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Determinants of Labor Productivity of Turkish Manufacturing Sectors: The Role of Global Value Chain Participation

Pınar Tat[1], Abdullah Altun[1], Halit Yanıkkaya[1]

ABSTRACT

Purpose: This paper investigates the determinants of labor productivity of Turkish manufacturing sectors by taking into account both the global value chain (GVC) participation and the research and development (R&D) expenditure for the period of 1995-2018.

Methodology: To analyze the determinants of labor productivity in Turkish manufacturing sectors, we specify the labor productivity model and estimate this empirical model by the Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS) methods.

Findings: Our estimation results indicate that while simple forward GVC participation enhances the labor productivity of Turkish high-tech manufacturing sectors if they trade with developing countries, complex forward GVC participation increases productivity regardless of trading partners. For low-tech sectors, there is no significant impact of GVCs or R&D on productivity. There is no significant impact of backward GVC participation and sectoral R&D intensity on labor productivity. These significant results provide strong evidence for the importance of deeper involvement of high-tech sectors in GVCs for higher sectoral productivity. Given the strong heterogeneity in terms of sectors and trading partners, specific policies should be targeted to benefit from the productivity gains of the global value chains.

Originality: This study contributes to the current studies by focusing on disaggregated measures of GVC participation indices and enlarges the empirical analysis by considering the heterogeneity in trading partners (developed and developing trading partners).

Keywords: Labor Productivity, Simple/Complex GVC Participation, R&D Expenditure, The Turkish Manufacturing Sector.

JEL Codes: F14, F68, O47.

Türk İmalat Sektörlerinin İş Gücü Verimliliğinin Belirleyicileri: Küresel Değer Zincirine Katılımın Rolü

ÖZET

Amaç: Bu makale, 1995-2018 dönemi için hem küresel değer zinciri (KDZ) katılımı hem de araştırma ve geliştirme (Ar-Ge) harcamalarını dikkate alarak Türk imalat sektörlerinin işgücü verimliliğinin belirleyicilerini incelemektedir.

Yöntem: Türk imalat sektörlerinde işgücü verimliliğinin belirleyicilerini analiz etmek için, işgücü verimliliği modelini belirlemekte ve bu ampirik modeli Sıradan En Küçük Kareler (OLS) ve İki Aşamalı En Küçük Kareler (2SLS) yöntemleri ile tahmin etmekteyiz.

Bulgular: Tahmin sonuçlarımız, gelişmekte olan ülkelerle ticaret yapmaları durumunda basit ileriye dönük KDZ katılımının, Türk ileri teknoloji imalat sektörlerinin işgücü verimliliğini artırırken, karmaşık ileri KDZ katılımının ticari ortaklardan bağımsız olarak üretkenliği artırdığını göstermektedir. Düşük teknolojili sektörler için KDZ'lerin veya Ar-Ge'nin üretkenlik üzerinde anlamlı bir etkisi yoktur. Geriye dönük KDZ katılımının ve sektörel Ar-Ge yoğunluğunun işgücü verimliliği üzerinde anlamlı bir etkisi yoktur. Bu önemli sonuçlar, daha yüksek sektörel üretkenlik için yüksek teknoloji sektörlerinin KDZ'lere daha derin bir şekilde dahil edilmesinin önemine dair güçlü kanıtlar sunmaktadır. Sektörler ve ticaret partnerleri açısından güçlü heterojenlik göz önüne alındığında, küresel değer zincirlerinin üretkenlik kazanımlarından yararlanmak için belirli politikalar hedeflenmelidir.

Özgünlük: Bu çalışma, KDZ katılım endekslerinin ayrıştırılmış ölçütlerine odaklanarak mevcut çalışmalara katkıda bulunmakta ve ticaret partnerlerindeki (gelişmiş ve gelişmekte olan ticaret partnerleri) heterojenliği dikkate alarak ampirik analizi genişletmektedir.

Anahtar Kelimeler: İş Gücü Verimliliği, Basit/Kompleks KDZ Katılımı, Ar-Ge Harcamaları, Türk İmalat Sektörü.

JEL Kodları: F14, F68, O47.

[1] Gebze Technical University, Department of Economics, Kocaeli, Türkiye

Corresponding Author: Pınar Tat, pinartat@gtu.edu.tr

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1. INTRODUCTION

This study investigates the determinants of labor productivity for Turkish manufacturing sectors by considering both the global value chain (GVC) participation and the research and development (R&D) expenditure. Labor productivity is an important proxy for understanding the evolution of value-added and employment through the period. Therefore, it is important to understand the drivers of labor productivity for Turkish manufacturing sectors. Apart from sector and country-level endowments that can affect sectoral productivity, trade structure also has a significant impact on productivity. Given the high ratio of intermediate trade in the globally integrated world production system, the importance of the potential impact of trade on labor productivity becomes more evident.

