

Factors Influencing Labor Productivity in Modern Economies: A Review and Qualitative Text Analysis

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Abstract: We conduct a semi-systematic literature review and a qualitative text analysis of 141 publications on labor productivity. We have identified 12 factors that play a leading role in economic research of labor productivity: (i) agglomerations effect; (ii) business cycles and market selection; (iii) cross-country institutional differences; (iv) environmental aspects; (v) foreign direct investment (FDI); (vi) globalization and international trade; (vii) global value chains (GVC); (viii) human capital; (ix) information and communications technology (ICT); (x) labor allocation; (xi) R&D and innovation; (xii) regional differences. When it comes to the quotes count, the most prominent factor is (xi) R&D, followed by (vi) globalization and (viii) human capital. When it comes to the co-occurrence and c-coefficient, the most prominent factor is (viii) human capital, closely followed by (i) agglomerations, then either (xi) R&D or (vi) globalization. Network analysis reveals two communities, the bigger one centered around (i) agglomerations, and the smaller one centered around (vi) globalization.

Key-Words: labor productivity, factors of productivity, qualitative text analysis, network analysis, literature review, bibliometric analysis

Received: June 27, 2021. Revised: December 27, 2021. Accepted: January 12, 2022. Published: February 4, 2022.

1 Introduction

Labor productivity is one of the tenets of mainstream economic theory. For decades it has been at the forefront of academic research, yet its relevance remains as high as ever. It is also future-proof, as even in a robot-dominated workplace environment there will still be labor productivity to be measured – albeit of a different kind. With a subject so broad and important it is worthwhile to systematize and predict the direction the specific research field is going to take – and the following review and qualitative text analysis represent our attempt to provide that.

2 Methodology

The aim of this article is twofold. First, we want to identify the factors that influence labor productivity in modern economies. Second, an attempt is made to create an original theoretical framework for future empirical research. To fulfill the abovementioned research aims, we put forward three research questions: [RQ1] What are the key recent insights in the literature? [RQ2] Are there significant themes in the literature? [RQ3] Which factor is the most prominent in the literature?

No single theoretical study can capture every single topic in the history of labor productivity. However, we believe that the factors identified in our research are crucial for understanding the changes in labor productivity in modern economies. The categories proposed by us have been identified as important factors during the initial review process and word count analysis of collected publications and confirmed as such through a more in-depth qualitative study. Initially, we had identified 42 potential topics that we later combined into 12 categories used throughout this article (see: Table 1).

The primary research methods used in this article are literature review, bibliometric analysis, and qualitative text analysis. Following the methodology of Snyder [1] and motivated by the overwhelming number of publications on the broad topic of our research, we have adapted a semi-systematic approach to the literature review. Bibliometric analysis is rather brief and conducted entirely using the Web of Science analyzing tool. Furthermore, for the qualitative text analysis, we utilize a computer-assisted qualitative data analysis using Atlas.ti software. Following Kuckartz's [2] methodology, we chose a thematic qualitative text analysis with quantitative elements. Finally, there

are several network views constructed using Gephi software. The qualitative text analysis is based on the concepts of codes and sub-codes which are described in detail in section four.

Analyzed scientific papers mostly concern more than one issue, for example, it is hard to imagine research about the impact of agglomerations that disregards the role of human capital. This intuitive interdependence will be put to test during the qualitative text analysis. As such, for the sake of clearness, each paper has been assigned to only one category that best describes its subject matter. The literature was collected using the Google Scholar bibliometric database (general search term of “labor OR labour productivity”) with a supplementary search conducted in the Web of Science bibliometric database. The primary criteria of inclusion were relevance to the topic, language (only publications in English), timeliness (how recent is the research), and the importance of the paper (measured by the number of citations in Google Scholar). Some subjective judgments were necessary for the selection of the literature due to the overwhelming number of publications on this topic. The exclusion of literature not in English is motivated by the computer-assisted qualitative data analysis, which would be much more complicated in multiple languages. Future research could explore potential differences present in qualitative text analyses conducted in different languages. There is a small number of works cited in this article that play a supporting role (e.g. methodological context), which are not included in the 141 publications utilized in the qualitative text analysis.

During the course of the literature review, we have divided the selected analyzed papers (n=141) into 12 categories: (i) agglomerations effect; (ii) business cycles and market selection; (iii) cross-country institutional differences; (iv) environmental aspects; (v) foreign direct investment (FDI); (vi) globalization and international trade; (vii) global value chains (GVC); (viii) human capital; (ix) information and communications technology (ICT); (x) labor allocation; (xi) R&D and innovation; (xii) regional differences.

Table 2 shows the simplified versions of codes used in the auto-coding process of the qualitative text analysis. The results were manually revised.

Table 1. Initial categories/themes identified during literature review

Initial	Final	Initial	Final
aging workforce	(viii)	ICT-intensive	(ix)

Initial	Final	Initial	Final
		sectors/ICT	
agglomerations	(i)	infrastructure	(viii)
agriculture sector	various	innovation	(xi)
broadband access	(ix)	intangible investment	(xi)
business cycles	(ii)	internal economies of scale	(x)
climate change/environment	(iv)	international M&A	(vi)
construction sector	(viii)	labor allocation	(x)
convergence	(xii)	labor mobility	(x)
countercyclical behavior	(ii)	labor unions/privatization	(x)
employment density	(i)	liberalization	(vi)
employment type	(x)	manufacturing sector	various
exchange rate	(iii)	motivational factors/morale/HR management	(viii)
export/international trade	(vi)	outsourcing	(vi)
FDI	(v)	pollution	(iv)
financial crisis	(ii)	production specialization	(iii)
firm's lifecycle	(ii)	R&D	(xi)
globalization	(vi)	regional differences	(xii)
government expenditure/public policies	(viii)	services	various
GVC	(vii)	theoretical descriptions of methods	various
health	(viii)	vertical specialization	(vii)
human capital/education quality	(viii)	violence/crime	(viii)

Source: Own preparation.

Table 2. Simplified codes for the qualitative text analysis (codes include themselves and their every sub-code)

Code/sub-code	Coding keywords
AGGLOMERATIONS	AGGLOMERATION CITY URBAN
AGGLOMERATIONS: Congestion	congestion traffic jam commute gridlock overcrowding
AGGLOMERATIONS: Employment density	employment density
AGGLOMERATIONS: Spillovers	spillover
BUSINESS CYCLES	BUSINESS CYCLE
BUSINESS CYCLES: Crisis	crisis economic downturn economic collapse market crash bubble burst
BUSINESS CYCLES: Employment (total)	total employment labor force
BUSINESS CYCLES: Market selection	market selection market forces market failure reallocation of resources
BUSINESS CYCLES: Procyclicality	procyclicality cyclicality
COUNTRY DIFFERENCES	COUNTRY DIFFERENCES NATIONAL DIFFERENCES
COUNTRY DIFFERENCES: Country specialization	country specialization specialized economies comparative advantage absolute advantage localized productivity

