Can misallocation explain productivity dispersion across firms?

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1. Introduction

Allocation of resources plays an important role in determining productivity outcomes and fostering economic growth. Understanding the relationship between resource allocation and productivity is essential for policymakers and businesses alike. Recent research conducted by Kuosmanen et al. (2022) and Dai et al. (2022) sheds light on the misallocation of labor and capital in 16 Finnish industries analyzed for the years 2005, 2012, and 2018. Their findings suggest that many industries achieve only about half of their potential output with the available labor and capital resources. Notably, there is a capital bias, as average unit costs of capital consistently exceed the marginal product, indicating inefficient utilization of capital resources. On the other hand, the marginal product of labor tends to exceed the average unit cost, suggesting that hiring additional employees would benefit the society. Misallocation is particularly severe in manufacturing industries, while service industries with strong market competition demonstrate higher allocative efficiency. Potential factors contributing to these findings include job and skills mismatch, taxation policies, labor outsourcing, and market power.

The previous studies by Kuosmanen et al. (2022) and Dai et al. (2022) examine misallocation of resources between firms at the industry level. To gain further insight on the misallocation of resources within firms, this report examines the relationship between labor and capital misallocation and productivity at the firm level. To ensure comparability, the same 16 Finnish industries during the years 2005, 2012, and 2018 are considered as in Kuosmanen et al. (2022) and Dai et al. (2022).

The main findings of this report are as follows:

- Labor misallocation has a significant negative association with labor productivity of the firm.
- The relationship between capital misallocation and productivity is more nuanced. While capital misallocation tends to hamper capital productivity, overinvestment in capital may increase labor productivity.

- The levels of labor and capital misallocation and their links with productivity differ considerably across the 16 industries considered.

The rest of the report is organized as follows: Section 2 explains how misallocation is operationalized. Section 3 introduces the data, variables, and describes the misallocation in the 16 Finnish industries in 2005, 2012, and 2018. Section 4 investigates the relationship between labor and capital misallocation and productivity. Section 5 concludes.

2. Misallocation of labor and capital

Misallocation of labor and capital can have significant implications for efficiency and productivity. The first-order conditions of profit maximization require that the marginal products of labor and capital equal their marginal costs. Therefore, the ratio of marginal cost to marginal product serves as a natural measure to evaluate the efficiency of resource allocation at the firm level. A ratio equal to one indicates efficient allocation of resources, whereas notable deviations from the value of one are an indication of misallocation.

The marginal cost of labor is the gross wage and the marginal cost of capital is the rate of return, both of which are usually taken as constants (assuming competitive labor and capital markets). Allowing for heterogenous employee skills and productivity across firms, we approximate the marginal cost of labor as the total gross payroll of the firm divided by the number of employees. Similarly, the marginal cost of capital is approximated at the firm level as the ratio of the gross accounting profit and the fixed assets.

To assess the efficiency of resource allocation, we calculate the ratios of the marginal costs and the marginal products for labor L and capital K as follows:

(1) $$E_L = MC_L/MP_L$$

$$E_K = MC_K/MP_K$$

Values of E_L and E_K closer to one indicate better allocation. To measure the extent of misallocation, we calculate the deviations of labor and capital allocation from their optimal level of one as follows:

(2) $$M_L = 0.5(E_L - 1)^2$$

$$M_K = 0.5(E_K - 1)^2$$

Higher values of M_L or M_K indicate greater deviation from optimal allocation. Incorporating these measures of labor (M_L) and capital (M_K) misallocation in regression analysis allows us to shed further light on the relationship between resource misallocation and productivity.

3. Data and variables

We utilize data from two distinct sources. First, we rely on the estimates of marginal products of labor (MP_L) and capital (MP_K) for 16 Finnish industries in the years 2005, 2012, and 2018, as obtained from the studies conducted by Kuosmanen et al. (2022) and Dai et al. (2022). These estimates serve as the basis for calculating indicators of labor (M_L) and capital (M_K) misallocation. Second, we utilize the Financial Statement Data Panel sourced from Statistics Finland, which provides extensive firm-level accounting data covering a wide range of enterprises across almost all industries.