The concept describing fragmented and integrated production systems and prominent circulation of intermediates is called global value chains. GVC involvement may promote labor productivity by triggering several channels. Firstly, GVC participation provides access to the international markets. While backward GVC participation brings intermediates goods and knowledge/technology spillovers to importer countries (Amiti and Konings, 2007; Halpern et al., 2015), forward GVC participation introduces new management practices, standards, and opportunities to benefit from economies of scale in the production process (De Marchi et al., 2018). These two types of GVC eventually are expected to boost the sectoral labor productivity. Secondly, participating in GVC enables sectors to specialize in a specific task where they have comparative advantages (Grossman and Rossi-Hansberg, 2008). This high-level specialization may bring productivity gains for these globalized sectors. In other words, greater productivity gains are expected through participation in GVC rather than traditional trade (Kummritz, 2016; Taglioni and Winkler, 2016; Antrás et al., 2017). However, the theoretical expectations may not be reached in reality due to the special characteristics and high heterogeneity of the Turkish manufacturing industry as well as different types of GVC participation. Therefore, investigating the determinants of labor productivity of Turkish manufacturing sectors by considering the role of a variety of global value chain participation is an interesting research subject and a worthwhile effort.

The number of sector-level studies examining the connection between GVC involvement and labor productivity is rapidly increasing (Formai and Caffarelli, 2015; Kummritz, 2016; Constantinescu et al., 2019; Jona-Lasinio and Meliciani, 2019; Pahl and Timmer, 2020; Jangam, 2021). Formai and Caffarelli (2015) indicate a positive labor productivity effect of backward GVC participation for the manufacturing sectors of 46 countries. Kummritz (2016) finds that forward GVC participation boosts labor productivity for all sectors of 54 countries. Constantinescu et al. (2019) suggest that backward GVC participation is a significant driver for productivity by using 13 manufacturing sectors of 40 countries. Jona-Lasinio and Meliciani (2019) report that the positive impact of GVC participation on productivity growth is higher in industries having greater intangible capital intensity. Pahl and Timmer (2020) observe the positive effects of backward GVC participation in the manufacturing sectors of 58 countries. Finally, Jangam (2021) the positive impact of GVC participation on labor productivity for the 16 Asia-Pacific countries. As can be seen, studies in the literature generally exploit multi-country datasets mostly including developed countries, while studies conducted for developing countries remain limited.

The current empirical literature about productivity in Türkiye focuses on conventional trade variables (Filiztekin, 2000; Taymaz and Yilmaz, 2006; Ozler and Yilmaz, 2009; Dalgıç et al., 2015). Filiztekin (2000) claims that changing trade policies from import-substituting to trade liberalization boosts the productivity of the Turkish manufacturing industry. Taymaz and Yilmaz (2006) assert that import competing Turkish manufacturing sectors raises their productivity during the liberalization period. Ozler and Yilmaz (2009) also reach the same conclusion for Turkish firms regarding a rapid decline in tariff rates. Dalgıç et al. (2015) claim that both the importing and exporting activities of Turkish firms increase their labor productivity after the trade liberalization.

In one of the few studies that employ GVC measures, Kılıçaslan et al. (2021) show that supplier position in the GVC increases the productivity of Turkish firms. Altun et al. (2023) investigate the impacts of both forward and backward GVC participation on the labor productivity of Turkish firms for the period 1993-2015. They find that while backward GVC participation decreases labor productivity, forward GVC participation increases productivity.

To precisely analyze the impacts of participating in trade activities, researchers should calculate the trade measures correctly. To this end, within the interdependent trade and production structures especially after the 1980s, the studies in international trade have evolved with the enhancement in inter-country input-output tables (WIOD, OECD, EORA) and the new calculation methodologies (Koopman et al., 2014; Wang et al., 2017; OECD, 2021d) through time. We also utilize a variety of different GVC participation indices, which enables us to track true sectoral value-added embedded in trade flows.

This study contributes to the current studies by focusing on disaggregated measures of GVC participation indices and enlarges the empirical analysis by considering the heterogeneity in trading partners (developed and developing trading partners) for the Turkish manufacturing industries. To this end, we look at the impacts of both forward/ backward GVC participation indices and R&D intensity on the labor productivity of Turkish manufacturing sectors for the period 1995-2018. We then employ heterogeneity in trading partners (developed and developing), simple/complex GVC participation, and heterogeneity in manufacturing sectors (high and low-tech). The closest article, Altun et al. (2023), differs from our study in some respects. First, while their study is firm level, our study is sector level. Secondly, they also employ simple and complex GVC participation as well as high- and low-tech disaggregation. We further extend our analysis by considering the heterogeneity in trading partners. Thirdly, unlike them, we employ the Two-Stage Least Squares (2SLS) to evaluate the impacts GVCs on productivity.

The estimation results imply that complex forward GVC participation increases productivity regardless of trading partners, but simple forward GVC participation increases the labor productivity of Turkish high-tech manufacturing sectors if they deal with emerging economies. For low-tech sectors, there is no significant impact of any variable on the productivity of these sectors. Backward GVC participation and sectoral R&D intensity have no significant effect on labor productivity. The significance of deeper involvement in forward GVCs for enhanced sectoral productivity is apparent. Policies should specifically aim at the considerable heterogeneity in sectors and trade partners to benefit from productivity gains of the global value chains.