Code/sub-code	Coding keywords
COUNTRY DIFFERENCES: Institutions	institution institutional
COUNTRY DIFFERENCES: Relative prices	relative prices comparative prices
ENVIRONMENT	ENVIRONMENT ENVIRONMENTAL
ENVIRONMENT: Air pollution	air pollution air contamination lung disease lung cancer asthma toxic particles fine particles particulate matter
ENVIRONMENT: Climate change	climate change climate warming global warming
ENVIRONMENT: Green investment	green investment eco investment responsible investment sustainable investment ecological investment environmental regulation
FDI	FDI Foreign direct investment
FDI: Investment policy	investment policy FDI policy Foreign direct investment policy FDI policies Foreign direct investment policies investment policies
FDI: Inward FDI	inward FDI FDI inflow investment inflow incoming investment FDI host incoming FDI iFDI
FDI: Outward FDI	outward FDI FDI outflow investment outflow outgoing investment outgoing FDI oFDI
GLOBALIZATION	GLOBALIZATION INTERNATIONALIZATION
GLOBALIZATION: Financial liberalization	financial liberalization financial integration capital flows capital market liberalization
GLOBALIZATION: Outsourcing	outsourcing offshoring
GLOBALIZATION: Trade	trade
GLOBALIZATION: Trade liberalization	trade liberalization free trade free market trade integration
GLOBALIZATION: Transnational corporations	transnational corporations TNC multinational corporations MNC international firm multinational enterprise MNE transnational enterprise multinationals
HUMAN CAPITAL	HUMAN CAPITAL
HUMAN CAPITAL: Education	education schooling scholarship academic
HUMAN CAPITAL: Health	health disease caloric intake nutrition vaccine
HUMAN CAPITAL: Healthcare	healthcare medical personnel medics nurse medical doctor hospital clinic
HUMAN CAPITAL: Knowledge	knowledge know-how
HUMAN CAPITAL: Life expectancy	life expectancy life span lifespans
ICT	ICT Information and Communications Technology
ICT: ICT capital	ICT capital Information Technology capital computers
ICT: ICT intensive industry	ICT intensive industry IT intensive industry ICT related industry ICT firm
ICT: ICT investment	ICT investment IT investment computer investment ICT expenditure
ICT: Internet	Internet world wide web broadband Wi-Fi
LABOR ALLOCATION	LABOR ALLOCATION
LABOR ALLOCATION: Employment type	employment type seasonal employment part-time seasonal work formal employment informal employment temporary employment
LABOR ALLOCATION: Labor market	labor market

Code/sub-code	Coding keywords
LABOR ALLOCATION: Labor mobility	labor mobility
LABOR ALLOCATION: Migration	migration emigration immigration
LABOR ALLOCATION: Worker reallocation	worker reallocation retraining program job change employment change labor reallocation
R&D	R&D research and development research & development
R&D: Innovation	Innovation innovative
R&D: Intangible investment	Intangible investment intellectual property intellectual properties intangibles intangible capital
R&D: Process innovation	process innovation innovative process
R&D: Product innovation	product innovation innovative product
R&D: R&D expenditure	R&D expenditure expenditure on R&D research expenditure research and development expenditure
R&D: R&D intensity	R&D intensity research and development intensity research intensity
REGIONAL DIFFERENCES	REGIONAL DIFFERENCES high-productivity regions productive region regional growth high-growth region specialized region
REGIONAL DIFFERENCES: Beta convergence	beta convergence β-convergence
REGIONAL DIFFERENCES: Convergence	convergence
REGIONAL DIFFERENCES: Geographic location	geographic location North South West East
REGIONAL DIFFERENCES: Sigma convergence	sigma convergence σ-convergence
GVC	GLOBAL VALUE CHAINS GVC
GVC: Upstream activities	upstream activities upstreamness upstream flow upstream stages
GVC: Downstream activities	downstream activities downstreamness downstream flow downstream stages
GVC: Vertical integration	vertical integration vertical specialization vertically specialized
GVC: Linkage direction	forward linkage backward linkage forward link backward link buyer linkage seller linkage

Source: Own preparation.

3 Review of the Factors

The following is an overview of the twelve factors that have been identified in the course of the semi-systematic literature review. The following sections show the main factors (categories of the literature review and qualitative text analysis), literature assigned to each factor, and the main findings of the literature review. There are several definitions of labor productivity in economic literature, but they are mostly similar (Table 3). Labor productivity is a measure of how effective is the employed labor, be it in an economy (aggregate labor productivity), region (regional labor productivity), or sector (sectoral labor productivity).

Table 3. Definitions of labor productivity

Source	Definition
Cai et al. [3]	Sectoral value added divided by labor force in a sector
Constantinescu et al. [4]	“(…) real value- added divided by the number of persons employed”
Dietzenbacher et al. [5]	“(…) we define labor productivity in vertically integrated industry <i>i</i> as the ratio of value added created in vertically integrated industry <i>i</i> and the number of jobs in vertically integrated industry <i>i</i> ”
Eurostat [6]	“(…) value added per employed person”
Hatzikian [7]	“(…) ratio between turnover or annual sales and the number to employees in the reference year (…)”
Lemos [8]	“(…) output divided by number of employees”
McGowan et al. [9]	“(…) gross output per employee (…)”
Mohnen & Hall [10]	“(…) amount of output per labor (…)”
OECD [11]	“(…) output per unit of labour input”
Ortega-Argilés [12]	“(…) GDP per hour worked (…)”

Source: Own preparation.

3.1 Agglomerations Effect

With rapidly increasing urbanization, the importance of cities in economic sciences is hard to overstate. Throughout numerous publications, agglomerations have been shown to have a significant positive impact on labor productivity. Notable examples include studies conducted in Sweden [13, 14], the Netherlands [15, 16], Italy [17], China [18, 19], and the United States [20, 21].

Agglomerations strongly influence labor productivity primarily because of the clustering of human capital (job density), increased R&D expenditures, the effectiveness of investment, and multiple positive spillover effects. Agglomerations have a very strong positive impact on levels of labor productivity, mainly through the job density channel; at the same time, they negatively impact the future growth of labor productivity because of the harmful congestion effect [15]. Crucially, R&D expenditure has a higher impact on labor productivity for firms located in agglomerations [14]. From the macroeconomic perspective, they almost universally increase the aggregate labor productivity of a country [15]. The positive spillovers have a surprisingly wide range, as the cities can have a positive influence on other cities located up to 100km from each other [19]. Both urban areas and industrial districts have a positive impact on labor productivity, but the effect is stronger for urban areas as they increase the resilience to financial shocks [17]. In the context of urban planning, polycentric agglomerations have a higher positive impact on labor productivity than monocentric agglomerations [20].

There are, however, some significant caveats when assessing their impact on the economy. Firstly, agglomerations can also hurt the growth of labor productivity in some regions. There are productivity spillovers when surrounded by dense agglomerations, which increase aggregate productivity but hurt regional productivity; additionally, the density of neighboring regions can dampen the congestion channel [15]. Secondly, while they have a significant impact on regional labor productivity, they also actively increase economic inequality [18]. Finally, there are diminishing returns to labor productivity gain as agglomerations become too congested in time [16]. The dangers of the congestion spillovers and congestion in agglomeration themselves, as well as the tendency to have greater economic inequality in their populations, will only become exacerbated as a larger percentage of the population will move to the big cities.

3.2 Business Cycles and Market Selection

Business cycles periodically accelerate the process of market selection during an economic downturn. As such, their impact can be positive (due to Schumpeter’s [22] creative destruction) or negative (due to lower output and accumulation). Recent studies have indeed confirmed the positive impact of crises on innovation [23–25]. Still, the global financial crisis and the following recession have had a negative impact on productivity in Europe [26].

The process of market selection has a more clear-cut impact on labor productivity. Market share reallocations resulting from market selection are important for labor productivity growth [27]. New entrants initially lower industry productivity growth, with time their contributions increase, and the biggest contributors to productivity growth are old and established firms experiencing productivity renewal [28]. Old firms with persistently low productivity (zombie firms) have a negative impact on aggregate industry productivity because they congest the market and waste invested capital [9]. According to a study conducted in Italy, manufacturing industries are characterized by the existence of several highly innovative firms and a larger number of regressive firms that exploit local markets, which can be described as neo-dualism of market selection [29].