In our regression analysis, the dependent variables of interest are labor productivity (LP) and capital productivity (KP). LP is calculated as the ratio of value added (in euros) to the labor input, measured in terms of the number of employees in full-time equivalent. KP is calculated as the ratio of value added to fixed assets (in euros). To explore the factors associated with LP and KP, we use several explanatory variables in the regression equation. These include indicators of labor and capital misallocation measured by the deviation from optimal levels of labor and capital allocation. Additionally, we consider the number of employees, firm age, and equity ratio as explanatory variables. These variables allow us to examine the associations between workforce size, firm maturity and financial structure and LP and KP. To ensure comparability and account for inflationary effects, all nominal values in the analysis are deflated to the constant prices of the year 2015 using the GDP deflator provided by Statistics Finland.

3.1 Descriptive analysis

Figures 1-4 provide industry- and year-level summaries of labor (M_L) and capital (M_K) misallocation in 16 industries (see Appendix A for the list of the analyzed industries), capturing overall trends and patterns of misallocation more informatively.

Figures 1 and 2 present the median values of labor misallocation in eight manufacturing industries and eight other industries, respectively. Particularly, the *Manufacture of basic pharmaceutical products and pharmaceutical preparations* industry shows significant deviations from optimal labor allocation in 2005 and 2012, with some improvements observed by 2018.

Generally, the allocation of labor in the considered manufacturing industries demonstrates limited improvement over time, except for *Food manufacturing*. Noteworthy misallocation in the allocation of labor is observed in other industries, such as the *Production of electricity with hydropower and wind power* in 2005 and 2012, *Combined heat and power production* in 2005 and 2018, and *Activities of sport clubs* in 2012 and 2018.

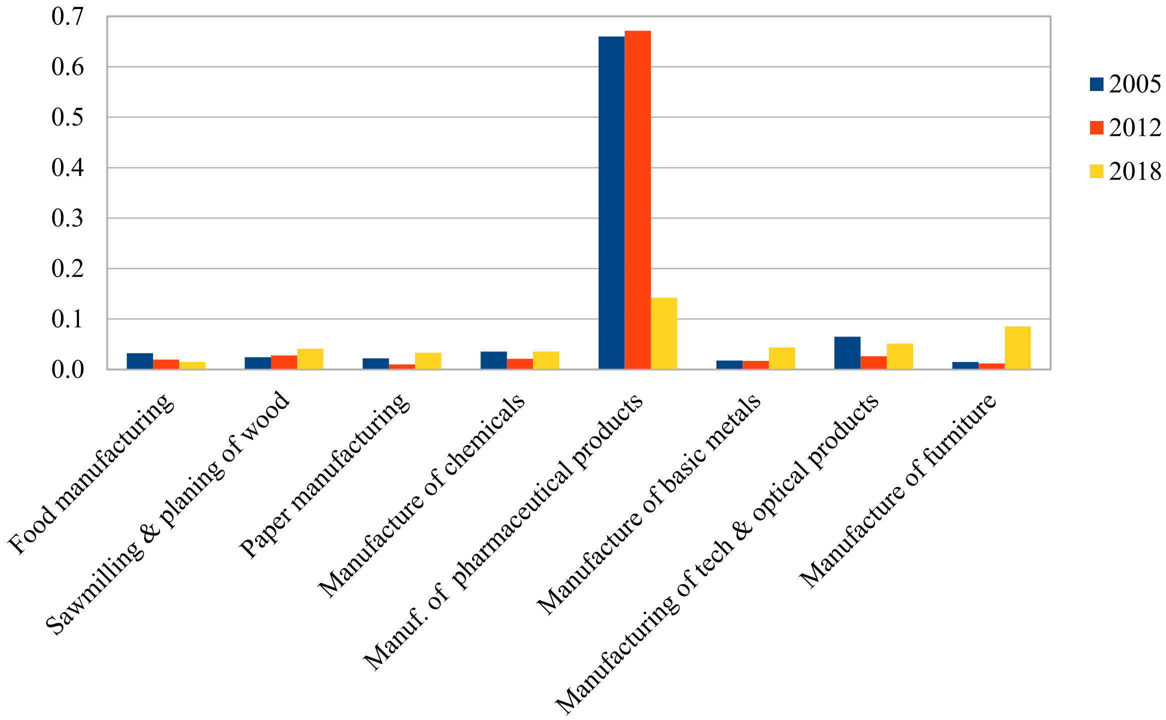

Figure 1. The misallocation of labor in eight manufacturing industries measured in terms of deviation of labor from optimal allocation.

