

Digitalization, Market Concentration, and Labor Dynamics: evidence from CEE Countries *

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Abstract

This paper examines the relationship between market concentration, digitalization, and labor outcomes in Central and Eastern European (CEE) countries, using aggregated firm-level data from CompNet and EU-KLEMS from 2000 to 2019. We find that in the CEE region, industries characterized by higher market concentration tend to have higher labor productivity and wages, while also having a lower labor share, in line with the superstar firm hypothesis. However, there are differences across CEE countries, highlighting the complexity of labor market dynamics in the region. Moreover, our study underlines the important role of digitalization, which contributes positively to productivity and wage growth, especially in more concentrated industries. Increased investment in digitalization does not mitigate the decline in labor share caused by increasing market concentration, with the exception of investment in communication technologies.

Keywords: Market concentrations; digitalization; Productivity; Wages; Labor Share.
JEL Classification: J23; J24; J30.

1 Introduction

The ongoing technological revolution, characterized by digitalization, and robotization, is reshaping labor markets. Understanding the economic impact of this revolution requires examining its effects on labor productivity and labor share changes, as technological progress is typically associated with increased productivity and declining labor share through the reallocation of task production from labor to capital (Acemoglu & Autor, 2011). Moreover, increasing market concentration in North America and Europe is associated with the empirical phenomenon of stagnating labor productivity and declining labor share in recent decades, which has received considerable attention in the literature (Brynjolfsson, Benzell, & Rock, 2020). One of the explanations behind labor share declines is the superstar firm hypothesis (Autor, Dorn, Katz, Patterson, & Van Reenen, 2020) among alternative hypotheses such as an increase of outsourcing Feenstra and Hanson (1999),

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or institutional change, such as deunionization (Fortin & Lemieux, 1997; Lemieux, 2006). The primary subject of this paper is the empirical investigation of the first hypothesis. The superstar firm refers to large firms that dominate product market shares (Autor et al., 2020). These firms are the most productive therefore are able to capture the greater market share, they employ the latest technology (Tambe, Hitt, Rock, & Brynjolfsson, 2020), charge higher markups (De Loecker, Eeckhout, & Unger, 2020), and pay above average wages even though they have on average lower labor shares (Autor et al., 2020). Autor et al. (2020) provide two (not necessarily distinctive) explanations for why superstar firms have on average lower labor shares: (i) they charge above average firm-level markups; and (ii) fixed overhead costs (Autor, 2022; Autor, Dorn, Katz, Patterson, & Reenen, 2017). The first view is based on a model of monopolistic competition under which assumptions superstar firms face less elastic demand and choose higher markups, consequently, labor shares are decreasing as markup increases. The second lies in the fact that superstar firms are able to spread fixed overhead costs, especially fixed labor costs, over more revenues, thus having a lower labor share.

Extensive empirical research has been conducted to explore the relationship between technology (including digitalization), market concentration, and productivity. In the US, market concentration has increased by more than 75% over the last 20 years across all industries (Grullon, Larkin, & Michaely, 2019); in Europe, the effect over the same period is more muted (for extensive evidence see Bajgar, Berlingieri, Calligaris, Criscuolo, and Timmis (2019)). The market concentration is however positively associated with intangible capital (Affeldt, Duso, Gugler, & Piechucka, 2021) or investment to robots (Stiebale, Suedekum, & Woessner, 2020). Calvino, Criscuolo, Marcolin, and Squicciarini (2018) showed that increasing concentration trends are driven by firms at the top of the distribution and they tend to operate at higher in digital-intensive sectors. Ferschli, Rehm, Schnetzer, and Zilian (2021) documented the market concentration and productivity in Germany and found that the high industrial concentration and high digital-intensive sector do not necessarily coincide, however, they provided evidence that the highly concentrated industries do enjoy higher productivity. Stiel and Schiersch (2022) found that in German firms the highly concentrated firms indeed have higher productivity. Moreover, they documented that the extensive markups of superstar firms not raising overhead costs is the driver of labor share decline. (Calligaris, Criscuolo, & Marcolin, 2018) show that the average increase in markup across the firms is driven largely by the top firms of markup distribution, while the firms along the bottom half of the distribution plateaued over time. Additionally, they showed that the markups are higher in digital-intensive sectors. Mertens (2022), using German

firm-level data in manufacturing industries, has documented the positive associations between increasing market power, productivity, and wages. Furthermore, Mertens (2022) found that superstar firms do pay higher wages but that these wages are below competitive levels. Over time, the gap between the marginal revenue of products and wages paid by these firms has widened (Mertens, 2022).

However, it remains unclear what are the effects of firm heterogeneity within industries on the effects of new technologies on labor market dynamics in Central and Eastern European (CEE) countries. To our best knowledge, no empirical paper has examined the above-stated superstar firms hypothesis in the CEE countries, given their highly monopolized heavy industry and manufacturing sectors and the scarcity of large platform-based firms. They are only indirect pieces of evidence that the labor share and higher market concentration are positively related in Poland (Growiec, 2012), and indirect results that higher market concentration and labor share are negatively related in 19 European countries (Curuk & Rozendaal, 2022). Therefore our main objectives are to empirically test three key predictions of the superstar firm hypothesis as proposed by (Autor et al., 2017, 2020) in the context of CEE countries, using aggregate firm-level data from CompNet, which we complement with EU-KLEMS data to measure average labor productivity, wages, labor shares, and digital capital across industries between 2000 and 2019. First, this paper examines whether industries that experienced larger increases in labor market concentration also experienced larger decreases in labor shares. Second, we examine whether industries with higher concentration have also experienced faster productivity growth and whether innovations such as digitalization have contributed to productivity growth. Finally, we examine whether increased market concentration within industries is associated with a decline in labor share and whether digital technologies play a moderating or disruptive role in shaping labor productivity, wages, and average labor shares.

The main results of this paper can be summarized as follows. Industries with a higher concentration tend to have higher levels of labor productivity and wages, but the labor shares across industries tend to be lower as predicted by the superstar firms hypothesis. In CEE countries we observed a more significant increase in the stock and flows of digitalization capital in an average manufacturing industry more than in average non-manufacturing industries between 2005 and 2019. We document that technological intensity, knowledge intensity, and digital capital deepening improve productivity in all industries. Moreover, industries characterized by higher concentration and greater levels of digitization also exhibit notably heightened levels of productivity.

