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DETERMINANTS OF SECTORAL PRODUCTIVITY IN TÜRKİYE: THE ROLE OF MARKET CONCENTRATION AND PRODUCTION STRUCTURE

Sinem SEFİL TANSEVER
Associate Professor
Istanbul Ticaret University
ssefil@ticaret.edu.tr
0000-0001-7124-8618

ABSTRACT

This study examines the determinants of sectoral productivity in Türkiye within the framework of market concentration, production structure, and macroeconomic factors using a fixed effects panel data model. The study utilizes the Annual Industry and Services Statistics (AISS) dataset from the Turkish Statistical Institute (TÜİK), creating a panel dataset covering 16 sectors at the NACE Rev.2 level for the period 2009–2022. The impact of market concentration on labor productivity is measured using the Herfindahl-Hirschman Index (HHI) and, alternatively, the CR4 concentration index. Capital intensity, employment-dependent sector size, adjusted labor share, and education level variables are used to examine the effect of production structure on productivity. Additionally, exchange rate and interest rate are included in the model as macroeconomic control variables. The empirical findings show that market concentration has a positive and significant effect on both productivity level and productivity growth; capital intensity and education level increase productivity; while labor share has a negative effect on productivity. The concentration-productivity relationship persists even when macroeconomic variables are included in the model. The fact that the CR4 variable, used as an alternative concentration indicator, was found to be statistically insignificant suggests that the sector-level market structure in Türkiye can be better represented by more comprehensive concentration indicators such as HHI. This reveals that sectoral productivity differences in Türkiye are shaped by the combined effect of market structure, capital-labor mix, and macroeconomic conditions. The findings offer important implications for competition policies, sector-based productivity strategies, and structural transformation policies.

Keywords: Multiple Criteria Decision Making, Regional Healthcare, Hybrid Criteria Weighting

1. INTRODUCTION

Sectoral productivity differences in Türkiye occupy a central place in discussions of economic growth and structural transformation. Understanding productivity dynamics, particularly in developing countries, is of great importance for sustainable growth, efficient resource allocation, and the effectiveness of competition policies. Labor productivity is a multidimensional phenomenon influenced by numerous micro and macro variables, including technological structure, capital intensity, production organization, human capital, market structure, and macroeconomic conditions. The pronounced productivity differences observed across sectors in Türkiye point to significant heterogeneities in terms of production structure, technological intensity, labor-capital composition, and market concentration.

Although studies on Türkiye have yielded important findings regarding productivity, labor share, and market structure, the relationship between concentration and productivity at the sectoral level has not been sufficiently examined within a long-run panel data framework. In particular, there is a significant gap in the literature regarding the effects of market concentration on both productivity levels and productivity growth, and how this relationship is shaped jointly by capital intensity, labor share, sector size, and macroeconomic variables. Furthermore, the effect of measuring concentration with alternative indicators on results has also been addressed in a limited manner.

2. LITERATURE REVIEW

Studies examining the relationship between competition, concentration, and productivity draw attention to the effects of market structure on firms' production behavior and resource allocation. Syverson (2004, 2011) shows that the exit of low-productivity firms from the market due to competitive pressure increases sectoral productivity. Similarly, Foster et al. (2008) demonstrate that sectoral productivity gains largely stem from the inter-firm reallocation mechanism within sectors. On a broader scale, De Loecker and Eeckhout (2017), Calligaris et al. (2018), and Autor et al. (2020) show that rising market concentration and markups at the global level are closely associated with productivity gains and a declining labor share.

Empirical findings from both developed and developing countries reveal that the concentration-productivity relationship can vary by country and sector structure. Rodríguez-Castelán et al. (2020) show that a reduction in market concentration increases firm-level productivity, while Savagar (2024) finds a positive relationship between rising concentration and increasing productivity for the United Kingdom. In contrast, Suyanto et al. (2022) demonstrate that high concentration in Indonesia's manufacturing industry can have adverse effects on productivity. These differing results suggest that the concentration-productivity relationship varies depending on the country structure, competitive conditions, and sectoral dynamics.

Another prominent element in the productivity literature is capital intensity. While Olley and Pakes (1996) and Melitz (2003) emphasize the role of capital deepening in productivity growth, Ahmad

and Peters (2018) draw attention to the quality and technological structure of capital equipment. In this context, capital intensity is regarded as one of the key determinants of inter-sectoral productivity differences.