This study is organized as follows. The next section reviews the related literature. The third section describes the dataset and measures. The fourth section provides the methodology. The fifth section reports the results. The final section presents the conclusion.

2. DATA

This study employs three main databases. Firstly, we employ inter-country input-output tables and value-added from the 2021 release of Trade in Value-Added Statistics (OECD, 2021a). We compute forward and backward GVC participation by using the value-added decomposition methodology of Wang et al. (2017) and calculation steps in UIBE (2017, 2017a, 2017b). *Forward GVC participation* means the ratio of domestic value-added of the sector embedded in its exports to sectoral value-added. If the exported products are processed and consumed within the border of the trading partner, it is called *simple forward GVC participation*. If the exported products are processed and sold to another third country, it is called *complex forward GVC participation*. *Backward GVC participation* means the ratio of foreign value-added embedded in imports to sectoral final demand. If the imported products are processed and consumed within the border of the country, it is called *simple backward GVC participation*. If the imported products are processed and sold to another third country, it is called *complex backward GVC participation*.

Secondly, we utilize R&D statistics in the OECD's Analytical Business Enterprise Research and Development (ANBERD) database (OECD, 2021b). Thirdly, we use data on employees from the OECD's Trade in Employment database (OECD, 2021c).

We calculate the main dependent variable, labor productivity, by dividing value-added by employees. We then take the natural logarithm of labor productivity. We also divide sectoral R&D expenditure by value-added.

As an operational sample, we have 17 manufacturing sectors for the years 1995-2018. It is important to note that we trim upper and lower one percent of all variables we employ in our analysis. In addition, R&D statistics are not available for some sectors and years. To decide the income levels of trading partners, we utilize the historical income classification of countries. Income classification is based on the country's 1995 income level, that is the initial year of our dataset (World Bank, 2020). We also employ the technology classification of OECD based on the R&D intensity of sectors (Galindo-Rueda and Verger, 2016). We categorize sectors mainly into two groups as high and low technology (see Table A1 in Appendix).

Table 1 provides the summary statistics of all measures employed in our analysis. The forward GVC participation of Turkish manufacturing industries is 15%. While the simple part is 10%, the complex part is 5% on average. The backward GVC participation of Turkish manufacturing industries is 24%. While the simple part is 14%, the complex part is 11% on average. We can argue that the production of Turkish manufacturing sectors depends highly on the backward GVC participation. Moreover, Turkish manufacturing sectors specialize in relatively simpler parts of the forward and backward GVCs. While the forward GVC participation of high-tech sectors (17%) is higher than that of low-tech sectors (13%), the backward GVC participations of these two sector groups are nearly the same (24%). Another noteworthy characteristic is higher R&D intensity of high-tech sectors compared to low-tech sectors.

Table 1. Summary statistics

	All sectors		High-tech		Low-tech	
Variables	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Ln (labor productivity)	10.39	0.92	10.40	0.69	10.37	1.21
Forward GVC participation	15.03	6.98	16.67	7.35	12.46	5.47
Simple forward GVC participation	10.30	5.00	11.39	5.46	8.55	3.53
Complex forward GVC participation	5.38	3.51	6.29	3.91	3.92	2.02
Backward GVC participation	24.43	10.47	24.68	6.64	24.02	14.70
Simple backward GVC participation	13.82	6.26	13.25	3.96	14.74	8.72
Complex backward GVC participation	10.61	5.71	11.43	4.92	9.28	6.61
R&D (% in VA)	3.12	5.17	4.81	5.98	0.40	0.59
# of Obs.	376		232		144	

Notes: SD means standard deviation, Ln means natural logarithm, GVC participations are in percentages,.VA stands for sectoral value-added.

3. METHODOLOGY

To analyze the determinants of labor productivity in Turkish manufacturing sectors, we specify the labor productivity model as in Equation 1.

$$LP_{s,t} = \beta_0 + \beta_1 GVC_{s,t} + \beta_2 R\&D_{s,t} + \beta_3 T_t + \varepsilon_{c,i,t} \quad (1)$$

where s and t stand for sectors and years, respectively. $LP_{s,t}$ stands for the natural logarithm of labor productivity. $GVC_{s,t}$ is forward or backward GVC participation. We also take the simple and complex parts of the forward and backward GVC participation. $R\&D_{s,t}$ is the ratio of R&D expenditure to value added. T_t stands for time dummies to take changes in government policies, other macroeconomic factors, and technological enhancements into account.

The empirical model above is first estimated by the Ordinary Least Squares (OLS). However, the model can suffer from omitted variables, reverse causality, and simultaneity. These may result in endogeneity problems, that is correlation of one or more independent variables with error term, and the OLS estimates can be biased and inefficient. Therefore, we utilize the Two-Stage Least Squares (2SLS) to obtain unbiased and consistent estimates to address these concerns.

