0.24)		0.16 (1.72)	0.03 (0.27)	0.03 (0.25)	0.05 (0.56)
INV		−0.98* (−2.06)		−0.48 (−0.98)			−0.60 (−1.36)		−0.94* (−1.91)			−1.55** (−4.18)		−0.58 (−1.42)	
EXP			0.27*** (1.48)		0.35*** (4.44)			0.32*** (4.25)		0.35*** (4.22)			0.32*** (6.02)		0.38*** (6.21)
R^2	0.65	0.73	0.87	0.71	0.87	0.64	0.70	0.87	0.69	0.87	0.63	0.74	0.86	0.73	0.89
R^2_{adj}	0.26	0.43	0.73	0.38	0.74	0.22	0.37	0.74	0.34	0.73	0.21	0.46	0.71	0.43	0.77
Periods: 13; Cross-sections: 6; Observations: 78															

Note: see note in Table 3.

Source: own elaboration.

sectors. If this is indeed the case, such a result would be in line with Botella et al. (2019), regarding the gender biases in STEM areas. In addition, we can stress that the contribution of educated women to growth is noticeable both in highly and intermediate innovative countries. This result is consistent with the findings of Xie et al. (2020) and Griffin et al. (2021), who note that gender diversity leads to higher innovative efficiency. Finally, the gender gap effect proves to be positive and significant in highly innovative countries, while it is negative but not significant for women in intermediate ones. In the case of scarcely innovative countries, the gender gap is significant only when the men's group is considered.

Conclusions

Our study has looked at the intricate relationship between innovation, human capital, employment, and economic growth within the EU, with particular emphasis placed on the roles of innovation and gender. Our analysis incorporates a variety of factors, including spending on R&D, employment in high-tech sectors, educational attainment, and participation in telework.

Our findings reveal that R&D spending, particularly in the higher education sector, appears to have a negative impact on economic growth. This raises questions about the timing of returns on investment and the potential for a brain drain. However, both employment in high-tech sectors and the level of higher education demonstrate a positive and significant correlation with economic growth. Interestingly, participation in telework shows a positive sign but lacks conclusive statistical significance.

The inclusion of gender perspectives allows for a nuanced understanding. While the overall gender gap in employment exhibits a non-significant negative association with economic growth, the separate analysis of female employment reveals a positive and significant relationship. This suggests that narrowing the gender employment gap could contribute significantly to boosting the economy´s performance.

Our analysis of innovation levels within member states has shed additional light. In highly innovative countries, employment in high-tech sectors exhibits a significant positive association with growth, as does the gender gap in employment. However, when disaggregated by gender, the gender gap variable and the number of women with higher education both show positive and significant associations with growth. Moderately innovative countries exhibit behaviour like the whole EU, although telework participation here displays a more noticeable positive association with growth. For emerging innovators, the negative and significant impact of public R&D spending on higher education is noteworthy. Additionally, telework participation and the number of men with higher education show positive associations.

Our conclusion, while emphasising the important role of employment in high-tech sectors for growth, could be the departure point for some policy recommendations. For highly innovative countries, promoting policies that address the gender gap in employment, particularly in high-tech sectors, would be vital. Moreover, for intermediate and low-innovation countries, it is important to foster policies that encourage investment in human capital, particularly by improving the efficiency of R&D spending in higher education and providing more accessible pathways for women to enter the STEM fields. Encouraging female participation in high-tech roles through targeted education and industrial policies is crucial.

Summarising our findings, we can state that employment in high-tech sectors is the variable that contributes most to growth in countries leading in innovation. For these highly innovative countries, the positive and significant effect of the gender gap in employment may indicate that men occupy more positions in high-technology sectors than women. Our second result is that women with a high level of education appear to have a stronger association with economic growth than men with the same level of training (except in the case of low-innovative countries), although their contribution through employment in high-tech sectors remains lower in all cases. These findings may help to inform future research and broader policy discussions concerning how gender, education, and innovation interact to shape growth trajectories. In particular, the analysis highlights the importance of exploring further the structural factors that limit women's participation in technological sectors, as well as the potential benefits of increasing their representation.

Future research should explore the specific reasons behind the negative short-term association between R&D spending on higher education and economic growth. Additionally, examining the mechanisms behind the observed gender-specific patterns in highly innovative countries could provide useful insights into the factors that influence female participation in innovation-driven economies.