Plant-level labor productivity is more vulnerable to business cycles than aggregate labor productivity of an economy [30]. Labor productivity moved in a countercyclical fashion during the Great Recession [31]. The procyclicality of labor productivity has declined greatly in the United States, at the same

time there has been a rise in the relative volatility of employment and the real wages – a possible cause is a decline in the labor market turnover [32]. There is a high correlation between employment growth and business cycle vulnerability: long-run downsizers experience a much higher drop in productivity than long-run upsizers [30].

3.3 Cross-country Institutional Differences

Internationally, innovation is heavily localized and occurs mostly in countries with high capital intensity. Most productive firms are heavily clustered in rich and developed economies with a strong institutional framework. In 2008, the percentage of country's firms in the global top decile of firms with the highest productivity level was the largest in the following five countries: 35.5% in the United States, 27.3% in Sweden, 25.2% in Finland, 19.4% in France, and 16.5% in the Netherlands; other notable examples include 11% in Germany, 4.2% in Poland, and 3.5% in Japan [33]. Internationally, innovation is heavily localized and occurs mostly in countries with high capital intensity [34].

In advanced economies, a convergence in labor productivity has occurred, however, its level differs between industries; a probable cause of labor productivity convergence is the convergence in the capital-labor ratios [35]. In Western Europe, labor productivity convergence has occurred on the national and industry levels, especially in the manufacturing sector [5]. In OECD economies, relative prices and relative labor productivities are proportional in the long run [36]. In the 1990s, the relative demand for skilled labor increased in Poland and decreased in Hungary and Czechia, which was accompanied by growing wage inequality in all three countries [37].

There is a substantial difference in priorities (product innovation vs. process innovation) between European countries. Northern European countries (Germany, United Kingdom, and the Netherlands) focus primarily on product innovation and new technologies, while Southern European (France, Italy, and Portugal) countries focus primarily on process innovation and cost-minimization [38].

3.4 Environmental Aspects

In recent years, the environment, climate change, and the shift to green energy have become some of the most discussed topics in economic sciences. When it comes to labor productivity, the analyses focus on two primary issues: severe air pollution and a high-temperature working environment, which harm health-related labor productivity and product

quality, especially in the long run. The most vulnerable sector is the construction industry. Given time, the average GDP is also highly likely to drop across the World.

Severe air pollution has a negative impact on labor productivity and product quality [39]. Prolonged exposure to air pollution has a small negative in the short run, however, long-term adverse effects might be more significant [40]. By 2060, air pollution will lower GDP by an average of 1%, but this drop will be much more significant in China and Eastern Europe. Additionally, labor productivity will suffer because of the indirect impact of worsening health [41].

In the coming decades, climate change will most likely have a strong negative impact on labor productivity, especially in Southeast Asia and Central America [42]. Climate change-related labor productivity loss is most pronounced in regions where agriculture is dominant [43]. A high-temperature working environment hurts construction labor productivity [44, 45]. The least productive and hazardous period of the day is between 2 pm and 3 pm [44].

Trade openness, as well as offshoring of production by European countries to developing countries with labor-intensive production, where labor is cheaper but less efficient, hurt the environment globally. Green investment has a positive impact on labor productivity [46]. The impact of stringent environmental regulation on investment is a positive one, but with clear diminishing returns at the higher levels of environmental taxation [47]. Trade openness has a negative impact on emissions efficiency, R&D expenditure has no impact, and for manufacturing the impact varies across sectors [48]. Offshoring of production by European countries to developing countries with labor-intensive production harms the environment [49].

3.5 Foreign Direct Investment (FDI)

The impact of inward FDI on labor productivity is generally positive, however, it depends on certain factors like the development level of the receiving country (GDP per capita), types of linkages (positive for vertical and negative for horizontal), type of production (services vs. manufacturing), duration (positive for the long run), regional aspects, and industry strength. The initial impact of inward FDI on productivity is neutral, however, it shows a positive effect in the long run [50]. The impact of technology diffusion-related-FDI on productivity is positive for vertical linkages and negative for horizontal linkages [51]. The effect that FDI has on

both host and home countries is undeniable, but its character depends greatly on the types of activities, level of competition, degree of internationalization, and host potential [52].

Several studies have focused on the effect on specific host countries. Inward FDI has no effect on domestic manufacturing labor productivity in the United States [53]. There has been a strong convergence effect on national and industry levels in Central and Eastern European countries with FDI playing a crucial role in this process [54]. FDI have a positive impact on productivity, but there is a big difference between inflows of FDI between regions in Romania: West is preferred to the East, and the capital region of Bucharest-Ilfov is much more heavily preferred than the rest of the country [55]. In China, FDI can have a positive impact on regional labor productivity and a negative impact on labor productivity in a given industry [56]. Higher per capita FDI inflow increases labor productivity in Chinese cities [57].

The impact of outward FDI on labor productivity is positive since it usually occurs in countries with prosperous and productive firms that extend or diversify their value chains. High FDI outflows are related to high productivity, on the other hand, high FDI inflows are related to an increase in productivity only for the countries above a certain GDP per capita threshold [58].

3.6 Globalization and International Trade

Firms that engage in international activities on average pay higher wages, conduct more innovative research, and have higher labor productivity. Exporting has a positive impact on productivity, and firms that export tend to pay higher wages and have higher R&D expenditure [59, 60]. Transnational corporations tend to have higher labor productivity and R&D expenditure than domestic firms [61, 62]. The size-wage effect shows that manufacturing labor productivity increases with firm size [63]. A firm's R&D productivity has a positive relationship with the globalization of its enterprises and a negative relationship with industrial diversification [64]. Firms' high-growth status and their TFP growth have a strong positive correlation, with one reinforcing the other [65].

Trade liberalization has a positive impact on manufacturing labor productivity in developing countries [66, 67]. The positive impact of financial liberalization on productivity is greater in the manufacturing sector than in the service sector [68]. Trade liberalization in services has a positive impact on the productivity of the manufacturing sectors when manufacturers benefit from using these

services in the production process – this effect is especially noticeable in countries with a strong institutional environment [69]. Trade liberalization should be accompanied by reforms aimed at changes in ownership concentration; with regards to labor productivity in manufacturing, low ownership concentration is preferred with high tariffs, concentrated ownership is preferred with low tariffs [70].

A bilateral trade agreement between the United States and Vietnam has increased labor productivity in Vietnam by increasing employment in the more productive export-oriented formal sectors at the cost of a decrease in employment in the less productive informal sectors [71]. Manufacturing industries in Latin America have focused on raw material processing and labor-intensive production, where they held a natural comparative advantage; their rapid specialization resulted in unemployment and long-run external imbalances of the economies [72].

Cross-border acquisitions, outsourcing, and offshoring help manufacturing productivity, including low-skilled labor. Outsourcing and offshoring have a positive impact on manufacturing productivity [73, 74]. International outsourcing has a positive impact on low-skilled labor productivity in the long run [75]. Cross-border acquisitions have a positive impact on domestic productivity, especially when the acquired firm is located in a more competitive market [76]. Additionally, high domestic competition increases the chances of cross-border acquisitions and the investment level of the domestic firm, in general, has a positive correlation with the increase in productivity resulting from cross-border acquisitions [76].