In the Two-Stage Least Squares (2SLS) or Instrumental Variables (IVs) estimation technique, the instrumental variables are correlated with the endogenous variables, but they are not correlated with the error term. The F statistics should be higher than the threshold level of 10 to ensure the validity of the instruments used in the model. To check the endogeneity in the model, the Durbin-Wu-Hausman test and the Wooldridge test for strict exogeneity can be employed. We report the Durbin-Wu-Hausman (DWH) test results because it is the most widely used test for endogeneity. DWH p-value is related to the null hypothesis that variables are exogenous. If the DWH p-value is less than 0.1, we can reject the null hypothesis and conclude that variables are endogenous. Therefore, the 2SLS estimates are more appropriate than the OLS estimates. If the DWH p-value is higher than 0.1, we cannot reject the null hypothesis. Still, providing 2SLS estimates can be appropriate.

Due to the unique characteristics of each manufacturing sector, the labor productivity, and the degree of integration, we expect different mechanisms and findings for each sector depending on the trading partner. We categorize our sample according to partner country and sector levels (such as developed/developing partner countries and high-tech-manufacturing and low-tech sectors) to solve the heterogeneity issue.

We follow the idea of previous studies (Autor et al., 2013; Constantinescu et al., 2019; Veeramani and Dhir, 2022). We instrument the GVC participation of the Turkish manufacturing sector with the average GVC participation of similar three countries with the USA, Germany, and Japan. The similarity is based on the GDP per capita in 1995. These similar countries are Russia, Estonia, and Mexico. The reason for the selection of specific destination countries such as the USA, Germany, and Japan are that there is a technological asymmetry between these countries and “factory” economies like Türkiye. The similarity argument is based on the fact that we can reduce the risk of violation of the exclusion restriction through many characteristics such as infrastructure and human capital when we use GDP per capita.[1]

[1] As a robustness check, we also assure that there are no free trade agreements between Türkiye and these similar countries. In that case, similar countries are Russia, India, and China. When we use these countries to compute instrumental variables, we reach similar results and the same conclusion. The results are available upon the request.

4. RESULTS

Tables 2 and 3 present the OLS and 2SLS estimation results for the Turkish manufacturing sectors, respectively. Panel I of Table 2 presents the estimations for the specification with total GVC participation. While forward GVC participation is more likely to increase the labor productivity of Turkish manufacturing sectors regardless of the income levels of trading partners, backward GVC participation is more likely to rise the labor productivity of Turkish manufacturing sectors if the trading partner is from developing countries. Panels II and III of Table 2 provide the estimations for the specification with simple and complex GVC participation, respectively. We observe similar results for both simple and complex GVC participation. Even though R&D intensity is significantly positive in some specifications, we cannot reach a strong conclusion regarding this measure.

Table 3 presents the 2SLS estimation results. It is important to note that our instruments are valid, especially for forward GVC participation by looking at the F statistics of the model and the coefficients of instrumental variables in the first stage. Contrary to the OLS results, we cannot find any significant impact of total, simple, and complex GVC participation on the labor productivity of Turkish manufacturing sectors. Given the heterogeneity in our sample, we investigate the reason for this insignificant impact in detailed sub-samples by dividing our sample into high and low-tech sectors. Furthermore, there is no significant effect of R&D intensity on labor productivity. This may be related to low variation in R&D intensity within each manufacturing sector.

Table 2. Labor productivity and global value chains: The OLS estimates

	All partners		*Developed partners*		*Developing partners*	
Panel I	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Forward GVC	0.042*		0.067**		0.055**	
	(0.021)		(0.032)		(0.020)	
Backward GVC		0.047*		-0.049		0.066***
		(0.024)		(0.037)		(0.010)
R&D (% in VA)	0.020	0.030*	0.008	0.039**	0.036*	0.050***
	(0.023)	(0.016)	(0.026)	(0.016)	(0.020)	(0.012)
Constant	9.608***	9.287***	9.562***	10.419***	9.848***	9.555***
	(0.283)	(0.349)	(0.312)	(0.530)	(0.268)	(0.213)
Observations	368	376	369	368	376	376
R-squared	0.271	0.423	0.269	0.211	0.245	0.586
Panel II	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Simple forward GVC	0.056**		0.123*		0.067**	
	(0.023)		(0.065)		(0.026)	
Simple backward GVC		0.064		-0.130*		0.100***
		(0.047)		(0.071)		(0.020)
R&D (% in VA)	0.027	0.041**	0.008	0.033*	0.037*	0.055***
	(0.020)	(0.017)	(0.026)	(0.017)	(0.019)	(0.014)
Constant	9.623***	9.303***	9.439***	10.773***	9.856***	9.500***
	(0.288)	(0.459)	(0.353)	(0.646)	(0.267)	(0.221)
Observations	376	376	371	367	376	376
R-squared	0.266	0.351	0.273	0.298	0.233	0.547
Panel III	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Complex forward GVC	0.083***		0.123**		0.232**	
	(0.025)		(0.046)		(0.081)	
Complex backward GVC		0.084*		0.001		0.151***
		(0.044)		(0.041)		(0.032)
R&D (% in VA)	0.017	0.014	0.012	0.024	0.028	0.037***
	(0.022)	(0.021)	(0.023)	(0.021)	(0.020)	(0.012)
Constant	9.791***	9.639***	9.762***	10.002***	9.860***	9.747***
	(0.282)	(0.239)	(0.288)	(0.325)	(0.269)	(0.223)
Observations	376	376	368	368	376	376
R-squared	0.268	0.392	0.252	0.180	0.270	0.549