Appendix

Table A1. Correlation matrix

	GDP	ERB	ERE	HTT	HTF	HTM	TWT	TWF	TWM	EHT	EHF	EHM	GAP	INV	EXP
GDP	1.00														
ERB	–0.05	1.00													
ERE	–0.09	0.73	1.00												
HTT	0.24	0.47	0.23	1.00											
HTF	0.22	0.25	–0.01	0.91	1.00										
HTM	0.23	0.57	0.35	0.97	0.80	1.00									
TWT	0.03	0.51	0.46	0.44	0.19	0.55	1.00								
TWF	0.24	0.47	0.23	1.00	0.91	0.98	0.44	1.00							
TWM	0.02	0.53	0.51	0.46	0.20	0.57	0.99	0.46	1.00						
EHT	0.15	0.25	0.25	0.36	0.18	0.44	0.46	0.36	0.47	1.00					
EHF	0.17	0.14	0.19	0.35	0.22	0.41	0.35	0.35	0.36	0.96	1.00				
EHM	0.12	0.34	0.28	0.36	0.15	0.46	0.54	0.36	0.54	0.94	0.81	1.00			
GAP	0.02	–0.37	–0.43	–0.07	0.09	–0.17	–0.27	–0.07	–0.28	–0.49	–0.48	–0.40	1.00		
INV	–0.07	–0.12	–0.02	–0.15	–0.12	–0.16	–0.08	–0.15	–0.09	–0.09	–0.02	–0.20	–0.17	1.00	
EXP	0.78	–0.13	–0.12	0.07	0.08	0.06	–0.05	0.07	–0.05	0.11	0.13	0.07	0.01	–0.08	1.00

Source: own elaboration.

Table A2. Unit root tests

	GDPg		ERB		ERE		HTT		TWT		EHT		GAP		INV		EXP	
	Stat	Prob	Stat	Prob	Stat	Prob	Stat	Prob	Stat	Prob	Stat	Prob	Stat	Prob	Stat	Prob	Stat	Prob
LLC	24.88	1.00	–5.02	0.00	–1.96	0.02	–1.92	0.02	–1.90	0.02	6.06	1.00	8.02	1.00	–4.46	0.00	34.47	1.00
Breitung	0.41	0.66	4.17	1.00	–0.41	0.34	5.65	1.00	5.65	1.00	–2.68	0.00	1.17	0.87	0.62	0.73	2.87	0.99
IPS	–0.83	0.20	–0.49	0.31	–0.89	0.18	1.30	0.90	1.30	0.90	0.34	0.63	1.11	0.86	–1.18	0.11	1.01	0.84
ADF - F	50.64	0.60	72.14	0.05	64.29	0.15	62.66	0.19	62.66	0.19	46.66	0.75	33.27	0.98	65.44	0.13	34.56	0.95
PP - F	187.94	0.00	48.43	0.68	115.76	0.00	80.73	0.01	80.73	0.01	85.42	0.00	98.02	0.00	95.03	0.00	194.74	0.00
Hadri	5.75	0.00	7.11	0.00	7.10	0.00	12.20	0.00	8.21	0.00	13.66	0.00	11.08	0.00	7.54	0.00	4.44	0.00

Note: Null hypothesis: No stationarity. LLC, Breitung, IPS, ADF-F and PP-F. Stationarity. Hadri.

Source: own elaboration.

Table A3. Cointegration tests

Pedroni		
	Statistic	**Probability**
Panel v-Statistic	–1.43	0.92
Panel rho-Statistic	4.53	1.00
Panel PP-Statistic	–13.71	0.00
Panel ADF-Statistic	–3.04	0.00
Group rho-Statistic	6.69	1.00
Group PP-Statistic	–24.31	0.00
Group ADF-Statistic	–5.57	0.00
Kao		
	Statistic	**Probability**
ADF	–7.47	0.00

Note: Null hypothesis: no cointegration.

Source: own elaboration.