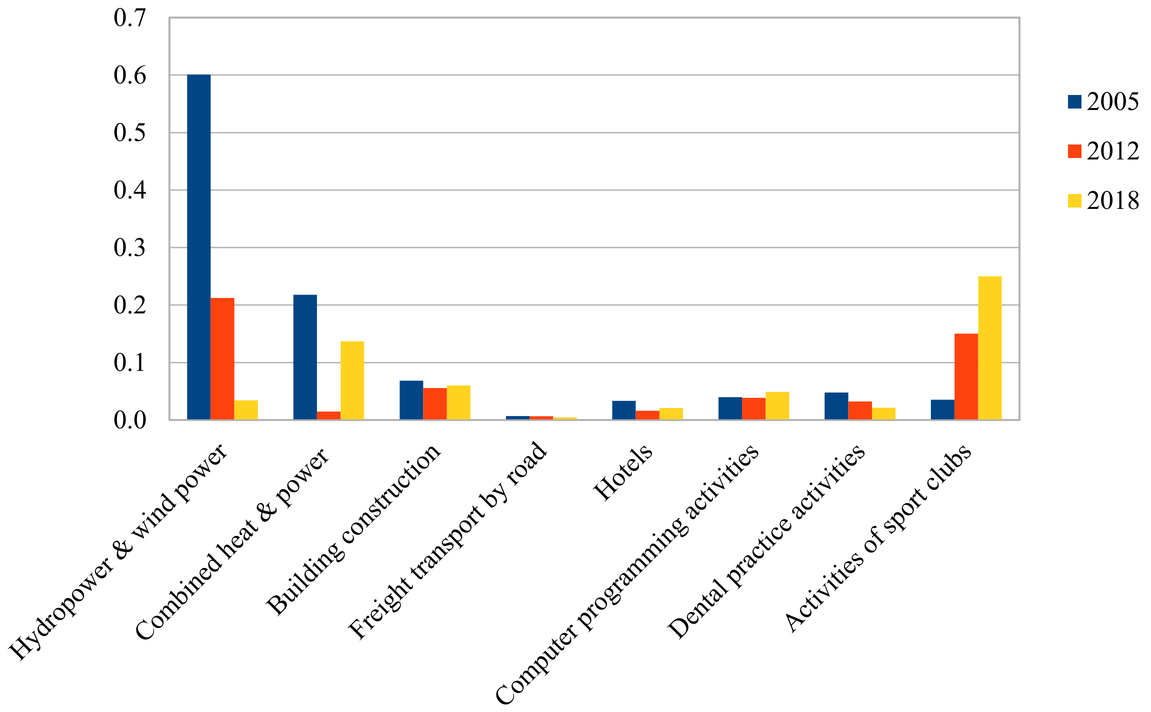

Figure 2. The misallocation of labor in eight other industries measured in terms of deviation of labor from optimal allocation.

Figures 3 and 4 display the median values of capital misallocation in eight manufacturing industries and eight other industries, respectively. The *Manufacture of computer, electronic and optical products* industry exhibits significant deviations from optimal capital allocation in both 2012 and 2018. Similarly, the *Manufacture of furniture* industry demonstrates notable misallocation in 2012. However, certain manufacturing industries, such as *Food manufacturing*, *Sawmilling and planing of wood*, *Manufacture of paper and paper products*, and *Manufacture of basic pharmaceutical products and pharmaceutical preparations*, show improvements in capital allocation over time. In other industries, remarkable deviations from optimal capital allocation are observed in 2005, including the *Production of electricity with hydropower and wind power* and *Hotels* industries. Additionally, significant deviations from optimal capital allocation are observed in the *Dental practice* and *Sport clubs* industries.