3.7 Global value chains (GVC)

Global value chains are one of the most important, and still relatively recent, additions to the literature on international economics. The crucial conclusion is that GVC participation has a significant positive impact on labor productivity [4, 77–79]. GVCs have a positive impact on labor productivity through four primary channels: firm specialization, easier access to inputs, knowledge spillovers, and increased competition [80]. Furthermore, GVCs tend to form as a consequence of regional clusters and activities of multinational enterprises [80].

Position in the chain is a key distinction for the estimation of the impact of GVCs. For upstream GVC activities, business cycle-related demand volatility has a negative impact on labor productivity [81]. A study of enterprises belonging to different GVC stages conducted in Italy and Spain shows a positive impact of agglomerations on

labor productivity only for supplier firms [82]. When trade barriers exist, downstream GVC activities can be most cost-effectively placed in relatively central economies, as their proximity to locations of the upstream stages in the chain might outweigh the higher marginal cost; e.g. a country with lower labor productivity might still have a comparative advantage due to its location [83]. When it comes to domestic value-added, forward GVC linkages are more beneficial than backward GVC linkages [84]. In recent decades, production chains in China have lengthened, while those in the United States have shortened [85].

Another aspect is the type of labor utilized in a particular stage of the chain. According to Degain et al. [86], with regards to the rise of GVCs in the United States and other advanced economies, “(...) *the big winners appear to be high-skilled workers and multinational corporations.*” GVCs are greatly beneficial to high-skilled workers with formal employment [87]. Rapid technological progress (Industry 4.0) has a chance to radically increase labor productivity and demand for high-skilled labor in GVCs [88]. However, in a study of GVCs in East Asia, Choi [89] finds that high-skilled labor productivity has not significantly contributed to value-added activities, as they were linked to limited technological innovation.

As usual, there are some important caveats. In recent years, GVCs’ growth has slowed down [4, 80, 86]. As such, labor productivity growth has also slowed down, partly because of the sluggish GVC growth [4]. While GVCs have a positive impact on labor productivity, they have little impact on actual employment [79]. Ultimately, GVCs contribute to the transmission of international economic shocks [85].

GVCs are much more beneficial to advanced economies while developing countries’ growth might even be hindered by them – still, for aggregate labor productivity alone their impact is generally positive regardless of the development level [90]. GVCs lead to an increase in labor productivity of advanced economies, however, this usually is accompanied by the outsourcing of the low-skilled labor to developing economies and increased unemployment in the former [86]. GVC integration has increased labor productivity in the Vietnamese garment and textile industries [91]. For developing countries, the need for higher labor productivity and the competitive pressure related to supplying a GVC might lead to an increase in informal employment with scarce work security [92]. Finally, Kummritz [78] finds that productivity

gains are visible for both upstream/downstream activities as well as developed/developing countries.

3.8 Human Capital

Human capital has, unsurprisingly, a strong positive impact on labor productivity. Education (years of schooling and % of tertiary education), health (nutrition, vaccines, and life expectancy), and technological progress are key elements of strong productivity growth.

Education and technological progress are the biggest contributors to labor productivity growth [93]. Human capital (high level of education) has a significant positive influence on labor productivity, however, for a low level of education, there is a significant negative relationship with labor productivity [94]. Depending on the situation, centralization or decentralization of education can have a positive impact on its quality and human capital. According to one study, to improve its human capital, China should decentralize higher education and centralize pre-tertiary rural education [95]. While education has no strong impact on agricultural productivity, it significantly increases off-farm income generation capabilities [96]. Effective human resource management, greater consideration for morale, and welfare all have a positive impact on labor productivity [97–99].

Knowledge spillovers help regional growth, which is most noticeable with close geographic proximity between urban areas. There are tertiary education spillovers with a highly positive impact on labor productivity [94]. The degree of impact of knowledge spillovers on regional productivity depends on geographic proximity, with neighboring regions benefiting the most from them [100]. An increase in human capital has a significant positive impact on regional labor productivity, however, this is negated by a significant negative impact of spatial spillovers [101]. From a perspective of a historically divided country, human capital is very similar between former West Germany and East Germany regions, but labor productivity is still noticeably higher in the West – potential explanations include historically larger firms and better infrastructure in the West [102].

Government expenditure can impact labor productivity. Government expenditures on education, agricultural research, and infrastructure have a positive impact on the economic growth of rural regions [103]. The use of vaccines has a positive impact on labor productivity [104]. In Mexico, violence and crime, and somewhat surprisingly anti-crime government expenditure, all negatively impact labor productivity [105]. Life

expectancy and infrastructure have a significant positive impact on labor productivity in the agriculture sector [106]. Nutrition has a positive impact on agricultural labor productivity [107].

3.9 Information and Communications Technology (ICT)

The impact of information and communications technology on the entire economy is undeniably immense. Investment in ICT capital has a positive impact on labor productivity [108–111]. Investment in ICT capital has a bigger impact on labor productivity than non-ICT capital by 25%-50% [109]. ICT has been one of the primary causes of major productivity trend breaks (positive shocks) for the past decades. Major productivity trend breaks include years following wars (WWII), global financial crises (Great Depression, Great Recession), global supply shocks (oil shocks), idiosyncratic shocks (country level drastic policy changes), and technological breakthroughs (development of ICT in the USA) [112].

Internet access (as well as its quality and speed) have a positive impact on labor productivity. Digitalization and access to information made possible by the Internet are important for inclusivity. Internet access and data standardization have a positive impact on labor productivity [110]. The impact of broadband access on labor productivity is positive, but its strength relies on better connection quality and is more pronounced for less developed regions – which makes it a tool for regional convergence [113].

In the late 1990s and early 2000s, total labor productivity in Germany, which at the time was one of the global leaders, has suffered because of limited gains in the ICT-intensive sectors despite large investments [114]. However, for ITC-intensive manufacturers since the 1990s in the United States, labor productivity growth is influenced mostly by the decline in output (Y) and decline in employment (L), and not in real improvements [115].

3.10 Labor Allocation

Labor allocation includes primarily the processes of labor mobility and migration. Skilled labor mobility has a positive impact on the manufacturing productivity of the receiving industry, especially in the case of employment in the high-tech sectors [116, 117]. Worker reallocation from less to more innovative firms has a positive impact on aggregate labor productivity [118]. Migration has a positive impact on income convergence rate; immigration into regions with high income per capita pushes the

value down, while emigration from low-income regions pushes per capita values up [119].

Labor unions have a positive impact on manufacturing labor productivity [120]. The use of temporary contracts has a small negative impact on labor productivity [121]. External labor flexibility has a negative impact on productivity growth in Italy, which is especially noticeable in SMEs [122]. Labor market distortions lower labor productivity and the speed of convergence between regions in China, which is especially exemplified by artificial labor mobility barriers and inferior social security systems in rural areas [3].

Vergeer and Kleinknecht [123] show that higher wages lead to an increase in labor productivity, while high labor turnover decreases productivity. Consequently, a higher wage share of labor has a positive impact on labor productivity, while income inequality has a negative one [124]. Wage share in advanced economies has decreased in the past decades [125].

In the United States, plants that have increased labor productivity done so either by downsizing or by increasing their output with upsized employment – manufacturers in mature industries tended to downsize (i.e. steel industry), while there have been some correlation of upsizing to a regional location (i.e. New England) and firm size (i.e. large firms) [126]. Also in the United States, Snowbelt states have experienced a higher level of manufacturing labor productivity growth than Sunbelt states, at the same time they lost employment while sunbelt states gained employment [127].