Table A4. The DOLS regressions on real GDP growth rate in EU-27, 2008–2021. Interactions

	Female				Male			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
ERB	–0.59 (–1.22)	–0.83** (–2.55)	–0.30 (–0.61)	0.14 (0.44)	–0.63 (–1.51)	–0.01* (–3.00)	–0.59 (–1.52)	–0.19 (–0.58)
ERE	–2.31* (–1.81)	–0.55 (–0.58)	–1.58 (–1.17)	–0.98 (–1.15)	–1.93* (–1.68)	–0.67 (–0.77)	–1.43 (–1.32)	–1.03 (–1.29)
HTF	–0.14 (–0.21)	0.25 (0.80)	0.33 (0.79)	–0.52 (–1.71)				
HTM					0.62*** (3.37)	0.69*** (5.55)	0.61*** (4.10)	0.33** (2.85)
TWF	0.61 (1.20)							
TWM					0.01 (0.18)			
EHF	0.04** (2.23)							
EHM					0.03* (1.64)			
GAP	0.09** (2.19)	0.10** (2.51)	0.10** (1.99)	0.06** (1.87)	–0.01 (–0.16)	–0.01 (–0.38)	0.01 (0.22)	–0.02 (–0.06)
TWF*EHF		0.01** (2.48)	0.01 (1.19)	0.01* (2.63)				
TWM*TWM						0.01 (1.52)	0.01 (1.11)	0.01 (0.21)
INV			0.21 (1.40)				0.10 (0.83)	
EXP				0.37** (12.47)				0.30*** (9.91)
R^2		0.65	0.71	0.86	0.76	0.71	0.76	0.88
R^2_{adj}		0.42	0.46	0.73	0.54	0.52	0.54	0.78
Periods: 13; Cross sections: 27; Observations: 351								

Note: See note in Table 3.

Source: own elaboration.

References

Acemoglu, D., & Angrist, J. (2000). How large are human capital externalities? Evidence from compulsory schooling laws. *NBER Macroeconomics Annual*, *15*, 9–59. https://doi.org/10.2307/3585383

Alsos, A., Ljunggren, E., & Hytti, U. (2013). Gender and innovation: State of the art and a research agenda. *International Journal of Gender and Entrepreneurship*, *5*(3), 236–256. https://doi.org/10.1108/ijge-06-2013-0049

Álvarez, F., Buera, F., & Lucas, R. (2008). *Models of idea flows*. NBER Working Paper, 14135. https://doi.org/10.3386/w14135

AlQershi, N., Mohd Mokhtar, S., & Abas, Z. (2021). The relationship between strategic innovations, human capital, and performance: An empirical investigation. *Sustainable Futures*, *3*, 100056. https://doi.org/10.1016/j.sftr.2021.100056

Althoff, L., Eckert, F., Ganapati, S., & Walsh, C. (2022). The geography of remote work. *Regional Science and Urban Economics*, *93*, 103770. https://doi.org/10.1016/j.regsciurbeco.2022.103770

Arawatari, R., Takeo, H., & Kazuo, M. (2023). Government expenditure and economic growth: A heterogeneous-agents approach. *Journal of Macroeconomics*, *75*, 103486. https://doi.org/10.1016/j.jmacro.2022.103486

Bassanini, A., Scarpetta, S., & Hemmings, P. (2001). *Economic growth: The role of policies and institutions. Panel data evidence from OECD countries*. OECD Economics Department, Working Papers, 282. https://doi.org/10.2139/ssrn.265091

Berthou, A. & Dhyne, E. (2018). *Exchange rate movements, firm-level exports and heterogeneity*. Banque de France Working Paper, 660. https://doi.org/10.2139/ssrn.3123035

Bilbao-Osorio, B., & Rodríguez-Pose, A. (2004). From R&D to innovation and economic growth in the EU. *Growth and Change*, *35*, 434-455. https://doi.org/10.1111/j.1468-2257.2004.00256.x

Birdsall, N., & Rhee, C. (1993). *Does results and development (R&D) contribute to economic growth in developing countries?* Policy Research Working Paper, 1221. World Bank Group.

Bongers, A., Díaz-Roldán, C., & Torres, J. L. (2022). Highly skilled international migration, STEM workers, and innovation. *Economics*, *16*(1), 73–89. https://doi.org/10.1515/econ-2022-0022

Botella, C., Rueda, S., López-Iñesta, E., & Marzal, P. (2019). Gender diversity in STEM disciplines: A multiple factor problem. *Entropy*, *21*(1), 30. https://doi.org/10.3390/e21010030

Bowen, D.E. (2016). The changing role of employees in service theory and practice: An interdisciplinary view. *Human Resource Management Review*, *26*(1), 4–13. https://doi.org/10.1016/j.hrmr.2015.09.002

Broughel, J., & Thierer, A. D. (2019). *Technological innovation and economic growth: A brief report on the evidence*. Mercatus Research Paper. https://doi.org/10.2139/ssrn.3346495

Cameron, G. (1996). *Innovation and economic growth*. London School of Economics and Political Science. Centre for Economic Performance.