The rest of the paper is structured as follows. Section 2 describes the methods

and data used in the paper. Section 3 discusses the main results, and section 4 concludes.

2 Data and Methods

To empirically examine the relationships between digitalization, industry concentration, productivity, wages, and labor share in Central and Eastern European (CEE) countries, we combined data at the NACE 2-digit industry level from EU-KLEMS created (Bontadini, Corrado, Haskel, Iommi, & Jona-Lasinio, 2023) with aggregated firm-level data from CompNet 9th vintage. This allowed us to analyze industry concentration, average labor productivity, wages, and labor share for the period 2005 to 2020 (for the precise definition and selection of variables from the CompNet database, see the description under Tables 1-8 in the Appendix).

Our study defines labor productivity as the ratio of real value added to total labor, using CompNet data. Wages are measured as the ratio of total labor costs to total labor. In contrast, the labor share is measured as the ratio of total labor costs to total revenue, both using CompNet data only. Due to the more detailed industry breakdown in the CompNet database compared to the EU-KLEMS data, we calculated weighted averages of mean labor productivity, wages, and labor share using total industry revenues as the weighting factor.

Due to the lack of data on digital capital investments and stocks, we omitted Poland and Croatia from the panel data set in order to examine the digitalization indicators constructed from the EU-KLEMS data and to pool the remaining three countries into one. However, we included a full set of CEE countries when examining the relationship between industrial concentration and labor market outcomes, as data for these countries are reported for the period 2000 to 2019 in the CompNet data. We rely on the sample that covers firms with 20 or more employees, as Slovakia does not cover all firms in the CompNet database. We obtain an unbalanced panel due to missing values in the digital capital measure in some industries and estimate the model in the form:

$$\log y_{c,i,t} = \beta_0 + \beta_1 \log HHI_{c,i,t-1} + \beta_k \log DI_{c,i,t-1} + \beta_9 \log Capital\ intensity_{c,i,t-1} + \alpha_c + \gamma_i + \rho_t + \varepsilon_{c,i,t} \quad (1)$$

The outcome $y_{i,t}$ is the average labor productivity, wage, or labor share across industries. All covariates, that are included in the models are lagged by one period, to minimize the contemporaneous endogeneity between covariates and labor mar-

ket outcomes. To measure average industrial concentration we use the Hirschman-Herfindahl Index (HHI) measured by total revenue. To investigate the role of digitalization in CEE countries, we use EU-KLEMS data and borrow the definition of digitalization indicators (\mathcal{DI}) from Ferschli et al. (2021) to measure three additive aspects of digitalization: (1) technological intensity, (2) knowledge intensity, and (3) digital capital deepening. We approximate, technological intensity by investment in information and communication technology (ICT) as a share of gross fixed capital formation. We distinguish between information technology ('IT share'), communication technology ('CT share'), and software and databases ('Soft share'). Knowledge intensity is approximated by research and development investment as a share of gross fixed capital formation ('R&D share'). In addition, we measure not only the flows but also the relative importance of digital capital deepening in the production process. We measure the stock of information technology digital capital ('IT deep') and communication digital capital ('CT deep'), both relative to hours worked. All the digitalization indicators are used iteratively, for β_k , where $k = \{2, 3, 4, 5, 6, 7\}$. In addition, we control for different capital intensities, defined as the ratio of real capital to labor, obtained from the CompNet database. Finally, the parameters $\alpha_c, \gamma_i, \rho_t$ stand for country, industry and time fixed effects, respectively.

To explore different effects of our digitalization indicator across industries that have a higher concentration, we interacted our digitalization indicator, capital intensity with HHI in the form:

$$\begin{aligned} \log y_{c,i,t} = & \beta_0 + \beta_1 \log HHI_{c,i,t-1} + \beta_k \log \mathcal{DI}_{c,i,t-1} + \beta_l \log \mathcal{DI}_{c,i,t-1} \times \log HHI_{c,i,t-1} + \\ & \beta_{14} \log Capital\ intensity_{c,i,t-1} + \beta_{15} \log Capital\ intensity_{c,i,t-1} \times \log HHI_{c,i,t-1} + \\ & \alpha_c + \gamma_i + \rho_t + \varepsilon_{c,i,t} \end{aligned} \quad (2)$$

$l = \{8, 9, 10, 11, 12, 13\}$ To exclude the possibility that our results of models specified in Equation (1), and (2) are driven by outliers, we winsorized all variables at 1 and 99 percentile.

3 Results and discussion

In this section, we examine the relationship between industry concentration, labor productivity, wages, and labor share across Central and Eastern European (CEE) countries. Table 1, and 2, which make use our first proxy for digitalization capital as a mean lagged level of intangible capital intensity that combines expenditures

to R&D, software, and patents from the CompNet database empirically support two stylized facts. Firstly, we observe that industries with a higher concentration of firms tend to exhibit higher levels of labor productivity and wages. Simultaneously, a higher concentration in these industries is correlated with a lower labor share over capital. This observation aligns with the ‘superstar firm hypothesis’ proposed by (Autor et al., 2020). Additionally, as industries employ a higher share of intangible capital, we observe higher wages and labor shares across country industries.

Interestingly, these findings remain consistent when we narrow our analysis to a subset of manufacturing industries. However, the magnitude of estimates reveals a noteworthy distinction. The reduced relationship between industry concentration and labor productivity and wages in manufacturing industries is approximately two times greater, while in the case of labor share, the magnitude of estimates is approximately five times greater. To illustrate, a 10% increase in concentration is associated with a $\hat{\beta}_1 = 0.28\%$ (0.09) lower labor share in all industries (Table 1), compared to a more intensive decline of $\hat{\beta}_1 = 1.1\%$ (0.12) in a subset manufacturing industries (Table 2). Figures 1, 2 document the reduced form of the relationship between industry concentration and labor productivity and wages, but specifically on the country dimension. With the exception of Slovakia, which exhibits a negative slope in the estimated relationship, all CEE countries experience higher productivity in highly concentrated industries, most notably in Poland and Czechia. The relationship between wages and industrial concentration is less pronounced, with all countries following a similar pattern as indicated in Table 1. However, when examining the reduced form of the relationship between labor share and industrial concentration depicted in Figure 3, we observe more substantial heterogeneity among countries. Croatia and Hungary deviate from the pooled observation in Table 1, demonstrating that a higher concentration of firms in industries correlates with a lower average labor share.