Studies on Türkiye show that there are pronounced differences in productivity and market structure across sectors. Ünveren and Sunal (2015) demonstrate that the primary cause of the low labor share in Türkiye is not low productivity but high price markups, and that market concentration has important distributional consequences. The Central Bank of the Republic of Türkiye (2021) points to the importance of structural transformation by showing that changes in the labor share since the mid-2000s are related to intra-sector and inter-sector dynamics.

When sector-level studies are examined, concentration levels are found to vary significantly across sectors in Türkiye. While Sarıdoğan (2021) identifies moderate concentration in the information technology sector, Karaçayır (2021) shows that concentration in manufacturing increases export intensity. Polat (2007) and Öngel (2022) draw attention to high concentration levels in the cement sector, while Ünsal and Akbıyık (2019) show that concentration in the beverage sector has decreased over time. These findings reveal that there are strong heterogeneities across sectors in Türkiye in terms of both market structure and productivity.

This study makes three main contributions to the existing literature. First, it examines the concentration-productivity relationship across sectors at the NACE Rev.2 level in Türkiye within a long-run panel data framework. Second, it evaluates the dynamic effects of concentration by analyzing not only productivity levels but also productivity growth. Finally, the study provides empirical evidence on the sensitivity of concentration indicators by comparing HHI and CR4, shedding light on which metrics better represent the sector-level market structure in Türkiye.

3. DATA AND METHODOLOGY

This study uses the Annual Industry and Services Statistics (AISS) dataset published by the Turkish Statistical Institute (TÜİK) to examine the determinants of sectoral productivity in Türkiye. The study period covers the years 2009–2022, and the analysis is based on a balanced panel dataset of 16 sectors constructed according to the NACE Rev.2 classification. The AISS dataset provides a large-scale firm-level dataset covering approximately 3 to 4 million active enterprises annually during the analysis period, and contains detailed information on turnover, production value, value added at factor cost, personnel costs, and various firm characteristics.

From this dataset, key variables were constructed at the NACE2 sector level. The dependent variable, labor productivity (lnprod), is defined as the ratio of value added to employment at the sector level. In addition, the productivity growth variable (Δlnprod) was also used in the analysis to examine the dynamic nature of productivity.

The main variable representing market structure is the Herfindahl-Hirschman Index (HHI), calculated as the sum of squared market shares of firms within their respective sectors:

$$HHI_j = \sum_{(i=1)}^{N} s_{ij}^2 \quad (1)$$

where s_{ij}^2 = market share of firm i in sector j, and N = number of firms in the sector.

Market shares in Equation 1 are measured using the turnover variable. HHI is preferred because of its potential to more comprehensively reflect the market structure at the NACE2 level and its capacity to yield more reliable results. To test the robustness of the results, the CR4 variable (the combined share of the top four firms) is also included in the model as an alternative concentration measure:

$$CR4_j = \sum_{(i=1)}^{4} s_{ij} \quad (2)$$

where s_{ij} = market shares of the 4 largest firms in sector j.

Since the CR4 concentration ratio only takes into account the market share of the four largest firms, it risks being unable to adequately represent the broad and heterogeneous sector structure at the NACE2 level in Türkiye. In contrast, since the HHI index encompasses the market shares of all firms, it reflects sector-level concentration more comprehensively.

Control variables reflecting the production structure include capital intensity (lncer), sector size by number of employees (lnemployment), and adjusted labor share (adj_ls). Capital intensity is calculated as the ratio of fixed assets to employment, and fixed asset data were obtained from TÜİK's Sector Balance Sheet Statistics (SBSS) dataset. The adjusted labor share is corrected using the ratio of total employment to the number of employees to account for differences in employment structure. In addition, the average years of schooling variable is included in the model to control for the human capital effect.

To control for macroeconomic conditions, the exchange rate and interest rate variables are included in the analysis. These variables do not vary across sectors, change only in the time dimension, and represent common macroeconomic shocks affecting all sectors.

The study uses a fixed effects (FE) panel data model to analyze the determinants of sectoral productivity. This method ensures more reliable estimates by controlling for unobserved, time-invariant sector-specific characteristics.