Capozza, C., & Divella, M. (2019). Human capital and frms' innovation: Evidence from emerging economies. *Economics of Innovation and New Technology*, *28*(7), 741–757. https://doi.org/10.1080/10438599.2018.1557426

Chabbouh, H., & Boujelbene, Y. (2020). Open innovation in SMEs: The mediating role between human capital and firm performance. *The Journal of High Technology Management Research*, *31*(2), 100391. https://doi.org/10.1016/j.hitech.2020.100391

Choi, I., & Kurozumi, E. (2012). Model selection criteria for the leads-and-lags cointegrating regression. *Journal of Econometrics*, *169*(2), 224-238. https://doi.org/10.1016/j.jeconom.2012.01.021

Cropley, D., & Cropley, A. (2017). Innovation capacity, organisational culture and gender. *European Journal of Innovation Management*, *20*(3), 493–510. https://doi.org/10.1108/ejim-12-2016-0120

Delaney, J. M., & Devereux, P. J. (2019). Understanding gender differences in STEM: Evidence from college applications. *Economics of Education Review*, *72*, 219–238. https://doi.org/10.1016/j.econedurev.2019.06.002

Elsamani, Y., & Kajikawa, Y. (2024). How teleworking adoption is changing the labor market and workforce dynamics? *PLoS One*, *19*(3), e0299051.

European Commission. (2020). *The gender equality strategy 2020–2025*. https://ec.europa.eu/newsroom/just/items/682425/en

European Commission. (2023a). *European Innovation Scoreboard 2023*. https://data.europa.eu/doi/10.2777/119961

European Commission. (2023b). *European Innovation Scoreboard: Technical note on the gender perspective in innovation*. https://data.europa.eu/doi/10.2777/645520

Gasparri, L., Villasalero, M., Escobar, O. & Mora-Valbuena, M. (2023). *Foreign subsidiaries' innovation objectives in moderate innovator countries*. 95th International Atlantic Economic European Conference. Universidad de Castilla-La Mancha, Rome.

Griffin, D., Li, K., & Xu, T. (2021). Board gender diversity and corporate innovation: International evidence. *Journal of Financial and Quantitative Analysis*, *56*(1), 123–154. https://doi.org/10.2139/ssrn.3266080

Griliches, Z. (1992). *Output measurement in the service sectors*. University of Chicago Press. https://doi.org/10.7208/chicago/9780226308890.001.0001

Gumus, E., & Celikay, F. (2015). R&D expenditure and economic growth: New empirical evidence. *Margin: The Journal of Applied Economic Research*, *9*(3), 205–217. https://doi.org/10.1177/0973801015579753

Heredia, J., Castillo-Vergara,M., Geldes, C., Carbajal Gamarra, F. M., Flores, A. & Heredia, W. (2022). How do digital capabilities affect firm performance? The mediating role of technological capabilities in the "new normal". *Journal of Innovation & Knowledge*, *7*(2), 100171. https://doi.org/10.1016/j.jik.2022.100171

Iranzo, S., & Peri, G. (2009). Schooling externalities, technology, and productivity: Theory and evidence from US states. *Review of Economics and Statistics*, *91*(2), 420–431. https://doi.org/10.1162/rest.91.2.420

Jones, C. I. (1995). Time series tests of endogenous growth models. *Quarterly Journal of Economics*, *110*(2), 420–431. https://doi.org/10.2307/2118448

Jones, C. I. (2002). Sources of U.S. economic growth in a world of ideas. *American Economic Review*, *92*(1), 220–239. https://doi.org/10.1257/000282802760015685

Jones, C. I. (2005). Growth and ideas. In P. Aghion and S. N. Durlauf (Eds.), Handbook of economic growth (vol. 1B, 1063–1111). Elsevier. https://doi.org/10.1016/s1574-0684(05)01016-6

Kadir, A. A., Afriana, W., & Azis, H. A. (2020). The effects of R&D expenditures on economic growth in OECD countries. *Airlangga Journal of Innovation Management*, *1*(2), 203–220. https://doi.org/10.20473/ajim.v1i2.21607