3.11 R&D and Innovation

Research and development expenditure and intensity have a very strong positive impact on labor productivity for both manufacturing and services. R&D expenditure has a clear-cut positive impact on labor productivity [10, 128–135]. R&D is positively correlated with firm size, R&D intensity is negatively correlated with firm size, and R&D intensity is positively correlated with future innovations [129]. The impact of R&D on labor productivity is positive for both manufacturing and services. Regional specialization is more important for labor productivity in services than in manufacturing [134]. Creative service industry specializations have a positive impact on regional labor productivity [136]. R&D intensity has a positive impact on labor productivity; this effect is especially noticeable in advanced industries [133]. Lack of availability of qualified personnel and the availability of finance harm firms' productivity

[137]. In general, R&D expenditure has a positive influence on the innovativeness of MSMEs [129].

Intangible investments have a positive impact on labor productivity [138–140]. The positive impact of intangible investment on labor productivity is the highest in the manufacturing and finance industries [139]. Technology acquisition expenditures have a positive impact on productivity [130].

The impact of product innovation on productivity is positive, but the impact of process innovation is less unequivocal [141]. The impact of innovation intensity on labor productivity follows a U-curve [7]. The crucial element of inducing productivity growth in the early stages of economic development is the widespread use of technology [142]. In Latin America, two determinants of innovation crucial for the region have been observed: public support and the intellectual property rights system [131]. Technology shocks have a positive impact on labor productivity [143]. Sudden losses in human capital have a much stronger short-run and long-run impact on innovation than physical capital [144].

3.12 Regional Differences

Regional differences can be difficult to measure, as the quantitative analysis of institutions and other factors is more difficult than in the international comparisons. Consequently, further exploration of regional differences and convergence/divergence trends could be an important topic of future research.

In the 1980s, there has been a significant regional labor productivity convergence across Europe [145]. The polarization was present in the regional labor productivity of the European Union. At the sectoral level, regional labor productivity polarization was present in the services, but not in manufacturing [146]. This can be explained by the concentration of highly productive tradable services in agglomerations and interregional differences in productivity in non-tradable services. Productivity of non-tradable services results to a greater extent from the level of wages in a given region, as the demand for them is local and they can be provided locally. While tradable services can be provided remotely, which is often done, for example, in service centers located in agglomerations. There are two equilibria in regional productivity growth, with high-productivity regions converging in the center of Europe, and low-productivity regions converging in the peripheries. The low-productivity convergence is a type of low-productivity trap [147]. Since the early 1980s, regional convergence

in labor productivity in Spain had stopped as there has been limited technological diffusion between the regions; convergence occurs in aggregate labor productivity at the regional level but not at the sectoral level [148, 149]. Regional labor productivity in Russia has converged [150].

Productivity levels across regions in the United States are highly differentiated. The main forces in labor productivity convergence have been the manufacturing and mining sectors [151]. Differences in productivity across regions were caused by different growth rates of capital and labor input [152].

In the past, the labor productivity and agricultural surplus in China were high and unevenly spread between regions. Labor productivity in agriculture was much lower than in manufacturing; increased urbanization improves labor productivity in rural areas [153]. China's East Rim provinces have had higher labor productivity and labor productivity growth than the rest of the country [154]. Increases in regional labor productivity in China were mostly the results of new labor-saving processes [155]. In 1995, the labor surplus in agriculture in China was substantial (120 million), with very large differences between regions: 44.8% of the agriculture labor force for the Southwest region and 0.3% for the Northeast region [153].

4 Qualitative Text Analysis

The qualitative text analysis section of this article presents the results of the computer-assisted qualitative data analysis using Atlas.ti software. There are 141 publications used in the qualitative text analysis. A small but notable number of works cited in this article play a supporting role (e.g. provide methodological context), as such, they are not included in the qualitative analysis [1, 2, 8, 12, 22–25, 52, 123–125]. This analysis is based on the concepts of codes and sub-codes: they are assigned quotes (portions of the reviewed literature). If their quotes overlap it means that the codes (or sub-codes) co-occur with other codes (or sub-codes). The co-occurrence is measured using the co-occurrence count (the number of times they co-occur) and the c-coefficient (the number of times they co-occur adjusted for the size of each code). The former is an integer, and the latter is a standardized coefficient (between 0 and 1). If the codes co-occur, we can assume that there is some interdependence between them.

4.1 Bibliometric Analysis

The bibliometric analysis is using the Web of Science analyzing tool. Fig. 1 shows the number of articles per year for the search term “labo*r productivity” (considering both spellings) available in the Web of Science Core Collection (WoS-CC) and Web of Science all databases (WoS-AD). Even though labor productivity is a very old concept, the trend clearly shows a rapidly growing interest, indicating its timelessness. As of today, and the number is sure to increase as the database gets updated, there have been 1,013 publications in the WoS-AD and 572 publications in the WoS-CC in 2019 alone. For the entire analyzed period, there are 8,962 publications in the WoS-AD and 5,373 in the WoS-CC. The numbers emphasize how vast this topic is, and that the semi-systematic approach is advantageous.

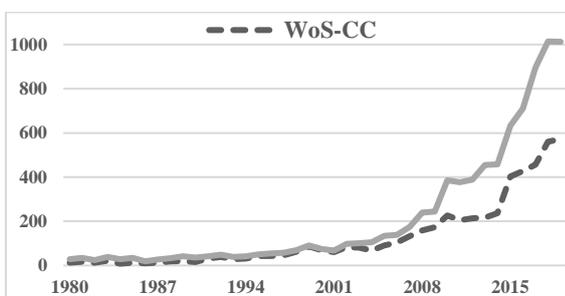


Fig. 1: Bibliometric trends of labor productivity, 1980-2019
Source: Own preparation based on the Web of Science [156].

Table 4 **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.** presents the number of publications on selected search topics in the WoS-CC for the 1980-2019 period. The percentage increase is the number of publications compared to the preceding decade. Notable figures include the increase in ICT-related publications, especially in 2000-2009 (1,229%), the explosion of popularity of globalization since the 1990s, and the consistent popularity of R&D. For GVC, 2019 alone brought 106 publications (15% of total). Of course, it is hard to directly compare these topics, as some of them are much broader, but it should give a general idea of how crucial they are to any economic analysis – in particular that of labor productivity.

Table 4. Number of publications on selected search topics, WoS-CC, 1980-2019

Search topic	1980-1989	1990-1999	2000-2009		2010-2019		Total
			number	% increase	number	% increase	
“labo*r productivity”	144	427	1,021	139	3,519	245	5,111
“agglomerations”	18	216	605	180	2,495	312	3,334
“business cycle”	225	1,128	2,388	112	5,371	125	9,112
“market selection”	7	20	116	480	271	134	414
“international differences”	44	147	251	71	472	88	914
“environmental aspects”	120	606	1,097	81	3,425	212	5,248
“FDI”	27	621	3,075	395	8,940	191	12,663
“human capital”	222	1,601	4,786	199	15,026	214	21,635
“GVC”	94	113	81	-28	420	419	708
“ICT”	37	503	6,684	1,229	32,129	381	39,353
“international trade”	695	2,085	4,236	103	12,224	189	19,240
“globalization”	58	3,452	19,638	469	45,210	130	68,358
“labo*r mobility”	48	156	353	126	987	180	1,544
“labo*r allocation”	5	40	77	93	135	75	257
“regional convergence”	1	41	161	293	321	99	524
“R&D”	123	8,696	19,258	121	30,317	57	58,394

Source: Own preparation based on the Web of Science database (Accessed 17.07.2020).