The baseline model estimated is expressed as follows:

$$\ln prod_{\{it\}} = \beta_0 + \beta_1\, hhi_{\{it\}} + \beta_2\, lncer_{\{it\}} + \beta_3\, lnemployment_{\{it\}} + \beta_4\, adj\_ls_{\{it\}} + \gamma_t + u_i + \varepsilon_{\{it\}} \quad (3)$$

This model estimates the effects of concentration (HHI), capital intensity, sector size, and adjusted labor share on productivity while controlling for unobserved, time-invariant sector-specific heterogeneity. In subsequent models, year fixed effects are included to control for common time shocks. Later specifications add macroeconomic control variables such as exchange rate and interest rate. To test sensitivity related to the measurement of concentration, CR4 is used instead of HHI. The average years of schooling variable is included to examine the human capital effect, and in the final model the dependent variable is redefined as productivity growth (Δlnprod) to analyze the effect of concentration on productivity dynamics. All regression models are estimated using cluster-robust

standard errors at the sector level to reduce autocorrelation and heteroskedasticity. This stepwise modelling strategy allows a systematic examination of how the concentration-productivity relationship changes under different control variables and model specifications.

4. RESULTS

Table 1. Panel Data Descriptive Statistics (2009–2022)

Variable	Mean	Std. Dev.	Min	Max	Between Std. Dev.	Within Std. Dev.
Labor Productivity (lnprod)	11.584	1.045	9.687	15.150	0.856	0.635
Concentration (HHI)	0.034	0.083	0.001	0.633	0.075	0.040
Concentration (CR4)	0.193	0.193	0.026	0.895	0.192	0.050
Capital Intensity (lncer)	4.696	1.373	1.958	8.957	1.277	0.590
Sector Size (lnemployment)	12.441	1.379	9.876	15.254	1.405	0.207
Labor Share (adj_ls)	0.456	0.223	0.041	1.000	0.224	0.047
Average Years of Schooling	9.558	2.120	5.564	13.983	2.128	0.481
Exchange Rate	4.495	4.007	1.500	16.564	0.000	4.007
Interest Rate	15.559	4.471	8.908	24.078	0.000	4.471

Table 1 shows that there are pronounced heterogeneities both across and within sectors at the NACE2 level in Türkiye over time. First, the high between-sector (0.856) and within-sector (0.635) variance of labor productivity indicates high variability and underscores the necessity of the panel data approach as the methodological choice. Among concentration indices, the fact that the between-sector variance of HHI (0.075) is higher than its within-sector variance (0.040) indicates that the primary source of concentration lies in structural differences across sectors. The considerably higher between-sector variance of the CR4 concentration index compared to its within-sector variance points to the static nature of this index. Capital intensity (lncer) has meaningful variances both between and within sectors; the relative magnitude of between-sector variance is an indicator of the determining role of sectors' technological structures on this variable. Similarly, for sector size (lnemployment), between-sector variance (1.405) is considerably larger than within-sector variance (0.207). This suggests that sector size is a structural characteristic that does not change much over time. In the labor share (adj_ls) variable, the much higher between-sector variance (0.224) compared to within-sector variance (0.047) reveals that differences in labor intensity are pronounced across sectors. The average years of schooling variable, included as a human capital measure, similarly has high between-sector variance (2.128) and low within-sector variance (0.481), indicating that the education level differs across sectors but changes little over time.

The high within-sector variance values of the macroeconomic variables show that these variables fluctuated significantly during the analysis period. In general, the table shows that the determinants of sectoral productivity have both structural and dynamic components, and in particular that variables such as concentration, capital structure, and labor share may have significant explanatory power.