Kahn, K., & Candi, M. (2021). Investigating the relationship between innovation strategy and performance. *Journal of Business Research*, *132*, 56–66. https://doi.org/10.1016/j.jbusres.2021.04.009

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel Data. *Journal of Econometrics*, *90*(1), 1–44. https://doi.org/10.1016/s0304-4076(98)00023-2

Kao, C., & Chiang, M. H. (2000). On the estimation and inference of a cointegrated regression in panel data. *Advances in Econometrics*, *15*, 179–222. https://doi.org/10.1016/s0731-9053(00)15007-8

Kemeny, T., & Osman, T. (2018). The wider impacts of high-technology employment: Evidence from US cities. *Research Policy*, *47*(9), 1729–1740. https://doi.org/10.1016/j.respol.2018.06.005

Kuschel, K., Ettl, K., Díaz-García, C., & Alsos, G. A. (2020). Stemming the gender gap in STEM entrepreneurship—insights into women's entrepreneurship in science, technology, engineering, and mathematics. *International Entrepreneurship and Management Journal*, *16*(1), 1–15. https://doi.org/10.1007/s11365-020-00642-5

Lee, N., & Clarke, S. (2019). Do low-skilled workers gain from high-tech employment growth? High-technology multipliers, employment and wages in Britain. *Research Policy*, *48*(9), 103803. https://doi.org/10.1016/j.respol.2019.05.012

Lucas, R. E. Jr. (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

Maeso-Fernandez, F., Osbat, C., & Schnatz, B. (2004). *Towards the estimation of equilibrium exchange rates for CEE acceding countries: Methodological issues and a panel cointegration perspective*. Working Paper, 353. https://doi.org/10.2139/ssrn.533022

Maradana, R. P., Pradhan, R. P., Dash, S., Gaurav, K., Jayakumar, M., & Chatterjee, D. (2017). Does innovation promote economic growth? Evidence from European countries. *Journal of Innovation and Entrepreneurship*, *6*, 1-23. https://doi.org/10.1186/s13731-016-0061-9

Mark, N., & Sul, D. (1999). *A computationally simple cointegration vector estimator for panel data*. Mimeo, Ohio State University.

Mark, N., & Sul, D. (2001). Nominal exchange rates and monetary fundamentals: Evidence from a small post-Bretton Woods panel. *Journal of International Economics*, *53*, 29–52. https://doi.org/10.2139/ssrn.146188

Moretti, E. (2004). Workers' education, spillovers, and productivity: Evidence from plant-level production functions. *American Economic Review*, *94*(3), 656–690. https://doi.org/10.1257/0002828041464623

Parasuraman, A. (2000). Technology readiness index (TRI): A multiple-item scale to measure readiness to embrace new technologies. *Journal of Service Research*, *2*(4), 307–320. https://doi.org/10.1177/109467050024001

Pece, A. M., Simona, O. E. O., & Salisteanu, F. (2015). Innovation and economic growth: An empirical analysis for CEE countries. *Procedia Economics and Finance*, *26*, 461–467. https://doi.org/10.1016/s2212-5671(15)00874-6

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61*, 653–670.

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time-series tests with application to the PPP hypothesis. *Econometric Theory*, *20*(3), 597–625. https://doi.org/10.1017/s0266466604203073

Perez-Felkner, L., Felkner, J. S., Nix, S., & Magalhães, M. (2020). The puzzling relationship between international development and gender equity: The case of STEM postsecondary education in Cambodia. *International Journal of Educational Development*, *72*, 102102. https://doi.org/10.1016/j.ijedudev.2019.102102

Pradhan, R. (2023). The effect of R&D on economic growth: Evidence from cross-country panel data. *The Journal of Developing Areas*, *57*(4), 245–256. https://doi.org/10.1353/jda.2023.a908655

Ritter-Hayashi, D., Vermeulen, P., & Knoben, J. (2019). Is this a man's world? The effect of gender diversity and gender equality on firm innovativeness. *PLoS One*, *14*(9), 1–19. https://doi.org/10.1371/journal.pone.0222443

Sylwester, K. (2001). R&D and economic growth. *Knowledge, Technology & Policy*, *13*, 71–84. https://doi.org/10.1007/bf02693991

Ulku, H. (2004). *R&D, innovation, and economic growth: An empirical analysis*. IMF Working Paper, 185. https://doi.org/10.5089/9781451859447.001

Uzawa, H. (1965). Optimum technical change in an aggregative model of economic growth. *International Economic Review*, *6*(1), 18–31. https://doi.org/10.2307/2525621

Verspagen, B. (2009). Innovation and economic growth. In J. Fagerberg & D. C. Mowery (Eds.), *The Oxford handbook of innovation* (pp. 487–513). Oxford University Press.