Notes: Clustered robust standard errors in parentheses. Year dummies are included. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Labor productivity and global value chains: The 2SLS estimates

	All partners				*Developed partners*				*Developing partners*			
	First	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*
Panel I	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Forward GVC	1.173***				0.577***				0.636***			
	(0.221)				(0.140)				(0.107)			
Forward GVC		0.002				-0.006				0.009		
		(0.028)				(0.055)				(0.048)		
IV_Backward GVC			0.453				1.130***				-0.706	
			(1.081)				(0.196)				(0.992)	
Backward GVC				-0.135				-0.055				0.087
				(0.489)				(0.087)				(0.065)
R&D (% in VA)	0.105	0.028	-0.211	0.013	0.266***	0.030	-0.080	0.037**	-0.175***	0.029	-0.120	0.052***
	(0.116)	(0.024)	(0.203)	(0.082)	(0.082)	(0.033)	(0.088)	(0.015)	(0.051)	(0.020)	(0.166)	(0.019)
Constant	-1.326	9.978***	12.160	12.081	1.300	10.041***	0.205	10.460***	-2.969**	9.975***	12.175	9.388***
	(2.144)	(0.247)	(10.039)	(8.044)	(1.320)	(0.289)	(1.664)	(0.976)	(1.202)	(0.229)	(9.075)	(0.451)
Observations	364	364	368	368	363	363	360	360	368	368	368	368
R-squared	0.548	0.198	0.152		0.488	0.184	0.570	0.211	0.625	0.207	0.181	0.559
IV F-stat		28.303		0.176		17.019		33.210		35.230		0.506
DWH pval		0.046		0.255		0.078		0.913		0.176		0.803
Panel II	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Simple forward GVC	0.973***				0.351***				0.592***			
	(0.243)				(0.117)				(0.143)			
Simple forward GVC		-0.006				-0.040				-0.010		
		(0.045)				(0.127)				(0.074)		
IV_Simple backward GVC			-0.330				0.824***				-1.222	
			(1.090)				(0.223)				(1.048)	
Simple backward GVC				0.272				-0.103				0.073
				(0.515)				(0.207)				(0.094)
R&D (% in VA)	-0.026	0.027	-0.207	0.083	0.145**	0.034	0.051	0.032***	-0.168***	0.026	-0.256*	0.046**
	(0.087)	(0.022)	(0.139)	(0.101)	(0.051)	(0.036)	(0.059)	(0.010)	(0.047)	(0.021)	(0.125)	(0.021)
Constant	0.096	10.044***	12.335*	7.044	2.174**	10.183***	2.310*	10.612***	-1.883	10.024***	10.319*	9.636***
	(1.808)	(0.292)	(5.881)	(5.622)	(0.890)	(0.485)	(1.101)	(1.430)	(1.150)	(0.236)	(5.626)	(0.408)
Observations	368	368	368	368	365	365	359	359	368	368	368	368
R-squared	0.489	0.177	0.110		0.410	0.144	0.238	0.300	0.558	0.180	0.206	0.518
IV F-stat		16.050		0.0918		8.975		13.694		17.262		1.361
DWH pval		0.044		0.605		0.117		0.881		0.146		0.754

Table 3. (*Continued*)

	All partners				*Developed partners*				*Developing partners*			
	First	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*
Panel III	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Complex forward GVC	2.162***				1.327***				0.750***			
	(0.196)				(0.126)				(0.080)			
Complex forward GVC		0.060				0.084				0.172		
		(0.041)				(0.078)				(0.119)		
IV_Complex backward GVC			0.921*				0.728***				0.120	
			(0.476)				(0.122)				(0.393)	
Complex backward GVC				-0.063				-0.095				-0.486
				(0.119)				(0.125)				(2.122)
R&D (% in VA)	0.096	0.019	-0.174	0.032	0.105**	0.017	-0.046	0.040**	-0.014	0.027	-0.125*	-0.018
	(0.065)	(0.023)	(0.105)	(0.019)	(0.041)	(0.028)	(0.044)	(0.016)	(0.019)	(0.020)	(0.071)	(0.247)
Constant	-2.154**	9.850***	1.308	10.257***	-0.937*	9.837***	0.277	10.238***	-1.024***	9.897***	1.297	10.803***
	(0.771)	(0.225)	(2.260)	(0.755)	(0.461)	(0.210)	(0.630)	(0.558)	(0.269)	(0.233)	(1.777)	(3.990)
Observations	368	368	368	368	362	362	360	360	368	368	368	368
R-squared	0.683	0.256	0.324		0.624	0.243	0.600	0.130	0.718	0.262	0.204	
IV F-stat		121.067		3.748		110.196		35.649		88.001		0.093
DWH pval		0.388		0.061		0.542		0.358		0.391		0.160