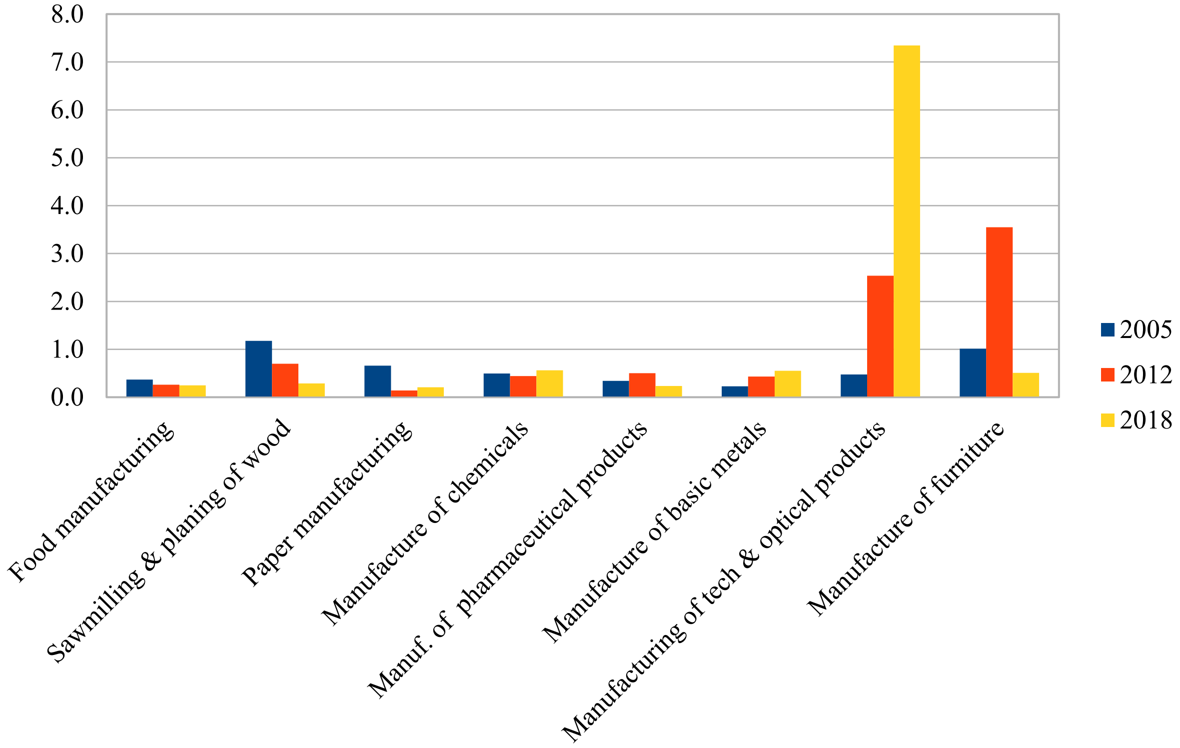

Figure 3. The misallocation of capital in eight manufacturing industries measured in terms of deviation of capital from optimal allocation.