Table 2. Average Values of Productivity and Structural Indicators by Sector

Sector Name	Ln_productivity	HHI	CR4	lncer	Ln_employment	adj_ls
Mining and Quarrying	12.050	0.022	0.234	5.533	11.466	0.286
Manufacturing	11.451	0.003	0.077	4.728	14.948	0.427
Electricity, Gas, Steam and Air Conditioning Supply	13.083	0.032	0.261	7.651	11.249	0.142
Water Supply; Sewerage, Waste Mgmt. and Remediation	11.801	0.055	0.355	3.790	11.027	0.401
Construction	11.652	0.002	0.062	4.821	13.820	0.227
Wholesale and Retail Trade	11.256	0.001	0.046	4.227	14.584	0.457
Transportation and Storage	11.419	0.035	0.256	5.035	13.418	0.494
Accommodation and Food Service Activities	10.725	0.002	0.056	4.701	13.344	0.631
Information and Communication	12.276	0.051	0.389	5.218	11.893	0.389
Real Estate Activities	12.130	0.010	0.131	7.136	10.628	0.259
Professional, Scientific and Technical Activities	11.258	0.001	0.041	3.973	12.913	0.527
Administrative and Support Service Activities	10.569	0.003	0.077	3.486	13.577	0.776
Education	10.871	0.006	0.101	3.824	12.072	0.734
Human Health and Social Work Activities	11.011	0.009	0.155	3.949	12.384	0.631
Arts, Entertainment and Recreation	13.083	0.032	0.261	7.651	11.249	0.142
Other Service Activities	10.371	0.002	0.066	2.633	11.361	0.832

Table 2 shows that there are marked differences across sectors at the NACE2 level in Türkiye in terms of productivity, market concentration, capital intensity, sector size by employment, and adjusted labor share. Sectors with high productivity are generally those with high capital and market concentration, while sectors with a high labor share tend to have lower productivity. This indicates that production structure and factor composition are the main determinants of productivity. On the other hand, it is observed that sector size by employment does not by itself signal productivity, as some large sectors have low productivity. The sectoral differences in concentration measures are noteworthy. In particular, the simultaneous high values of HHI and CR4 in some sectors indicate that the market structure is concentrated around specific firms, while in sectors with low concentration values, competition is more widespread — though this does not always result in higher productivity.

Table 3. Descriptive Statistics by Concentration Level

Concentration Level	lnprod (Mean)	lnprod (Std. Dev.)	lncer (Mean)	lncer (Std. Dev.)	adj_ls (Mean)	adj_ls (Std. Dev.)
Low Concentration	10.998	0.752	4.028	0.905	0.574	0.198
High Concentration	12.169	0.969	5.364	1.437	0.338	0.179
Total	11.584	1.045	4.696	1.373	0.456	0.223

Note: Concentration level is determined based on the median value of the HHI variable.

Table 3 shows that there are pronounced differences between the low and high concentration groups formed based on the sample median of the HHI variable. First, average productivity levels and capital intensity are higher in high-concentration sectors. In contrast, the higher labor share in

low-concentration sectors suggests that labor-intensive sectors may be more competitive but have lower productivity levels. These findings indicate that the relationship between market structure and production structure is important for sectoral performance.

Table 4. Determinants of Sectoral Productivity: Fixed Effects Panel Data Estimation Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
HHI	2.718***	1.789***	2.282***		1.768***	0.328***
	(0.226)	(0.127)	(0.180)		(0.104)	(0.085)
CR4				0.645		
				(0.478)		
lnCER	0.760***	0.144**	0.484***	0.027	0.160**	-0.080*
	(0.044)	(0.060)	(0.042)	(0.107)	(0.057)	(0.045)
Ln_Employment	0.746***	0.025	0.524***	-0.134	0.070	
	(0.118)	(0.152)	(0.064)	(0.245)	(0.160)	
(adj_ls)	-2.696***	-2.116	-1.822***	-2.142***	-2.094***	-1.226
	(0.570)	(0.457)	(0.503)	(0.409)	(0.438)	(0.249)
Exchange Rate			0.050***			
			(0.006)			
Interest Rate			0.010***			
			(0.002)			
Avg. Years of Schooling					0.059**	
					(0.023)	
(c)	-0.129	10.882***	3.165***	13.194***	9.726***	0.925***
	(1.601)	(2.149)	(0.842)	(3.381)	(2.349)	(0.207)
Year Fixed Effects	No	Yes	No	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Dependent Variable	Log Productivity	Log Productivity	Log Productivity	Log Productivity	Log Productivity	Productivity Growth
Observations	208	208	208	208	208	208
No. of Sectors	16	16	16	16	16	16
Within R^2	0.949	0.982	0.970	0.972	0.982	0.737

Note: Values in parentheses are cluster-robust standard errors at the sector level. *, **, and *** denote significance levels of p<0.10, p<0.05, and p<0.01, respectively.