4.2 Codes

Fig. 2 and Table 5 show the word count for the reviewed literature (n=141). For clarity, we omit the common words irrelevant to the topic like “the,” “we,” “and,” etc. This figure and table are the only ones that differentiate between different spellings (e.g. labor/labour). As expected, “productivity” is by far the most common word, followed by “labor” (American spelling), “growth,” “capital,” and “data.” The word count list is interesting in its own right, but its primary function is to help with the initial exploration of literature and the creation of codes (factors) and sub-codes.

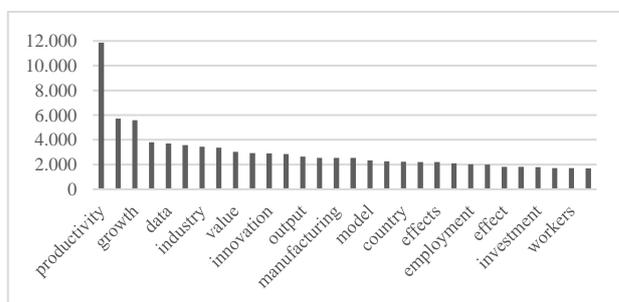


Fig. 2: Word count
Source: Own preparation.

Table 5. Word count

productivity	11,871	share	1,626	global	1,095
labor	5,724	regions	1,614	estimates	1,091
growth	5,583	regional	1,603	business	1,090
capital	3,810	market	1,579	OECD	1,083
data	3,698	across	1,534	FDI	1,060
level	3,564	labour	1,529	empirical	1,006
industry	3,450	sectors	1,503	worker	1,005
countries	3,363	foreign	1,429	knowledge	983
value	3,031	variable	1,426	relative	976
economic	2,937	research	1,388	region	969
innovation	2,913	rate	1,375	increase	968
production	2,858	impact	1,365	product	967
output	2,638	size	1,303	input	961
results	2,543	international	1,302	process	955
manufacturing	2,541	economics	1,289	European	944
trade	2,534	domestic	1,287	measures	942
model	2,323	technology	1,266	aggregate	935
industries	2,260	convergence	1,263	world	934

country	2,235	work	1,259	China	932
firms	2,211	they	1,253	economies	930
effects	2,193	percent	1,188	performance	924
sector	2,105	income	1,165	costs	919
employment	2,033	development	1,161	inputs	914
average	2,010	activities	1,124	spatial	914
effect	1,822	products	1,120	factor	859
variables	1,806	firm	1,119	information	859
investment	1,795	levels	1,116	EU	845
services	1,716	TFP	1,114	GVC	843
workers	1,702	human	1,111	industrial	839
analysis	1,676	ICT	1,104	national	836

Source: Own preparation.

Table 6 shows the number of quotes per code (n=12) and sub-code (n=49) for the reviewed literature (n=141). The number in the brackets is the number of papers with at least one quote for this code (the maximum possible value would be 141). The assigned codes are: (i) agglomerations effect; (ii) business cycles and market selection; (iii) cross-country institutional differences; (iv) environmental aspects; (v) foreign direct investment (FDI); (vi) globalization and international trade; (vii) global value chains (GVC); (viii) human capital; (ix) information and communications technology (ICT); (x) labor allocation; (xi) R&D and innovation; (xii) regional differences.

The number of quotes per code is different than the sum of its sub-codes since the codes also include generic terms (e.g. R&D). The more general sub-codes (e.g. innovation) have a higher number of quotes than the more specialized sub-codes (e.g. product innovation). There are is one dominant factor with more than three thousand quotes: (xi) R&D. Other prominent codes are (vi) globalization and (viii) human capital, with more than two thousand quotes. The code with the lowest quote count is (iii) country differences. (i) Agglomerations are especially interesting, as most of its quotes co-occur with other codes.

While the publications are assigned to a single code in the review, the qualitative analysis shows that these topics are difficult to isolate. Most of the codes occur at least once in the majority of the analyzed literature, e.g. the code for human capital occurs in 133 publications. When it comes to quotes per individual publications, the average is 218 and the median is 181. There are seven publications with more than 500 quotes: Antràs & Gortari [83], Crespi & Zuniga [131], Criscuolo & Timmis [80], Degain et al. [86], Foster-McGregor & Pöschl [116], Fuchs-Schündeln & Izem [102], and Kummritz et al. [84].

Table 6. Number of quotes per code and sub-code

(i) AGGLOMERATIONS	1,751 [99]	(vi) GLOBALIZATION	2,676 [115]	Internet	250
Congestion	115	Financial liberalization	20	(x) LABOR ALLOCATION	615 [72]

Employment density	60	Outsourcing	376	Employment type	51
Spillovers	666	Trade	2,042	Labor market	265
(ii) BUSINESS CYCLES	823 [115]	Trade liberalization	137	Labor mobility	94
Crisis	261	Transnational corporations	148	Migration	191
Employment (total)	559	(vii) GVC	1,067 [24]	Worker reallocation	47
Market selection	46	Downstream activities	59	(xi) R&D	3,117 [108]
Procyclicality	74	Linkage direction	56	Innovation	2,091
(iii) COUNTRY DIFFERENCES	479 [97]	Upstream activities	84	Intangible investment	287
Country specialization	75	Vertical integration	53	Process innovation	105
Institutions	350	(viii) HUMAN CAPITAL	2,417 [133]	Product innovation	92
Relative prices	42	Education	678	R&D expenditure	40
(iv) ENVIRONMENT	813 [76]	Health	480	R&D intensity	81
Air pollution	117	Healthcare	38	(xii) REGIONAL DIFFERENCES	1,416 [102]
Climate change	70	Knowledge	889	Beta convergence	14
Green investment	63	Life expectancy	19	Convergence	808
(v) FDI	827 [51]	(ix) ICT	1,062 [66]	Geographic location	1,128
Investment policy	12	ICT capital	247	Sigma convergence	32
Inward FDI	79	ICT intensive industry	43	TOTALS:	30,675
Outward FDI	8	ICT investment	70		

Source: Own preparation.

Fig. 3 shows a simple network view of the codes and sub-codes. Fig. 4 shows a network view with weighted edges (using the number of quotes as weights). Fig. 5 shows the connections between the 12 codes (factors of labor productivity) and 141 publications; the exact number of edges per code/node is provided in Table 6. The factors and literature are highly interconnected and virtually impossible to analyze in a vacuum. The next section of this article deals with co-occurrence measures for the reviewed literature.

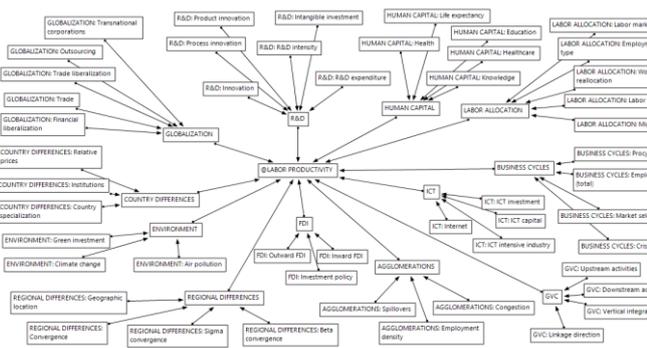


Fig. 3: Network view: overview
 Source: Own preparation.