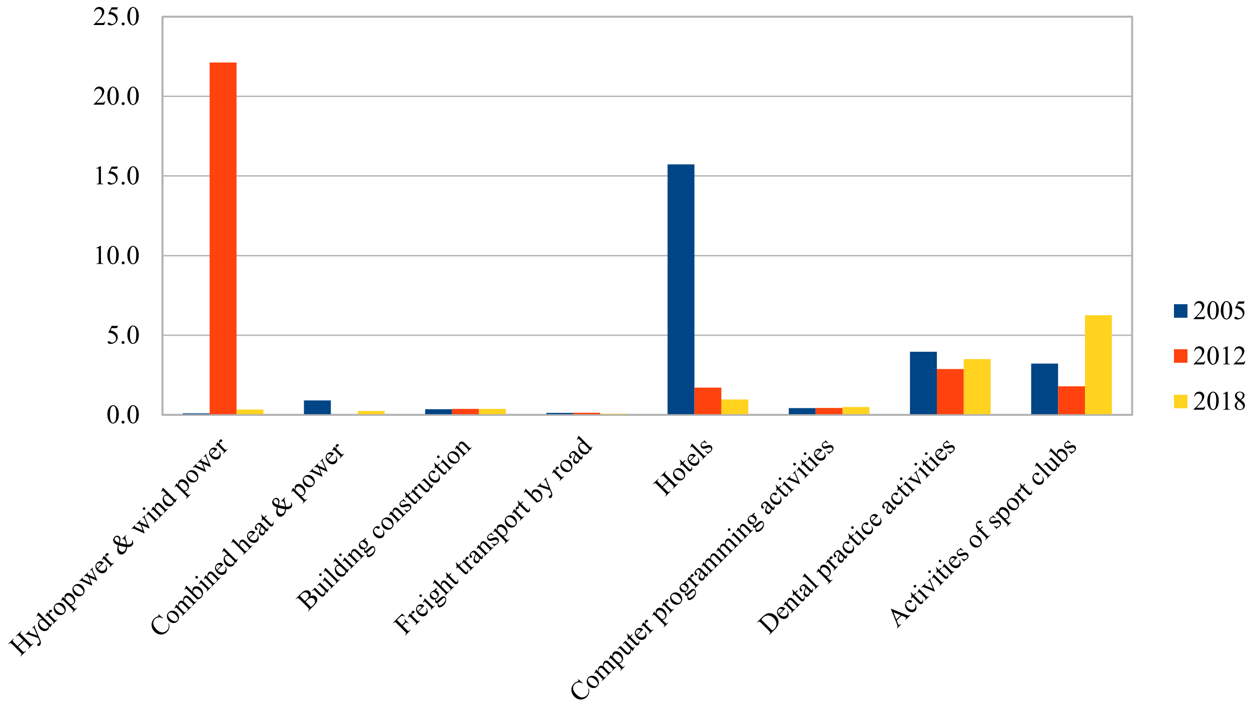

Figure 4. The misallocation of capital in eight manufacturing industries measured in terms of deviation of capital from optimal allocation.

4. Regression analysis

The regression analysis results presented in Table 1 provide some insights into the relationship between resource misallocation and productivity indicators LP and KP. The table displays the estimated coefficients and their statistical significance for the key variables of interest, namely labor misallocation, capital misallocation, labor input, firm age, and equity ratio of firms. To account for potential confounding factors, the regression models (1)-(2) incorporate industry and year dummy variables, which help control for the specific industries effects and time-related factors that may influence the relationship between resource misallocation and productivity. Additionally, fixed effects regression models (3) and (4) are employed to address time-invariant unobserved individual characteristics of firms that could be correlated with the observed independent variables.

Table 1. Regression results for labor productivity (LP) and capital productivity (KP)

	(1)	(2)	(3)	(4)
Variables	**lnLP**	**lnKP**	**lnLP**	**lnKP**
Labor misallocation	-9.50e-34*** (3.48e-34)	1.27e-33 (9.62e-34)	-1.61e-33*** (5.92e-34)	6.12e-35 (1.39e-33)
Capital misallocation	7.77e-37*** (2.25e-37)	-1.47e-36** (6.22e-37)	-1.10e-36 (8.68e-37)	-2.32e-36 (2.04e-36)
Number of employes	0.0001*** (1.64e-05)	-0.0003*** (4.53e-05)	-0.0001*** (2.21e-05)	0.0001*** (5.15e-05)
ln(Firm age)	0.0535*** (5.7e-03)	-0.170*** (0.016)	0.0553*** (0.0106)	0.0575 (0.0447)
Equity ratio	0.0017*** (7.02e-05)	-0.0012*** (0.0002)	0.0012*** (0.0002)	0.0005 (0.0003)
Year dummy	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	No	No
Firm fixed effects	No	No	Yes	Yes
Observations	14,096	14,096	14,096	14,096
R^2	0.166	0.206	0.037	0.008
Number of firms	8,866	8,866	8,866	8,866

Notes: Regression models (1) and (2) include controls for industry and year effects, while fixed effects regression models (3) and (4) account for time-invariant unobserved individual characteristics. Standard errors are reported in parentheses. The notation *** denotes statistical significance at the p<0.01 level, ** at the p<0.05 level, and * at the p<0.1 level.