In the previous analysis, we looked at intangible capital from the CompNet data, using pooled investments in software and databases, patents, and R&D across industries. To gain a more complete understanding of the interplay between digital capital and labor market outcomes, we prefer to complement these data with a more granular accounting of digital capital in the EU-KLEMS data that allows us to construct technological intensity, knowledge intensity, and digital capital deepening, as described in section 2. We depict the evolution of flows and stocks of ‘digital capital’ across four CEE countries (Czechia, Hungary, Slovakia, and Slovenia) in Figure 4. Interestingly, digitalization was much more intensive in manufacturing industries (top panel of Figure 4), contrasting with the relatively stagnant levels

observed in most digitalization capital indices within non-manufacturing sectors (bottom panel of Figure 4). To illustrate, the average share of investment in communication and information technologies (IT) relative to gross investment surged by 50% in 2020 compared to 2005 levels. Additionally, both IT capital deepening and IT's share of total investments soared by over 150% in 2020 when compared to the base year. Notably, within non-manufacturing industries, several digitalization capital indices exhibited negligible or even negative growth. However, exceptions were found in investments related to research and development (R&D) and IT capital deepening, which witnessed increases of nearly 50% and 150%, respectively, in 2020 relative to the base year.

In Table 3 and 4 we estimate the models specified in Section 2 for labor productivity and in Table 7, and 8 for labor share. Empirical findings support three aspects of the superstar firm hypothesis (Autor et al., 2020) to some extent. First, we find a positive relationship between increases in industry concentration and labor productivity in Table 3. Remarkably, this relationship persists even after controlling for various additive digital capital components and capital intensities among firms. Second, the estimates presented in Table 4 documents that both slope and the interaction terms of technological intensity, knowledge intensity, and digital capital deepening improve productivity in all industries, but more concentrated industries are even more digitized and more productive as well. While our primary focus remains on labor productivity, we also extend our examination to wages. In this context, the link between increasing digitalization and industry concentration appears somewhat more nuanced compared to the robust association observed in labor productivity. Nonetheless, even with limited significance, the data suggest that more concentrated firms tend to offer higher wages on average. Interestingly, the interaction term between digital capital investment and stocks is negative. We can say that in more concentrated industries, investments in digital capital do indeed improve productivity, but the same improvements are not translated into increases in wages. With great caution, this observation could indicate that superstar firms do not pay competitive levels of wages, which Mertens (2022)'s findings in Germany indicate as well. However, this finding is not consistent with findings that used CompNet data solely. The third aspect of the superstar firm hypothesis, a negative relationship between market concentration and labor share, is well documented in industries in CEE countries. Table 7, and 8 clearly document that higher market concentration is negatively related to labor share. The results document that industries that only invest in communication technologies play a mitigating role in the relationship between market concentration and labor share declines. Industries that invest more intensively in research and development have even lower

average labor shares in the examined industries in the CEE countries.

4 Conclusions

This paper examined three central predictions of the superstar firm hypothesis for industries in CEE countries. First, we examined whether industries with higher labor market concentration also had lower labor shares. Our findings align with the well-established fact in the literature, indicating that industries characterized by higher levels of concentration typically exhibit lower labor shares. While most digitalization indicators did not show significant effects, investment in communication technologies emerged as a notable moderator, while investment in R&D played an accelerating role in shaping this relationship.

Second, we examined whether more highly concentrated industries experienced accelerated productivity growth and whether digitalization played a role in this process. Our analysis showed that increasing market concentration across industries is indeed correlated with higher labor productivity and wage levels. In addition, we found that increased investment in digital capital had a significant accelerating effect on labor productivity, but a muted effect on wages.

Our reliance on industry-aggregated data is a significant limitation. Future research could improve the depth of the analysis by using more detailed, possibly firm-level or sub-industry data to gain deeper insights into the role of firms' heterogeneity and labor market outcomes. Furthermore, it's worth noting that digital capital is not evenly distributed across industries, and our study revealed disparities, particularly in the case of information and communication technologies, which were notably underrepresented in our dataset. Moreover, the interested researchers could run a quantile regression to capture within effects of superstar firms, not only between effects across industries.

References

- Acemoglu, D., & Autor, D. (2011). Skills, tasks and technologies: Implications for employment and earnings. In Handbook of labor economics (Vol. 4, pp. 1043–1171). Elsevier.
- Affeldt, P., Duso, T., Gugler, K. P., & Piechucka, J. (2021). Market concentration in europe: Evidence from antitrust markets. cesifo Working Papers.

- Autor, D. (2022). The labor market impacts of technological change: From unbridled enthusiasm to qualified optimism to vast uncertainty (Tech. Rep.). National Bureau of Economic Research.
- Autor, D., Dorn, D., Katz, L. F., Patterson, C., & Reenen, J. V. (2017). Concentrating on the fall of the labor share. American Economic Review, 107(5), 180–185.
- Autor, D., Dorn, D., Katz, L. F., Patterson, C., & Van Reenen, J. (2020). The fall of the labor share and the rise of superstar firms. The Quarterly Journal of Economics, 135(2), 645–709.
- Bajgar, M., Berlingieri, G., Calligaris, S., Criscuolo, C., & Timmis, J. (2019). Industry concentration in europe and north america. Industrial and Corporate Change.
- Bontadini, F., Corrado, C., Haskel, J., Iommi, M., & Jona-Lasinio, C. (2023). Euklems & intanprod: industry productivity accounts with intangibles. Sources of growth and productivity trends: methods and main measurement challenges, Luiss Lab of European Economics, Rome.
- Brynjolfsson, E., Benzell, S., & Rock, D. (2020). Understanding and addressing the modern productivity paradox. MIT Work of the Future.
- Calligaris, S., Criscuolo, C., & Marcolin, L. (2018). Mark-ups in the digital era.
- Calvino, F., Criscuolo, C., Marcolin, L., & Squicciarini, M. (2018). A taxonomy of digital intensive sectors.
- Curuk, M., & Rozendaal, R. (2022). Labor share, industry concentration and energy prices: Evidence from europe. Industry Concentration and Energy Prices: Evidence from Europe.
- De Loecker, J., Eeckhout, J., & Unger, G. (2020). The rise of market power and the macroeconomic implications. The Quarterly Journal of Economics, 135(2), 561–644.
- Feenstra, R. C., & Hanson, G. H. (1999). The impact of outsourcing and high-technology capital on wages: estimates for the united states, 1979–1990. The quarterly journal of economics, 114(3), 907–940.
- Ferschli, B., Rehm, M., Schnetzer, M., & Zilian, S. (2021). Digitalization, industry concentration, and productivity in germany. Jahrbücher für Nationalökonomie und Statistik, 241(5-6), 623–665.
- Fortin, N. M., & Lemieux, T. (1997). Institutional changes and rising wage inequality: Is there a linkage? Journal of economic perspectives, 11(2), 75–96.
- Growiec, J. (2012). Determinants of the labor share: evidence from a panel of firms. Eastern European Economics, 50(5), 23–65.
- Grullon, G., Larkin, Y., & Michaely, R. (2019). Are us industries becoming more concentrated? Review of Finance, 23(4), 697–743.