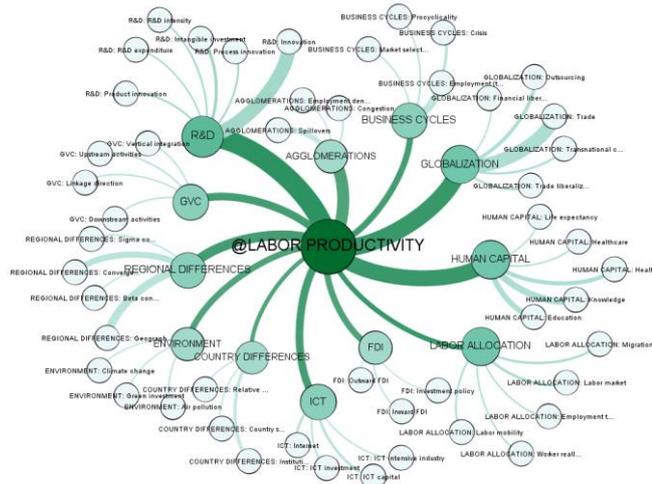


Fig. 4: Network view: weighted edges
 Source: Own preparation.

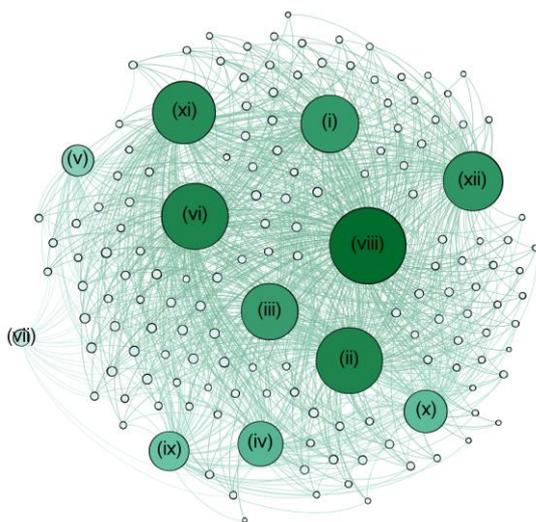


Fig. 5: Network view: codes and publications
 Source: Own preparation.

4.3 Co-occurrence

While the number of quotes is determined by the choice of publications, the co-occurrence analysis should provide a more nuanced result.

Table 7 presents the co-occurrence between codes and the c-coefficient (n=12) for the reviewed literature (n=141). The upper-right portion of the table shows the co-occurrence count, while the bottom-left portion shows the c-coefficient. The use of the c-coefficient allows for a fairer comparison of co-occurrence since it takes into consideration how numerous the code count is for each code.

The following two codes have the highest co-occurrence count and c-coefficient: (viii) human capital and (i) agglomerations. The code with the third-highest co-occurrence count is (xi) R&D, and the code with the third-highest c-coefficient is (vi) globalization. Among which, (viii) human capital leads the overall total co-occurrence count with 1,231 and the c-coefficient with 0.32 – the latter is tied with the result of (i) agglomerations. In general, the four leading codes (human capital, agglomerations, R&D, globalization) are the most important in this analysis and the differences in their scores are relatively small.

There is a notable cluster of scientific interest between R&D/human capital/agglomerations, visible in the crucial code dyads of (viii) human capital and (i) agglomerations, as well as (viii) human capital and (xi) R&D. There is also a high co-occurrence dyad of (i) agglomerations and (v) FDI. Another one is between (vi) globalization and (vii) GVC. This shows how the literature on international trade, the role of large multinational corporations, and knowledge spillovers play a crucial part in explaining labor productivity and its growth. These results are rather intuitive, as agglomerations have been shown to concentrate and enhance the regional human capital in densely populated, small areas, which in turn attracts investments. Globalization and global value chains are similarly interconnected. Noteworthy code dyads (with c-coefficient of 0.04 or higher) include:

- (i) agglomerations and (viii) human capital (294, 0.08);
- (i) agglomerations and (v) FDI (163, 0.07);
- (viii) human capital and (xi) R&D (301, 0.06);
- (vi) globalization and (vii) GVC (190, 0.05);
- (i) agglomerations and (x) labor allocation (85, 0.04).

On the other hand, and somewhat surprisingly, the total co-occurrence count and c-coefficient for (ix) ICT are the lowest (224, 0.08). ICT is ubiquitous and has a profound effect on almost every aspect of modern business life, yet the literature on its impact on labor productivity is somewhat confined to a relatively modest number of papers. A possible explanation could be that the impact is so great, that general economic models are

taking it for a given (exogenous variable) – or perhaps there are issues with quantifying it. Other codes with relatively low total co-occurrence count are (x) labor allocation (350), (iii) country differences (387), and the (iv) environment (392). For the latter, most of its co-occurrences (88) are related to (viii) human capital, which makes sense as the environmental damage is sure to cause health

problems, which in turn lowers labor productivity. The environmental aspects are relatively new to economic analysis – at least compared to other factors presented in this review. Their analysis is sometimes pushed outside of the mainstream macroeconomic and microeconomic models, be it for methodological difficulties or ideological differences.

Table 7. Co-occurrence count between codes and the c-coefficient

CODE	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)	(xi)	(xii)	TOTALS
(i)	-	48	32	32	163	89	41	294	23	85	149	70	1,026
(ii)	0.02	-	13	10	17	72	22	86	18	36	61	31	414
(iii)	0.01	0.01	-	39	21	92	34	53	9	16	58	20	387
(iv)	0.01	0.01	0.03	-	26	77	10	88	4	6	90	10	392
(v)	0.07	0.01	0.02	0.02	-	95	28	66	6	10	50	33	515
(vi)	0.02	0.02	0.03	0.02	0.03	-	190	107	25	32	153	61	993
(vii)	0.01	0.01	0.02	0.01	0.02	0.05	-	31	18	7	23	1	405
(viii)	0.08	0.03	0.02	0.03	0.02	0.02	0.01	-	50	79	301	76	1,231
(ix)	0.01	0.01	0.01	0	0	0.01	0.01	0.01	-	4	55	12	224
(x)	0.04	0.03	0.01	0	0.01	0.01	0	0.03	0	-	18	57	350
(xi)	0.03	0.02	0.02	0.02	0.01	0.03	0.01	0.06	0.01	0	-	48	1,006
(xii)	0.02	0.01	0.01	0	0.01	0.02	0	0.02	0	0.03	0.01	-	419
TOTALS	0.32	0.17	0.19	0.16	0.21	0.26	0.15	0.32	0.08	0.17	0.22	0.15	-

Source: Own preparation.

Fig. 6 presents the network view of the co-occurrence count, while Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε. visualizes one for the c-coefficient. The exact numbers for both figures are given in

Table 7. Both graphs have size-scaled nodes (by weighted degree) and edges (by weight value). We use modularity analysis to reveal two communities. The first community is centered around (i) agglomerations and (viii) human capital. The second one is centered around (vi) globalization. The node for (xi) R&D is visibly smaller when analyzing the c-coefficient. If codes are in the same community (modularity class) it means they are more likely to co-occur with other codes in the same community (modularity class). The figures show that whether we use the co-occurrence count or the c-coefficient the results are very similar, and only one code (ix) changes its community.

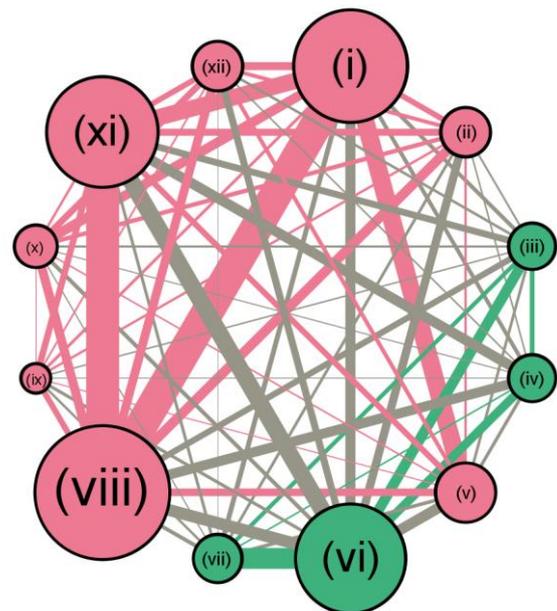


Fig. 6: Network view: co-occurrence count
 Source: Own preparation.