Table 4 examines the determinants of sectoral productivity at the NACE2 level in Türkiye through six fixed effects models with a stepwise and complementary model structure. Column (1) presents the baseline fixed effects model testing the main structural determinants of sectoral productivity. The positive and strong coefficient of the HHI index in the model suggests that more concentrated sectors have higher productivity. Similarly, the positive and strong coefficient of the capital intensity variable indicates that productivity increases with greater capital use. The positive and significant employment scale variable reveals that larger sectors can exhibit higher productivity. In contrast, the negative and significant effect of the adjusted labor share demonstrates the productivity-reducing effect of an increase in the share of labor costs in value added. In general, the baseline fixed effects

model in column (1) reveals that sectoral productivity differences in Türkiye are closely related to market structure and production composition. The model in which fixed effects are added to test whether the relationships in column (1) stem from time trends is presented in column (2). The fact that the employment variable becomes insignificant suggests that the effect of sector size in the model originates from time trends, while the unchanged significance of concentration and labor share variables indicates that these effects are more structural. In column (3), macroeconomic variables — exchange rate and interest rate — are added to the baseline model to examine the relationship between the concentration-productivity relationship and macro factors. Concentration and capital intensity maintain their positive and significant effects, labor share maintains its negative and significant effect, and employment becomes significant again. The positive and significant effects of the macro variables demonstrate that the concentration effect persists even after controlling for macroeconomic variables. In column (4), CR4 is used as an alternative concentration measure instead of HHI to test the sensitivity of results to measurement, and this variable is found to be statistically insignificant. This finding shows that sectoral productivity in Türkiye is better explained not merely by the share of the four largest firms, but by more comprehensive concentration indicators that reflect the entire market structure. Column (5) is the model in which the average years of schooling is added to control for the effect of human capital. The positive and significant effect of the education variable shows that sectors with higher human capital are more productive, and that the concentration effect persists independently of human capital. In column (6), the analysis is taken to a dynamic framework by using productivity growth as the dependent variable. The positive and significant HHI indicates that productivity growth is faster in more concentrated sectors. This model reveals that concentration is associated not only with productivity levels but also with productivity dynamics.

Overall, the findings presented in Table 4 show that sectoral productivity differences in Türkiye are shaped by the combined effect of market concentration, the composition of production factors, and macroeconomic conditions. The strong effect of concentration on both productivity levels and productivity growth reveals that market structure plays a central role in sectoral performance.

5. CONCLUSION

This study examines the structural and macroeconomic determinants of sectoral labor productivity at the NACE2 level in Türkiye using the fixed effects panel data method. Descriptive statistics and inferential analyses reveal significant heterogeneities across sectors stemming from production structure, factor composition, and market structure.

The positive and significant effect of concentration — measured by the Herfindahl-Hirschman Index — on both productivity levels and productivity growth demonstrates that more concentrated sectors are both more productive and exhibit faster productivity growth. The fact that the CR4 variable, used as an alternative concentration measure, was found to be statistically insignificant — consistent with expectations — indicates that more comprehensive concentration indicators should be preferred in analyzing market structure in Türkiye.

The role of production factor composition on productivity was observed through the capital intensity and adjusted labor share variables. The generally positive effect of capital intensity shows that a capital-intensive production structure positively affects productivity. On the other hand, the negative and significant effect of labor share across all models reveals that an increase in labor costs as a share of value added adversely affects productivity. This finding supports the view that labor-intensive sectors have relatively lower productivity levels.

The results obtained by including macroeconomic variables in the model show that productivity dynamics are related not only to within-sector factors but also to the general conditions of markets. Although the positive and significant effects of exchange rate and interest rate reveal that sectoral performance is not independent of macroeconomic fluctuations, it should be noted that the effects of these variables are specific to the time dimension.

The results of the model testing the effect of human capital show that sectors with higher education levels are more productive, and that the concentration effect persists independently of human capital. This indicates that sectoral productivity has a multidimensional structure shaped jointly by both market structure and human capital.

Finally, the model in which productivity growth rather than productivity level is analyzed as the dependent variable reveals that there are also dynamic effects of concentration. The faster productivity growth exhibited by concentrated sectors suggests that market structure may also be determinative of long-run performance.

Overall, the study shows that sectoral productivity differences in Türkiye are shaped by the combined effect of market concentration, capital-labor composition, and macroeconomic conditions. The findings offer important policy implications particularly regarding market structure regulations, competition policies, and sector-based production strategies. For a more balanced and sustainable productivity increase, it is important to develop policies that take into account structural differences across sectors and support capital accumulation and human capital.

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