- Lemieux, T. (2006). Increasing residual wage inequality: Composition effects, noisy data, or rising demand for skill? American economic review, 96(3), 461–498.
- Mertens, M. (2022). Labor market power, superstar firms, and between-firm wage (in) equality. Superstar Firms, and Between-Firm Wage (In) Equality.
- Stiebale, J., Suedekum, J., & Woessner, N. (2020). Robots and the rise of european superstar firms.
- Stiel, C., & Schiersch, A. (2022). Testing the superstar firm hypothesis. Journal of Applied Economics, 25(1), 583–603.
- Tambe, P., Hitt, L., Rock, D., & Brynjolfsson, E. (2020). Digital capital and superstar firms (Tech. Rep.). National Bureau of Economic Research.

A Appendix

	(1) Labor Productivity	(2) Wages	(3) Labor Share
HHI _{t-1}	0.055*** (0.014) (0.666)	0.018*** (0.006) (0.006)	-0.028*** (0.009) (0.002)
Intangible Capital _{t-1}	-0.018 (0.018)	0.057*** (0.007)	0.028*** (0.009)
Capital Intensity _{t-1}	0.335*** (0.018)	0.149*** (0.010)	-0.136*** (0.010)
Constant	2.275*** (0.187)	1.389*** (0.056)	-1.635*** (0.081)
Industry, Country, Year FE	Yes	Yes	Yes
R ²	0.663	0.901	0.874
N	2658	2649	2648

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1: The Relationship between Changes in Labor Productivity, Wages, Labor Share and Average Industrial Concentration and the Share of Intangible Capital Investment, 2000–2020, All Industries.

All variables are taken as means from CompNet 9th vintage database and aggregated to EU-KLEMS 2-digit industries as a weighted average by total revenues of CompNet industries. Labor productivity is measured as real value added over the total labor and labor share is measured as total labor costs over total revenues. Industrial concentration is proxied by HHI measured by total revenues (CV07_hhi_rev_pop_2D_tot), intangible capital ratio (FR11_ifa_k_mn), and capital intensity (FR30_rk_l_mn) directly obtained from the CompNet database. All variables are log-transformed. Dependent variables are winsorized at 1 and 99 percentile. Fixed effects are defined as twenty-eight EU-KLEMS industry categories and six CEE countries (Croatia, Czechia, Hungary, Poland, Slovakia, and Slovenia). Standard errors estimates are HAC robust.

	(1) Labor Productivity	(2) Wages	(3) Labor Share
HHI _{t-1}	0.090*** (0.024)	0.024*** (0.008)	-0.110*** (0.012)
Intangible Capital _{t-1}	-0.017 (0.025)	0.027** (0.014)	-0.002 (0.015)
Capital Intensity _{t-1}	0.558*** (0.047)	0.310*** (0.024)	-0.279*** (0.028)
Constant	1.111*** (0.226)	0.811*** (0.105)	-1.367*** (0.134)
Industry, Country, Year FE	Yes	Yes	Yes
R ²	0.659	0.896	0.766
N	1241	1241	1241

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: The Relationship between Changes in Labor Productivity, Wages, Labor Share and Average Industrial Concentration and the Share of Intangible Capital Investment, 2000–2020, Manufacturing industries.

All variables are taken as means from CompNet 9th vintage database and aggregated to EU-KLEMS 2-digit industries as a weighted average by total revenues of CompNet industries. Labor productivity is measured as real value added over the total labor and labor share is measured as total labor costs over total revenues using CompNet data. Industrial concentration is proxied by HHI measured by total revenues (CV07_hhi_rev_pop_2D_tot), intangible capital ratio (FR11_ifa_k_mn), and capital intensity (FR30_rk_l_mn) directly obtained from the CompNet database. All variables are log-transformed. Dependent variables are winsorized at 1 and 99 percentile. Fixed effects are twelve EU-KLEMS industry categories and six CEE countries (Croatia, Czechia, Hungary, Poland, Slovakia, and Slovenia). Standard errors estimates are HAC robust.