Notes: Clustered robust standard errors in parentheses. Year dummies are included. *** p<0.01, ** p<0.05, * p<0.1. Depending on the studies (Autor et al., 2013; Constantinescu et al., 2019; Veerama 2022), we instrument the GVC participation of the Turkish manufacturing sector with the average GVC participation of similar three countries with the USA, Germany, and Japan. The similarity is b GDP per capita in 1995. These similar countries are Russia, Estonia, and Mexico. In the method of 2SLS, the F statistics should be higher than the threshold level of 10 to ensure the validity of the used in the model. DWH p-value is related to the null hypothesis that variables are exogenous. If the DWH p-value is less than 0.1, we can reject the null hypothesis and conclude that variables are e Therefore, the 2SLS estimates are more appropriate than the OLS estimates. If the DWH p-value is more than 0.1, we cannot reject the null hypothesis. Still, providing 2SLS estimates can be approp

Given the sectoral heterogeneity in our sample, we divide our sample into high and low-tech sectors. Panel I of Table 4 suggests that forward GVC participation is a significant driver of labor productivity. In other words, participating in forward GVC enhances the labor productivity of high-tech manufacturing sectors, especially if Türkiye trades with developing countries. These results can be explained by the productivity gains through forward GVC participation in the form of knowledge spillovers, strong competition in the international market, hyper-specialization, and scale economies (Baldwin and Gu, 2003; Criscuolo and Timmis, 2017; De Marchi et al., 2018). While we observe a similar pattern for the simple forward GVC participation, participation in complex forward GVC with developed economies also enhances the labor productivity of Turkish manufacturing sectors. Turkish high-tech manufacturing sectors can benefit from experiences in advanced organizational environments, an obligation to adopt international standards, qualification and certification of processes, and better managerial skills through complex forward GVC participation with developed countries. Overall, we strongly argue that producing advanced manufacturing products that can be processed in the trading partner and resold to another third country promotes sectoral labor productivity.

Table 5 presents the results for low-tech sectors. Contrary to the high-tech manufacturing sectors, we cannot find any evidence for the significant impacts of GVC participation on the labor productivity of low-tech sectors. In addition, R&D intensity has no robust and significant impact on labor productivity.

Table 4. Labor productivity and global value chains - High-tech sectors: The 2SLS estimates

	All partners				*Developed partners*				*Developing partners*			
	First	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*
Panel I	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Forward GVC	1.350***				0.706***				0.724***			
	(0.225)				(0.131)				(0.128)			
Forward GVC		0.033*				0.049				0.063**		
		(0.018)				(0.033)				(0.027)		
IV_Backward GVC			1.449***				1.119***				0.324	
			(0.341)				(0.162)				(0.231)	
Backward GVC				0.009				0.011				0.039
				(0.028)				(0.035)				(0.128)
R&D (% in VA)	0.024	0.039***	-0.442***	0.028*	0.189*	0.032***	-0.155**	0.025**	-0.183**	0.051***	-0.278***	0.035
	(0.161)	(0.007)	(0.104)	(0.015)	(0.095)	(0.010)	(0.068)	(0.012)	(0.077)	(0.010)	(0.072)	(0.034)
Constant	-2.715	9.574***	3.928	9.744***	0.374	9.562***	1.187	9.769***	-3.820*	9.716***	2.787	9.669***
	(3.153)	(0.249)	(2.554)	(0.562)	(1.934)	(0.277)	(1.224)	(0.490)	(1.763)	(0.216)	(2.292)	(0.761)
Observations	220	220	224	224	219	219	216	216	224	224	224	224
R-squared	0.558	0.607	0.545	0.396	0.498	0.605	0.570	0.363	0.612	0.562	0.625	0.388
IV F-stat		36.040		18.095		28.920		47.794		31.829		1.960
DWH pval		0.651		0.345		0.652		0.015		0.845		0.790
Panel II	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Simple forward GVC	1.111***				0.412***				0.665***			
	(0.287)				(0.115)				(0.208)			
Simple forward GVC		0.047*				0.101				0.078*		
		(0.027)				(0.085)				(0.040)		
IV_Simple backward GVC			0.440				0.584				-0.226	
			(0.781)				(0.405)				(0.372)	
Simple backward GVC				0.183				0.154				-0.356
				(0.446)				(0.217)				(0.438)
R&D (% in VA)	-0.087	0.043***	-0.187*	0.064	0.096	0.030***	-0.021	0.032	-0.180**	0.053***	-0.161***	-0.028
	(0.125)	(0.008)	(0.092)	(0.090)	(0.070)	(0.011)	(0.068)	(0.024)	(0.069)	(0.013)	(0.036)	(0.075)
Constant	-0.588	9.566***	9.297**	7.851	1.986	9.411***	4.530*	8.807***	-2.328	9.720***	5.158**	11.384***
	(2.841)	(0.270)	(3.733)	(5.091)	(1.382)	(0.444)	(2.082)	(1.661)	(1.919)	(0.227)	(1.937)	(1.631)
Observations	224	224	226	226	221	221	217	217	224	224	226	226
R-squared	0.491	0.588	0.196		0.397	0.572	0.173		0.530	0.555	0.557	0.258
IV F-stat		14.995		0.318		12.801		2.077		10.243		0.370
DWH pval		0.777		0.122		0.936		0.032		0.861		0.539