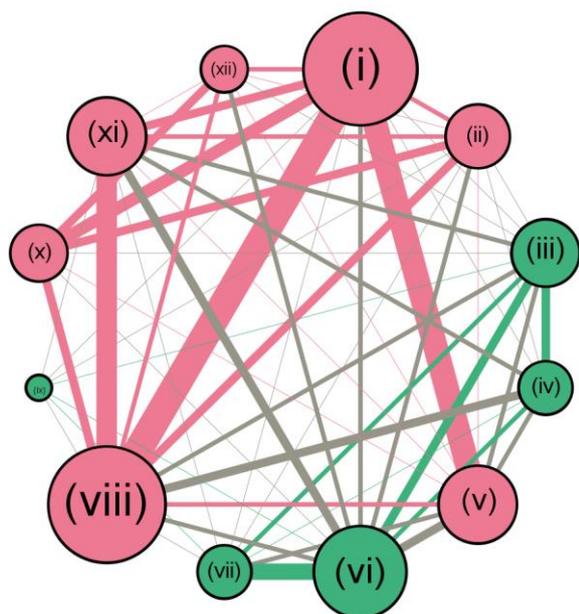


Fig. 7: Network view: c-coefficient
 Source: Own preparation.

Finally, we focus on the interdependencies between the sub-codes.

visualizes the co-occurrence between all sub-codes. The colors are determined by modularity class (codes in the same community that are more likely to co-occur with each other). This time there are seven modularity classes (communities). Table 8 shows the co-occurrence between 39 selected sub-code dyads for the reviewed literature (n=141). The pairs were selected in the following way:

- the 3 pairs with the highest co-occurrence count per category (factor) are chosen;
- due to some degree of overlap, both sub-codes in the pair cannot be from the same category;
- when both categories share each other’s highest pair, the pair is repeated but in reverse order;
- if there is an equal number of co-occurrences, all pairs are included and the category has more than 3 pairs.

As per above, every dyad in the table is notable because of its placement in the top three according to the co-occurrence count for its factor (code). Many of them are seemingly obvious, like spillovers/knowledge or innovation/knowledge. Some, however, should and have been of particular interest to economic research. The close relation between institutions, trade, and innovation signifies the ever-growing importance of a strong institutional framework for modern economies. While globalization is fraught with dangers, from a strictly theoretical standpoint, its benefits are almost

overwhelming when implemented correctly. For business cycles, the main questions are how geography, trade, and education determine differences in total employment between regions. Another important cluster of interest is formed by the relations between labor mobility and knowledge spillovers as well as between migration and regional convergence. Migration, both interregional and international, has become of the most hot-button issues in political discourse, so economic analyses must present its impact as clear as possible. Finally, the link between the environmental aspects (air pollution and climate change) and their impact on the decline in labor productivity due to worsening health has to become one of the paramount issues in economics.

Table 8 Co-occurrence between selected sub-codes

Sub-code 1	Sub-code 2	Count
Spillovers	Knowledge	166
Spillovers	Innovation	63
Spillovers	Trade	37
Employment (total)	Geographic location	45
Employment (total)	Education	45
Employment (total)	Trade	30
Institutions	Trade	54
Institutions	Innovation	35
Country specialization	Trade	20
Air pollution	Health	24
Climate change	Health	15
Green investment	Innovation	11
Inward FDI	Spillovers	8
Inward FDI	Convergence	7
Inward FDI	Geographic location	7
Trade	Geographic location	70
Trade	Innovation	60
Trade	Institutions	54
Vertical integration	Trade	19
Downstream activities	Trade	13
Upstream activities	Trade	12
Knowledge	Spillovers	166
Knowledge	Innovation	166
Education	Employment (total)	45
ICT capital	Innovation	9
ICT capital	Intangible investment	9
ICT capital	Knowledge	7
ICT capital	Trade	7
Internet	Knowledge	7
Labor mobility	Spillovers	31
Migration	Convergence	29
Migration	Geographic location	26
Labor mobility	Knowledge	26
Innovation	Knowledge	166
Innovation	Spillovers	63

capital. Digitalization and access to information made possible by the Internet make it a tool for regional convergence and inclusivity. Skilled labor mobility (x) has a positive impact on the manufacturing productivity of the receiving industry, especially in the case of employment in the high-tech sectors. Labor unions have a positive impact on manufacturing labor productivity. R&D and innovation (xi) have a very strong positive impact on labor productivity for both manufacturing and services. The impact of innovation intensity on labor productivity follows a U-curve. In the regional dimension (xii), economies experience fairly persistent interregional differences in labor productivity. On a regional level, there are two equilibria in regional productivity growth, with high-productivity regions converging in the center of Europe, and low-productivity regions converging in the peripheries. The polarization was present in the regional labor productivity of the European Union. Historically, the productivity levels across regions in the United States have been highly differentiated, while in Russia they have converged. China's East Rim provinces have had higher labor productivity and labor productivity growth than the rest of the country. In the past, the labor surplus in agriculture in China was high and unevenly spread between regions. Key recent insights from the above review concern the observed growing importance of global value chains and the impact of environmental and climate change factors.

The main limitation of this study is that it has not yet captured the impact of COVID-19 on labor productivity. Although we believe it may be partially internalized by the codes describing the business cycle and the development of global value chains, the full long-term impact of the pandemic is still unknown as of the writing of this article. However, these areas certainly require further and more in-depth exploration in future research. Another potential direction of future research could be a qualitative and quantitative text analysis of the differences present in literature published in different languages.

When analyzing significant themes in the literature, it is necessary to indicate the intensity of relationships between the identified research areas or factors. The network analysis allowed for the estimation of co-occurrence and c-coefficient indicators (see: network visualizations: Fig. 6 and **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**). As a result, pairs of connections within the network were identified, which then form the key links of the areas. Among closely related pairs, one should mention: (i) agglomerations +

(viii) human capital; (i) agglomerations + (v) FDI; (viii) human capital + (xi) R&D; (vi) globalization + (vii) GVC; (i) agglomerations + (x) labor allocation; and (i) agglomerations + (xi) R&D. These connections may indicate a strong correlation between the discussed factors. This is especially true for agglomerations which are linked to human capital, foreign investment, workforce allocation, and research and development. All these factors are part of the agglomeration phenomenon. The strong links between human capital and R&D are not surprising either, as high-quality human capital is essential for research development. Similarly, strong relationships between globalization and GVC are quite obvious.

The assessment of the most prominent factors in the literature to evaluate these factors is based on two criteria: quotes count and the above-mentioned co-occurrence and c-coefficient. When it comes to the quotes count, the most prominent factor is (xi) R&D, followed by (vi) globalization and (viii) human capital. When it comes to the co-occurrence and c-coefficient, the most prominent factor is (viii) human capital, closely followed by (i) agglomerations, then either (xi) R&D or (vi) globalization. Network analysis reveals two communities, the bigger one centered around (i) agglomerations, and the smaller one centered around (vi) globalization.

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Contribution of Individual Authors to the Creation of a Scientific Article (Ghostwriting Policy)

Both authors have contributed equally to the creation of this scientific article.

Sources of Funding for Research Presented in a Scientific Article or Scientific Article Itself

This research received funding within the framework of statutory research of the Collegium of World Economy, SGH School of Economics.

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