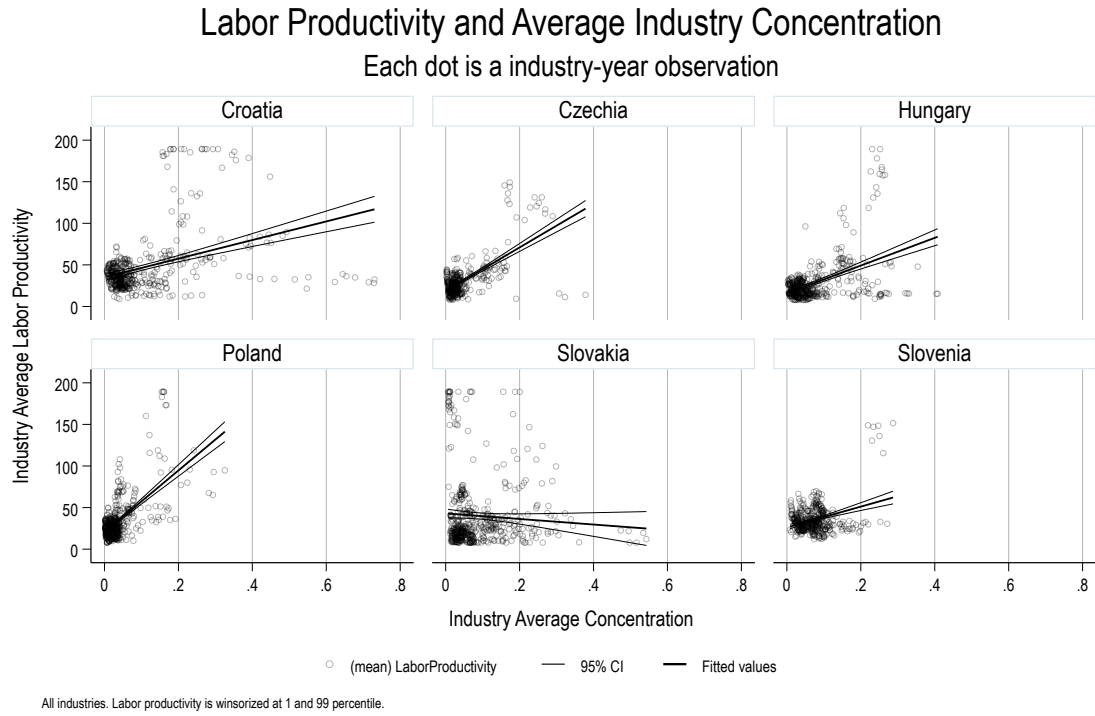


Figure 1: Average Industrial Concentration and Labor Productivity across all industries in CEE countries, 2000-2020.

Figure displays a scatter plot of the relationship between average industrial concentrations and labor productivity in six CEE countries across twenty-eight EU-KLEMS (aggregated as the weighted average of total revenues). Labor productivity is measured as real value added over the total labor and labor share is measured as total labor costs over total revenues. Industrial concentration is proxied by HHI in terms of total revenues (CV07_hhi_rev_pop_2D_tot) directly obtained from CompNet (2023) database.

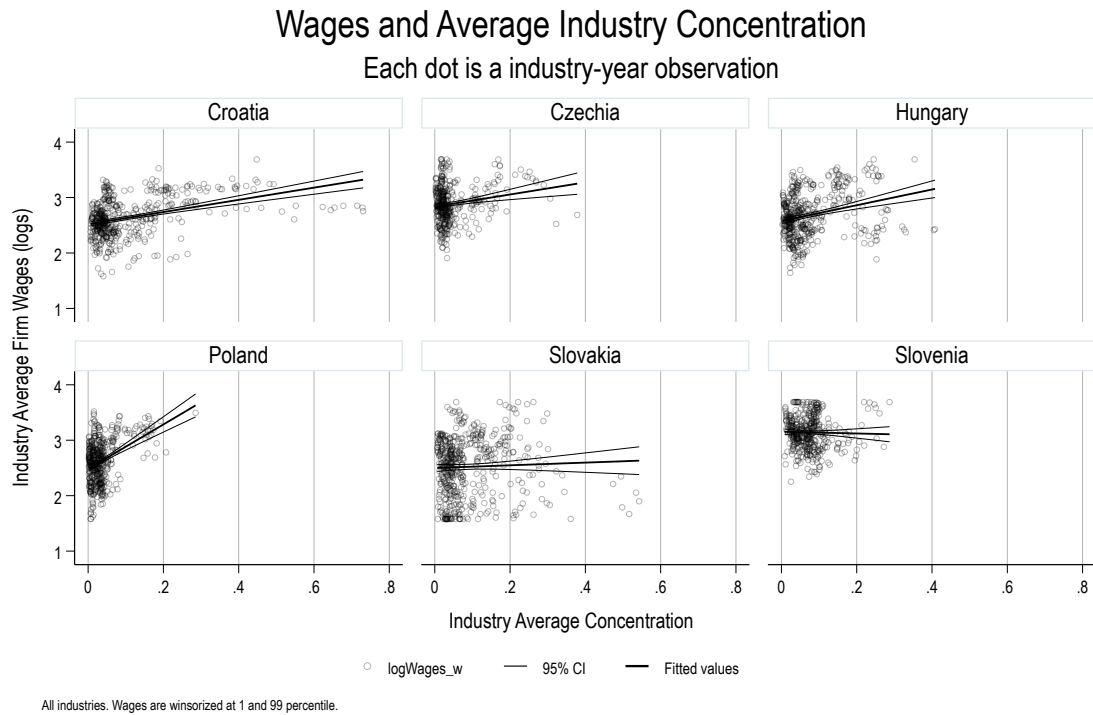


Figure 2: Average Industrial Concentration and Wages across all industries in CEE countries, 2000-2020.

Figure displays a scatter plot of the relationship between average industrial concentrations and average wages in six CEE countries across twenty-eight EU-KLEMS (aggregated as the weighted average of total revenues). Wages are log-transformed. Industrial concentration is proxied by HHI in terms of total revenues (CV07_hhi_rev_pop_2D_tot) directly obtained from CompNet (2023) database.