Table 4. (*Continued*)

	All partners				*Developed partners*				*Developing partners*			
	First	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*
Panel III	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Complex forward GVC	2.408***				1.496***				0.845***			
	(0.193)				(0.138)				(0.089)			
Complex forward GVC		0.087***				0.129***				0.248***		
		(0.028)				(0.050)				(0.081)		
IV_Complex backward GVC			1.150***				0.653***				0.403***	
			(0.263)				(0.131)				(0.125)	
Complex backward GVC				0.002				-0.009				0.007
				(0.031)				(0.054)				(0.088)
R&D (% in VA)	0.067	0.033***	-0.225**	0.031**	0.080*	0.029***	-0.063	0.031**	-0.017	0.043***	-0.155**	0.031*
	(0.067)	(0.008)	(0.099)	(0.013)	(0.043)	(0.010)	(0.047)	(0.013)	(0.022)	(0.008)	(0.059)	(0.018)
Constant	-2.755***	9.667***	0.054	9.875***	-1.279**	9.632***	0.663	9.919***	-1.307***	9.751***	-0.198	9.877***
	(0.767)	(0.198)	(1.916)	(0.280)	(0.530)	(0.203)	(0.919)	(0.300)	(0.222)	(0.198)	(0.871)	(0.268)
Observations	224	224	224	224	218	218	216	216	224	224	224	224
R-squared	0.707	0.610	0.560	0.409	0.629	0.606	0.596	0.395	0.758	0.581	0.558	0.411
IV F-stat		156.170		19.143		117.219		24.712		90.891		10.410
DWH pval		0.900		0.503		0.913		0.550		0.699		0.589

Notes: Clustered robust standard errors in parentheses. Year dummies are included. *** p<0.01, ** p<0.05, * p<0.1. See Notes in Table 3 for detailed explanations regarding instrumental variables.

Table 5. Labor productivity and global value chains - Low-tech sectors: The 2SLS estimates

	All partners				*Developed partners*				*Developing partners*			
	First	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*
Panel I	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Forward GVC	0.818				0.324				0.494**			
	(0.434)				(0.278)				(0.159)			
Forward GVC		-0.034				-0.087				-0.057		
		(0.111)				(0.296)				(0.177)		
IV_Backward GVC			-1.463				0.659				-2.123	
			(2.129)				(0.499)				(1.958)	
Backward GVC				0.132				-0.293				0.091**
				(0.100)				(0.324)				(0.044)
R&D (% in VA)	1.425	-0.236	0.413	-0.145	1.462	-0.158	-0.112	-0.124	-0.037	-0.287	0.525	-0.139
	(1.659)	(0.631)	(2.520)	(0.190)	(1.150)	(0.929)	(1.095)	(0.289)	(0.547)	(0.459)	(2.394)	(0.110)
Constant	1.188	10.379***	22.911	8.250***	2.999	10.599***	2.023	11.864***	-1.811*	10.236***	20.888	9.372***
	(2.790)	(0.428)	(16.181)	(1.412)	(2.119)	(1.157)	(2.978)	(2.370)	(0.732)	(0.286)	(14.958)	(0.354)
Observations	144	144	144	144	144	144	144	144	144	144	144	144
R-squared	0.568		0.146	0.038	0.420		0.295		0.705	0.020	0.172	0.709
IV F-stat		3.547		0.472		1.356		1.748		9.717		1.175
DWH pval		0.073		0.543		0.176		0.576		0.084		0.780
Panel II	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Simple forward GVC	0.691				0.204				0.487**			
	(0.351)				(0.223)				(0.132)			
Simple forward GVC		-0.075				-0.254				-0.106		
		(0.167)				(0.665)				(0.222)		
IV_Simple backward GVC			-1.235				0.863*				-2.098	
			(1.911)				(0.415)				(1.836)	
Simple backward GVC				0.177				-0.253				0.104
				(0.110)				(0.326)				(0.066)
R&D (% in VA)	0.564	-0.223	0.827	-0.261	0.729	-0.080	-0.132	-0.149	-0.165	-0.283	0.960	-0.215*
	(0.994)	(0.560)	(1.200)	(0.191)	(0.722)	(1.016)	(0.631)	(0.185)	(0.314)	(0.414)	(0.966)	(0.126)
Constant	1.473	10.538***	14.176	8.352***	2.794*	11.137***	0.903	11.091***	-1.321**	10.287***	13.273	9.478***
	(1.669)	(0.564)	(9.218)	(1.208)	(1.351)	(2.206)	(1.738)	(1.768)	(0.491)	(0.331)	(8.727)	(0.341)
Observations	144	144	142	142	144	144	142	142	144	144	142	142
R-squared	0.545		0.136	0.404	0.374		0.360	0.183	0.690		0.193	0.753
IV F-stat		3.867		0.418		0.837		4.326		13.627		1.307
DWH pval		0.022		0.666		0.138		0.816		0.064		0.867