WIPO. (2020). *Innovation gender gap: What do we know about the gender gap in innovation?* The World Intellectual Property Organization. https://www.wipo.int/about-ip/en/ip_innovation_economics/gender_innovation_gap/gender_by_fields.html

Wong, P. K., Ho, Y. P., & Autio, E. (2005). Entrepreneurship, innovation and economic growth: Evidence from GEM data. *Small Business Economics*, *24*, 335–350. https://doi.org/10.1007/s11187-005-2000-1

Xie, L., Zhou, J., Zong, Q., & Lu, Q. (2020). Gender diversity in R&D teams and innovation efficiency: Role of the innovation context. *Research Policy*, *49*(1), 103885. https://doi.org/10.1016/j.respol.2019.103885

Yue, W. (2024). Human capital and firm innovation: Evidence from China's higher education expansion in the late 1990s. *Emerging Markets Finance and Trade*, *60*(3), 500–518. https://doi.org/10.1080/1540496x.2023.2242568

Zhou, K. Z., & Wu, F. (2010). Technological capability, strategic flexibility, and product innovation. *Strategic Management Journal*, *31*(5), 547–561. https://doi.org/10.1002/smj.830

Aims and Scope

The aim of **Economics and Business Review** is to provide a platform for academicians from all over the world to share, discuss and integrate their research in the fields of economics and finance, including both behavioural economics and finance, with a key interest in topics that are relevant for emerging market economies. The journal welcomes submissions of articles dealing with micro, mezzo and macro issues that are well founded in modern theories or based on empirical studies and which are valuable for an international readership.

Your paper your way policy

The authors are initially expected to adjust their manuscripts to meet the basic requirements presented in the submission checklist below. Once the text has been accepted for publication, authors must adhere to all guidelines available on our website: https://journals.ue.poznan.pl/ebr

Basic requirements

- The submission has not been previously published nor is it under consideration for publication elsewhere (or an explanation has been provided in Comments to the Editor).
- The submitted manuscript must be anonymous. A separate title page must also be submitted, specifying each author's affiliation, email address, and ORCID iD. Acknowledgements and references to research grants should be included on the title page.
- The manuscript should be prepared in OpenOffice, Microsoft Word, or RTF document file format.
- The length of the manuscript should not exceed 8,000 words (including figures and tables, references, and footnotes).
- The manuscript includes an abstract of 100 to 150 words and is divided into clearly distinctive sections, including Introduction and Conclusions. The Introduction should state the aim of the study, research methods, main results, and particularly the study's contribution to international literature. The final paragraph should outline the article's content.
- All tables and figures should be numbered and presented consecutively according to their order in the text. Tables and figures should be as self-explanatory as possible, so readers do not need to refer to the main text to understand the information presented. The sources of all data used in tables and figures must be specified.
- The authors should use a consistent referencing style throughout the text.

The submission must be made via the **submission system**: https://journals.ue.poznan.pl/ebr/submission

More information and advice on the suitability and formats of manuscripts can be obtained from:

Economics and Business Review
al. Niepodległości 10
61-875 Poznań
Poland
e-mail: secretary@ebr.edu.pl
https://journals.ue.poznan.pl/ebr

Subscription

Economics and Business Review (EBR) is published quarterly and is the successor to the Poznań University of Economics Review. The EBR is published by the Poznań University of Economics and Business Press.

Economics and Business Review is indexed and distributed in Scopus, Claritave Analytics, DOAJ, ERIH plus, ProQuest, EBSCO, CEJSH, BazEcon, Index Copernicus and De Gruyter Open (Sciendo).

Subscription rates for the print version of the EBR: institutions: 1 year – €50.00; individuals: 1 year – €25.00. Single copies: institutions – €15.00; individuals – €10.00. The EBR on-line edition is free of charge.