Regarding labor misallocation, the coefficient estimates in models (1) and (3) show a significant negative relationship with LP, as denoted by the p-value of <0.01. This suggests that higher levels of misallocation in the allocation of labor resources across firms are associated with lower LP. However, it is important to note that the magnitude of the coefficient is very small, indicating that the impact of labor misallocation on LP is negligible. Nevertheless, the statistical significance implies evidence of a relationship between labor misallocation and LP. In models (2) and (4), the coefficient estimates for labor misallocation on KP fail to achieve statistical significance.

For capital misallocation, the coefficient estimate in model (1) is positive and statistically significant at the 1% level, indicating that higher levels of capital misallocation are associated with higher LP. However, in model (3), the coefficient estimate for capital misallocation is negative but not statistically significant. The coefficient estimates for capital misallocation indicate a negative relationship with KP in models (2) and (4), suggesting that reducing capital misallocation is associated with higher KP. However, in model (4), capital misallocation does not exhibit statistically significant effects on KP.

In addition, the labor input variable shows a positive and statistically significant relationship with LP in model (1), indicating that increased labor input is associated with higher LP. However, in fixed effects model (3), the relationship becomes negative. This suggests that the impact of labor input on LP may vary depending on the inclusion of time-invariant unobserved individual characteristics. Firm age is found to have a positive and significant association with LP in models (1) and (3), indicating that older firms tend to have higher LP levels compared to younger firms. However, the impact of firm age on KP is negative in model (2) but positive in model (4). These findings highlight the nuanced relationship between firm age and productivity, which may be influenced by various factors related to resource allocation and organizational dynamics. Furthermore, the estimated coefficient of the equity ratio exhibits a significant positive relationship with LP in models (1) and (3). This implies that firms with a higher degree of self-sufficiency or equity financing tend to have higher LP. However, the estimated coefficient of the equity ratio shows a significant negative relationship with KP in model (2), suggesting that a higher equity ratio may be associated with lower KP.

In summary, the regression results indicate a significant relationship between labor misallocation and LP. Higher levels of labor misallocation within a firm are associated with a lower labor productivity. This suggests that both positive and negative deviations from the profit maximizing labor demand can hamper labor productivity at the firm level. The result remains significant when we control for the firm-specific fixed effects. On the other hand, the relationship between capital misallocation and productivity is more nuanced. While deviations from the profit maximizing capital demand tends to hamper capital productivity, overinvestment in capital can increase labor productivity. But when we control for the firm-specific fixed effects, the association between the capital misallocation and productivity becomes insignificant.

Examining the regression results for each of the 16 industries separately provides additional insights. Table 2 presents the outcomes of the regressions, investigating the relationship between labor and capital misallocation with LP across these industries. Unlike Table 1, which presented results from a pooled sample, Table 2 presents the findings from separate regressions for each industry, resulting in 16 distinct regressions. The table includes the estimated coefficients for labor misallocation (M_L) and capital misallocation (M_K) within the regression model, where LP serves as the dependent variable. The analysis incorporates factors such as the number of employees, firm age, and equity ratio, while also controlling for industry and year effects. However, these additional factors are not reported in the table. The direction of the estimated coefficients is indicated by the minus '–' and plus '+' signs. A minus sign indicates a negative association, while a plus sign indicates a positive association between misallocation and LP. The presence of asterisks indicates the statistical significance of the coefficients.

Interestingly, the results for industries individually align with the findings presented in Table 1 regarding the negative association between labor misallocation and LP (except for the statistically insignificant result in the *Manufacture of basic metals* industry). This implies a consistent pattern across industries, suggesting that higher levels of labor misallocation tend to be associated with lower LP. The association between labor misallocation and LP is statistically significant at the 1% level for three industries: *Sawmilling and planing of wood*, *Construction of residential and non-residential buildings*, and *Freight transport by road*. Additionally, for the *Manufacture of computer, electronic and optical products* industry, the association is statistically significant at the 5% level, while for the *Combined heat and power production* industry, it is significant at the 10% level.