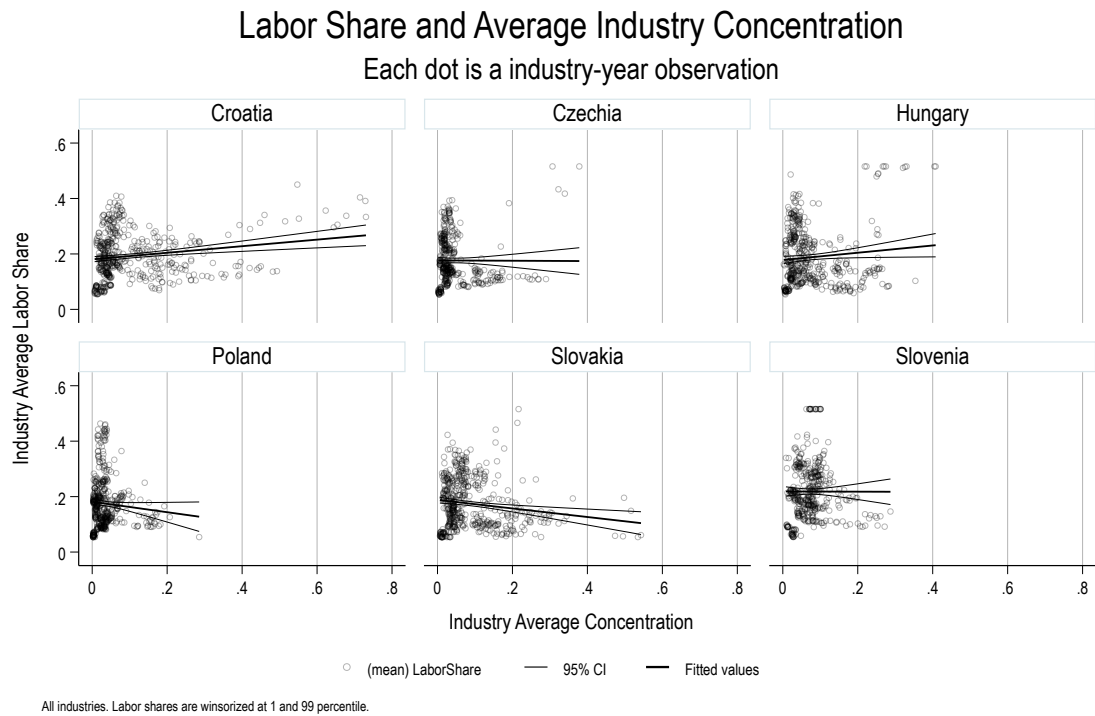


Figure 3: Average Industrial Concentration and Labor shares across all industries in CEE countries, 2000-2020.

Figure displays a scatter plot of the relationship between average industrial concentrations and average labor shares in six CEE countries across twenty-eight EU-KLEMS (aggregated as the weighted average of total revenues). Industrial concentration is proxied by HHI in terms of total revenues (CV07_hhi_rev_pop_2D_tot) directly obtained from CompNet (2023) database.

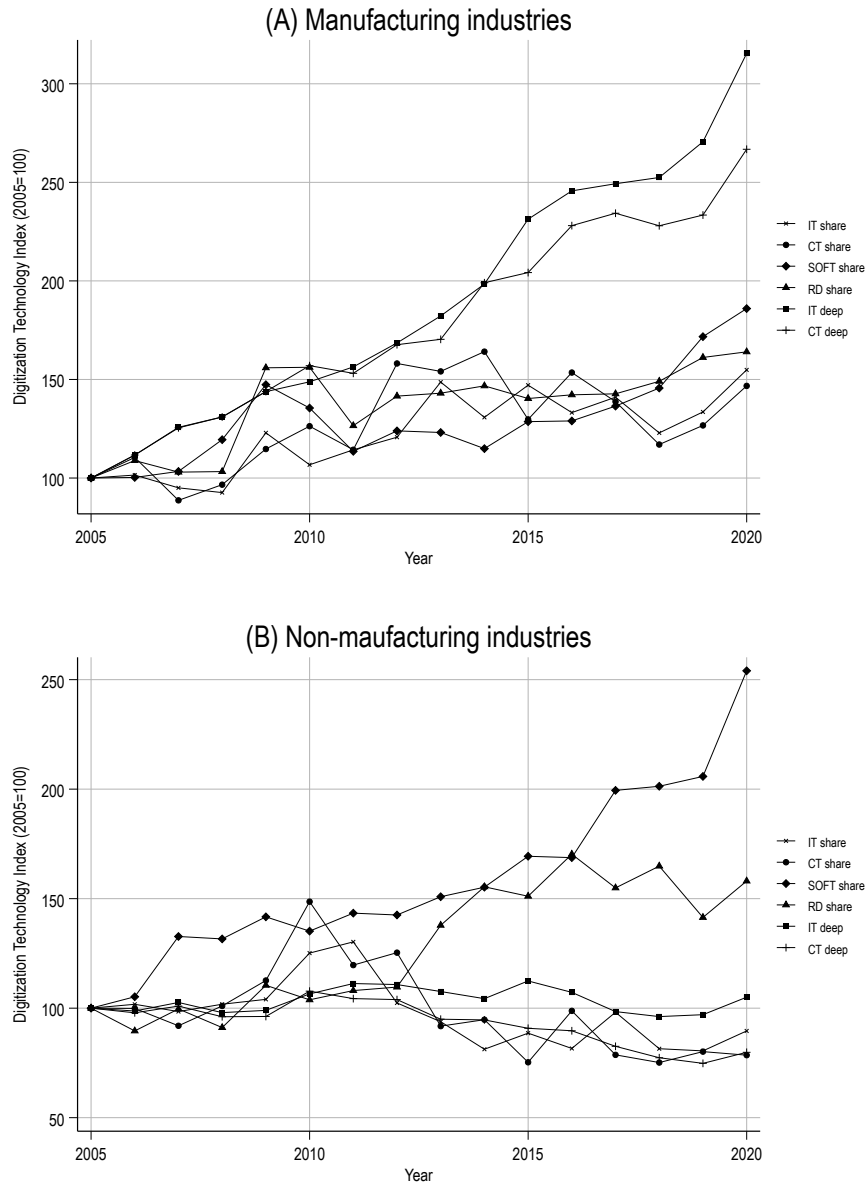


Figure 4: Digitalization technologies indexes over four CEE countries, 2005-2020.