Table 5. (*Continued*)

	All partners				*Developed partners*				*Developing partners*			
	First	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*	*First*	*Second*
Panel III	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
IV_Complex forward GVC	1.290*				0.793*				0.497			
	(0.596)				(0.345)				(0.258)			
Complex forward GVC		0.057				0.093				0.148		
		(0.298)				(0.487)				(0.768)		
IV_Complex backward GVC			-0.872				0.441				-1.313	
			(2.715)				(0.619)				(2.224)	
Complex backward GVC				0.611				-1.207				0.406
				(1.294)				(1.816)				(0.369)
R&D (% in VA)	0.835	-0.413	-0.341	0.230	0.699*	-0.430	-0.081	-0.075	0.137	-0.385	-0.260	0.128
	(0.546)	(0.679)	(1.382)	(0.971)	(0.331)	(0.768)	(0.476)	(0.384)	(0.219)	(0.542)	(1.165)	(0.363)
Constant	-0.417	10.002***	6.379	7.565	0.033	9.975***	0.983	12.650***	-0.450	10.045***	5.397	9.274***
	(1.225)	(0.297)	(8.039)	(5.128)	(0.750)	(0.382)	(1.667)	(4.302)	(0.488)	(0.286)	(6.572)	(0.781)
Observations	144	144	144	144	144	144	144	144	144	144	144	144
R-squared	0.633	0.153	0.168		0.622	0.149	0.297		0.656	0.158	0.168	
IV F-stat		4.690		0.103		5.292		0.509		3.700		0.348
DWH pval		0.423		0.167		0.421		0.288		0.479		0.210

Notes: Clustered robust standard errors in parentheses. Year dummies are included. *** p<0.01, ** p<0.05, * p<0.1. See Notes in Table 3 for detailed explanations regarding instrumental variables.

5. CONCLUSION

Considering the relevance of labor productivity for countries and overwhelmingly integrated world economies, this paper aims to evaluate the determinants of labor productivity of Turkish manufacturing sectors by controlling the GVC participation and R&D expenditures over the period of 1995-2018. It is worthwhile to note that our estimates substantially differ from the OLS and 2SLS estimates, which implies the importance of using instrumental variables to gauge the impacts of GVCs on productivity.

Our IV estimation results clearly show that when high-tech Turkish manufacturing sectors trade with developing countries, simple forward GVC participation increases labor productivity, while complex forward GVC participation increases productivity regardless of the income levels of trading partners. Backward GVC participation and sectoral R&D intensity seem not to have a significant effect on labor productivity. These key results provide strong evidence of the importance of deeper engagement in forward GVCs for the productivity of high-tech sectors. For low-tech sectors, we do not find any evidence for the impact of GVC participation and R&D intensity on the productivity of these sectors. This may be related to the inadequate technological capacity or infrastructure of the low-tech sector to benefit from participating in forward GVCs as well as the lower variation in forward GVC participation in low-tech manufacturing sectors, which may impede to grasp the true impact.

Overall, our results have important policy recommendations regarding the labor productivity of Turkish manufacturing. Given the strong evidence for the beneficial effects of GVC participation on the labor productivity of high-tech sectors, the importance of effective integration in the global supply chains and cross-border trade operations becomes more evident. Given the strong heterogeneity in the sectors and trading partners, specific sectoral policies should be targeted to benefit the productivity gains of global value chains.

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Author Contributions
Pınar Tat: Literature review, Conceptualization, Methodology, Data Curation, Analysis, Writing-original draft *Abdullah Altun*: Conceptualization, Methodology, Writing-review and editing *Halit Yanıkkaya*: Conceptualization, Methodology, Writing-review and editing

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It was declared by the authors that the tools and methods used in the study do not require the permission of the Ethics Committee.

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It was declared by the author(s) that scientific and ethical principles have been followed in this study and all the sources used have been properly cited.

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APPENDIX

Table A1. Sectors

ISIC Rev.4	*Sectors*	*Technology*
D10T12	Food products, beverages and tobacco	Low-tech
D13T15	Textiles, textile products, leather and footwear	Low-tech
D16	Wood and products of wood and cork	Low-tech
D17T18	Paper products and printing	Low-tech
D19	Coke and refined petroleum products	Low-tech
D20	Chemical and chemical products	High-tech
D21	Pharmaceuticals, medicinal chemical and botanical products	High-tech
D22	Rubber and plastics products	High-tech
D23	Other non-metallic mineral products	High-tech
D24	Basic metals	High-tech
D25	Fabricated metal products	Low-tech
D26	Computer, electronic and optical equipment	High-tech
D27	Electrical equipment	High-tech
D28	Machinery and equipment, nec	High-tech
D29	Motor vehicles, trailers and semi-trailers	High-tech
D30	Other transport equipment	High-tech
D31T33	Manufacturing nec; repair and installation of machinery and equipment	High-tech

Notes: The sectors are in the OECD's classification based on ISIC. Rev. 4. We also employ the technology classification of OECD based on the R&D intensity of sectors (Galindo-Rueda and Verger, 2016). We categorize sectors mainly into two groups high and low technology.