The results for capital misallocation in the 16 industries reveal a mixed association with LP. Surprisingly, 11 industries show a positive association, with some displaying statistical significance. This counterintuitive finding suggests that reducing capital misallocation may not necessarily lead to a positive impact on LP in those specific industries. It is important to note that statistical associations alone do not imply causality, and further comprehensive investigations are necessary to understand the underlying mechanisms driving this result. Conversely, the association between capital misallocation and LP is negative in 5 industries, but the statistical insignificance implies that capital misallocation may not have a significant effect on LP in those particular industries. These mixed results highlight the complexity of the relationship between capital misallocation and LP and emphasize the need for additional research and analysis to unravel the underlying factors influencing these associations.

Table 2. Association of labor and capital misallocation with labor productivity in 16 industries.

Industry	**Misallocation**	
	Labor	***Capital***
Food manufacturing	–	+
Sawmilling and planing of wood	– ***	–
Manufacture of paper and paper products	–	+
Manufacture of chemicals and chemical products	–	–
Manufacture of pharmaceutical products	–	+ **
Manufacture of basic metals	+	–
Manufacture of computer, electronic and optical products	– **	+
Manufacture of furniture	–	+
Production of electricity with hydropower and wind power	–	–
Combined heat and power production	– *	+
Construction of residential and non-residential buildings	– ***	+ **
Freight transport by road	– ***	+
Hotels	–	+
Computer programming activities	–	–
Dental practice activities	–	+ *
Activities of sport clubs	–	+

Notes: The '–' and '+' signs in the table indicate the direction of the estimated coefficient for labor misallocation (M_L) and capital misallocation (M_K) in the regression model where labor productivity is the dependent variable. The regression model also includes other factors such as the number of employees, firm age, and equity ratio, along with controls for industry and year effects. Statistical significance is denoted by asterisks: *** denotes statistical significance at the p<0.01 level, ** at the p<0.05 level, and * at the p<0.1 level.

5. Conclusions

This report contributes to the existing body of research by providing additional evidence on the complex relationships between resource misallocation and productivity. Through descriptive analysis of the 16 Finnish industries, significant deviations from optimal labor and capital allocation are observed, particularly in the manufacturing sector. The regression analysis offers additional insights into the relationship between resource misallocation and productivity. It reveals a significant negative association between labor misallocation and LP, highlighting the importance of efficient labor allocation. The relationship between capital misallocation and productivity, however, displays more varied results across industries, warranting further investigation. Overall, the findings underscore the inefficiency of resource distribution and the potential for productivity losses in the majority of the industries examined. Variations in misallocation are evident among industries and over time. To maximize productivity outcomes, resource optimization becomes imperative, necessitating further research to understand the underlying factors and inform effective policy considerations.

References

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Kuosmanen, T., Kuosmanen, N. and Dai, S. (2022) *Comparison of marginal products and average unit costs*. In book: Misallocation of labor and capital in Finland's business sector. Publications of the Government´s analysis, assessment and research activities 2022:44.

Appendix A. Analyzed industries and their TOL 2008 codes.

Industry	TOL08
Manufacturing	**C**
- Manufacture of food products	C10
- Sawmilling and planing of wood	C16100
- Manufacture of paper and paper products	C17
- Manufacture of chemicals and chemical products	C20
- Manufacture of basic pharmaceutical products and pharmaceutical preparations	C21
- Manufacture of basic metals	C24
- Manufacture of computer, electronic and optical products	C26
- Manufacture of furniture	C31
Electricity, gas, steam and air conditioning supply	**D**
- Production of electricity with hydropower and wind power	D35111
- Combined heat and power production	D35113
Construction	**F**
- Construction of residential and non-residential buildings	F41200
Transportation and storage	**H**
- Freight transport by road	H49410
Accommodation and food service activities	**I**
- Hotels	I55101
Information and communication	**J**
- Computer programming activities	J62010
Human health and social work activities	**Q**
- Dental practice activities	Q86230
Arts, entertainment and recreation	**R**
- Activities of sport clubs	R93120

Source: Kuosmanen et al. (2022).