The figure shows the evolution of the digitalization indices based on (Ferschli et al., 2021) and the KLEMS database. Investment in information technology ("IT share"), investment in communication technology ("CT share"), investment in research and development ("RD share"), and software and databases ("SOFT share"), all measured as a share of non-residential gross fixed capital formation. The stock of IT capital ("IT deep") and the stock of software and databases ("SOFT deep") are both relative to hours worked. Weighted averages by industrial employment of digitalization technologies are taken for four countries and all industries for which data on the above-mentioned flows and stocks of "digital capital" are available. All 2-digit manufacturing industries are imputed by the 1-digit manufacturing sector in Slovenia, as the data for 2-digit industries are not available.

	log(Labor Productivity)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HHI	0.088*** (0.028)	0.109*** (0.028)	0.052** (0.024)	0.043* (0.026)	0.082*** (0.027)	0.096*** (0.028)	0.088*** (0.032)
IT share _{t-1}	0.044** (0.019)						0.072** (0.033)
CT share _{t-1}		-0.011 (0.014)					-0.057** (0.029)
SOFT share _{t-1}			-0.070*** (0.020)				-0.090*** (0.031)
RD share _{t-1}				-0.004 (0.012)			0.007 (0.016)
IT deep _{t-1}					0.065*** (0.019)		0.014 (0.034)
CT deep _{t-1}						0.008 (0.015)	0.021 (0.031)
Capital Intensity _{t-1}	0.246*** (0.029)	0.221*** (0.032)	0.281*** (0.022)	0.272*** (0.023)	0.230*** (0.028)	0.237*** (0.029)	0.191*** (0.038)
Constant	2.556*** (0.193)	2.828*** (0.195)	2.544*** (0.149)	2.357*** (0.151)	2.657*** (0.184)	2.687*** (0.191)	2.934*** (0.221)
Industry, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.682	0.687	0.682	0.676	0.686	0.682	0.693
N	953	910	1344	1204	955	954	783

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Relationship between labor productivity and digitalization in CEE countries, 2005-2020.

All variables are taken as means from CompNet 9th vintage database and aggregated to EU-KLEMS 2-digit industries as a weighted average by total revenues of CompNet industries. Labor productivity is measured as real value added over the total labor using CompNet data. Industrial concentration is proxied by HHI measured by total revenues (CV07_hhi_rev_pop_2D_tot) and capital intensity (FR30_rk_l_mn) directly obtained from the CompNet database. All variables are log-transformed. The definitions of digitalization measures follow description under the Figure 4. All variables are log-transformed. Fixed effects are defined as twenty-eight EU-KLEMS (C - N NACE rev. 2) industry categories and four CEE countries (Czechia, Hungary, Slovakia, and Slovenia). Standard errors estimates are HAC robust.

	log(Labor Productivity)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HHI _{t-1}	0.058* (0.030)	0.039 (0.032)	0.014 (0.027)	0.018 (0.026)	0.179*** (0.034)	0.254*** (0.040)	0.230 (0.151)
IT share _{t-1}	0.155*** (0.047)						-0.015 (0.136)
IT share × HHI _{t-1}	0.039*** (0.014)						-0.025 (0.041)
CT share _{t-1}		0.113*** (0.036)					-0.079 (0.090)
CT share × HHI _{t-1}		0.045*** (0.012)					-0.000 (0.030)
SOFT share _{t-1}			0.060 (0.046)				0.129 (0.087)
SOFT share × HHI _{t-1}			0.044*** (0.014)				0.062*** (0.023)
RD share _{t-1}				0.076** (0.030)			-0.070* (0.037)
RD share × HHI _{t-1}				0.024*** (0.009)			-0.024** (0.011)
IT deep _{t-1}					0.184*** (0.029)		-0.064 (0.100)
IT deep × HHI _{t-1}					0.045*** (0.007)		-0.027 (0.031)
CT deep _{t-1}						0.139*** (0.026)	0.230** (0.098)
CT deep × HHI _{t-1}						0.048*** (0.007)	0.074** (0.030)
Capital Intensity × HHI _{t-1}							0.003 (0.039)
Capital Intensity _{t-1}	0.249*** (0.029)	0.220*** (0.032)	0.288*** (0.023)	0.260*** (0.023)	0.241*** (0.028)	0.252*** (0.029)	0.200 (0.125)
Constant	2.472*** (0.195)	2.687*** (0.197)	2.441*** (0.150)	2.303*** (0.149)	2.930*** (0.194)	3.114*** (0.209)	3.392*** (0.495)
Industry, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.685	0.694	0.685	0.680	0.703	0.701	0.720
N	953	910	1344	1204	955	954	783

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Relationship between labor productivity and digitalization in CEE countries, 2005-2020.

Data description, transformation, and industrial resolution follow description under the Table 3.

	log(Wages)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HHI	0.021** (0.008)	0.017** (0.009)	0.008 (0.008)	0.008 (0.008)	0.017** (0.008)	0.020** (0.008)	0.017** (0.009)
IT share _{t-1}	-0.001 (0.005)						-0.002 (0.010)
CT share _{t-1}		0.003 (0.005)					-0.003 (0.007)
SOFT share _{t-1}			-0.002 (0.006)				0.016** (0.006)
RD share _{t-1}				0.002 (0.003)			0.001 (0.004)
IT deep _{t-1}					0.011** (0.004)		0.001 (0.009)
CT deep _{t-1}						0.013** (0.005)	0.019* (0.010)
Capital Intensity	0.078*** (0.011)	0.077*** (0.012)	0.140*** (0.012)	0.144*** (0.013)	0.077*** (0.011)	0.081*** (0.011)	0.086*** (0.013)
Constant	2.090*** (0.060)	2.081*** (0.064)	1.946*** (0.059)	1.951*** (0.061)	2.071*** (0.057)	2.093*** (0.057)	2.097*** (0.072)
Industry, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.933	0.931	0.899	0.908	0.933	0.933	0.947
N	953	910	1344	1204	955	954	783

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Relationship between wages and digitalization in CEE countries, 2005-2020.

All variables are taken as means from CompNet 9th vintage database and aggregated to EU-KLEMS 2-digit industries as a weighted average by total revenues of CompNet industries. Wages are measured as a share of total labor costs over total labor ($FV05_nlc_mn * FV05_nlc_sw / LV21_l_mn * LV21_l_sw$) using the CompNet data. Industrial concentration is proxied by HHI measured by total revenues ($CV07_hhi_rev_pop_2D_tot$) and capital intensity ($FR30_rk_l_mn$) directly obtained from the CompNet database. All variables are log-transformed. The definitions of digitalization measures follow description under the Figure 4. All variables are log-transformed. Fixed effects are defined as twenty-eight EU-KLEMS (C - N NACE rev. 2) industry categories and four CEE countries (Czechia, Hungary, Slovakia, and Slovenia). Standard errors estimates are HAC robust.

	log(Wages)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HHI	0.027*** (0.009)	0.018* (0.011)	0.022** (0.010)	0.009 (0.009)	0.001 (0.009)	0.001 (0.009)	-0.185*** (0.047)
IT share _{t-1}	-0.023* (0.013)						0.033 (0.037)
IT share×HHI _{t-1}	-0.008** (0.004)						0.009 (0.011)
CT share _{t-1}		0.001 (0.010)					0.010 (0.022)
CT share×HHI _{t-1}		-0.001 (0.003)					0.007 (0.008)
SOFT share _{t-1}			-0.049*** (0.018)				0.024 (0.020)
SOFT share×HHI _{t-1}			-0.016*** (0.005)				0.006 (0.005)
RD share _{t-1}				-0.001 (0.010)			-0.008 (0.010)
RD share×HHI _{t-1}				-0.001 (0.003)			-0.004 (0.003)
IT deep _{t-1}					-0.009 (0.007)		-0.056 (0.038)
IT deep×HHI _{t-1}					-0.008*** (0.002)		-0.021* (0.012)
CT deep _{t-1}						-0.003 (0.007)	0.047 (0.038)
CT deep×HHI _{t-1}						-0.006*** (0.002)	0.011 (0.012)
Capital Intensity×HHI _{t-1}							0.055*** (0.012)
Capital Intensity _{t-1}	0.078*** (0.011)	0.077*** (0.012)	0.137*** (0.012)	0.145*** (0.013)	0.075*** (0.011)	0.079*** (0.011)	0.238*** (0.037)
Constant	2.107*** (0.063)	2.084*** (0.066)	1.983*** (0.063)	1.953*** (0.061)	2.026*** (0.057)	2.042*** (0.057)	1.564*** (0.143)
Industry, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.934	0.931	0.900	0.908	0.934	0.934	0.951
N	953	910	1344	1204	955	954	783

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Relationship between wages and digitalization in CEE countries, 2005-2020.

Data description, transformation, and industrial resolution follow description under the Table 5.

	log(Labor Share)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HHI _{t-1}	-0.073*** (0.017)	-0.068*** (0.018)	-0.080*** (0.014)	-0.092*** (0.015)	-0.069*** (0.017)	-0.072*** (0.017)	-0.084*** (0.020)
IT share _{t-1}	0.008 (0.008)						0.002 (0.012)
CT share _{t-1}		0.011* (0.006)					0.034** (0.014)
SOFT share _{t-1}			0.013 (0.009)				-0.004 (0.010)
RD share _{t-1}				-0.002 (0.004)			-0.008 (0.006)
IT deep _{t-1}					-0.018** (0.008)		0.016 (0.015)
CT deep _{t-1}						-0.018** (0.009)	-0.059*** (0.017)
Capital Intensity	-0.160*** (0.015)	-0.148*** (0.016)	-0.111*** (0.013)	-0.107*** (0.013)	-0.162*** (0.015)	-0.165*** (0.014)	-0.140*** (0.020)
Constant	-2.059*** (0.088)	-2.089*** (0.097)	-2.263*** (0.074)	-2.294*** (0.076)	-2.039*** (0.088)	-2.065*** (0.087)	-2.296*** (0.109)
Industry, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.920	0.922	0.907	0.907	0.920	0.920	0.931
N	954	911	1345	1205	956	955	784

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Relationship between labor share and digitalization in CEE countries, 2005-2020.

All variables are taken as means from CompNet 9th vintage database and aggregated to EU-KLEMS 2-digit industries as a weighted average by total revenues of CompNet industries. Labor share is measured as total labor costs over total revenues using CompNet data. Industrial concentration is proxied by HHI measured by total revenues (CV07_hhi_rev_pop_2D_tot) and capital intensity (FR30_rk_l_mn) directly obtained from the CompNet database. All variables are log-transformed. The definitions of digitalization measures follow description under the Figure 4. All variables are log-transformed. Fixed effects are defined as twenty-eight EU-KLEMS (C - N NACE rev. 2) industry categories and four CEE countries (Czechia, Hungary, Slovakia, and Slovenia). Standard errors estimates are HAC robust.

	log(Labor Share)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HHI _{t-1}	-0.072*** (0.018)	-0.087*** (0.020)	-0.073*** (0.015)	-0.070*** (0.015)	-0.066*** (0.017)	-0.061*** (0.018)	-0.015 (0.065)
IT share _{t-1}	0.006 (0.021)						-0.114** (0.051)
ITshare×HHI _{t-1}	-0.001 (0.006)						-0.042*** (0.016)
CT share _{t-1}		0.044*** (0.016)					0.135*** (0.038)
CT share×HHI _{t-1}		0.012** (0.005)					0.041*** (0.013)
SOFT share _{t-1}			-0.012 (0.023)				0.022 (0.034)
SOFT share×HHI _{t-1}			-0.008 (0.006)				0.006 (0.009)
RD share _{t-1}				-0.078*** (0.014)			-0.059*** (0.019)
RD share×HHI _{t-1}				-0.023*** (0.004)			-0.016*** (0.005)
IT deep _{t-1}					-0.014 (0.013)		0.088 (0.059)
IT deep×HHI _{t-1}					0.002 (0.003)		0.024 (0.019)
CT deep _{t-1}						-0.010 (0.014)	-0.137** (0.058)
CT deep×HHI _{t-1}						0.003 (0.003)	-0.028 (0.018)
Capital Intensity×HHI							-0.040** (0.017)
Capital Intensity	-0.160*** (0.015)	-0.148*** (0.016)	-0.112*** (0.013)	-0.096*** (0.013)	-0.161*** (0.015)	-0.164*** (0.014)	-0.254*** (0.055)
Constant	-2.057*** (0.091)	-2.125*** (0.099)	-2.244*** (0.076)	-2.249*** (0.073)	-2.029*** (0.087)	-2.037*** (0.088)	-2.058*** (0.205)
Industry, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R ²	0.920	0.923	0.907	0.912	0.920	0.920	0.935
N	954	911	1345	1205	956	955	784

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Relationship between labor share and digitalization in CEE countries, 2005-2020.

Data description, transformation, and industrial resolution follow description under the Table 7.