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Abstract

Based on the world input-output database 2016 (WIOD), this study examines the impact of the global value chain (GVCs), via the backward and forward linkages, on labor productivity. Using a spatial econometric approach, it pays particular attention to the spillover effects in productivity across industries through input-output relations. It is shown that a stochastic shock in productivity in one sector significantly transcends and boosts productivity in other sectors through input-output dependencies. Moreover, productivity significantly declines with backward linkages within their sectors. However, productivity increases with forward linkages both within own sectors and across sectors through input-output relations. A sectoral analysis of the GVCs' effects on productivity reveals that manufacturing backward linkages is negatively associated with productivity not only within own sectors but also across manufacturing sectors, whereas productivity in service sectors rises with forward linkages within and across service sectors. This study shows that ignoring the spillovers effects across sectors causes the estimates to be biased

Keywords: Labor Productivity, Spillover Effects, Backward Linkages, Forward linkages.
JEL Classifications: F61, F16, J24.

1. Introduction

With advances in transportation and communication technologies, improvement of the infrastructure facilities, and falling trade barriers, the process of international economic integration has been rapidly growing and organized around the concept of global value chains (hereafter, referred to as GVCs). Access to new modes of specialization has induced firms to slice down the production into tasks performed at different locations to optimize their factor costs (Feenstra and Hanson 1997; Grossman and Rossi Hansberg 2008). The fragmentation of the production process has stimulated a substantial growth in trade in final goods and intermediates, where the intermediates goods and services cross borders several times along the supply chains. This makes the traditional trade indicators accounting for multi-counting of the value-added across the supply chains, poor approximation of the trade statistics. New measures of trade-in value added have been set forth to report the extent to which an economy is involved in the GVCs. Particularly, the share of foreign value-added embodied in gross export is used as a measure of linkages to the GVCs from an importer standpoint, and the share of value-added embodied in third countries exports is used as an indicator of linkages from an exporter standpoint (Hummels et al, 2001, Koopman et al, 2014).

The impact of GVCs' integration on economies is increasingly explored. Some key outcomes of such integration are employment, productivity, and knowledge spillovers. Constantinescu et al. (2019) study the impact of the share of foreign value-added embodied in export (Backward linkages) on productivity for a sample of 40 countries with 13 manufacturing industries and found that GVCs integration boosts productivity. Baldwin et al. (2014) convey that productivity gains associated with GVCs integration may accrue from different channels such as increases in competition, access to a variety of inputs, learning externalities, and technology spillovers. Using intercountry input-output tables, Kummritz (2017) empirically examines the impact of GVCs integration on labor productivity and find that labor productivity significantly rises with forward linkages but not significantly associated with backward linkages. However, the impact of GVCs participation might be disproportionate among different economies because of the substantial heterogeneity among countries. Ignateko, Raei and Mircheva (2019) convey that the gain associated with GVCs participation is hard to be assessed because of the large degree of heterogeneity between economies. Consequently, the impact of GVCs participation may vary substantially across countries.

Another important feature of GVCs' participation is the presence of dependencies between sectors in the use of intermediates. Balassa (1961) argues that linkages between sectors are key sources of productivity spillovers and that the magnitude of the spillovers is even further amplified by the transmission of technological improvements. Most of the existing studies examine the direct effect of GVCs indicators on productivity without accounting for the spillover effects between sectors, which may arise as a result of sectors' interdependence. An exception is the study of Badinger and Egger (2008), which uses a spatial econometric approach to model the total factor productivity spillovers at the R&D industry level and a reminder spillover not related to knowledge spillovers, using an Autoregressive Error model. They find a significant intra- and inter-industry knowledge spillover effects on productivity. Nasser Dine (2019) uses a Spatial Lagged X Model to examine the impact of GVCs integration on employment in Turkey, accounting for the spillover effects. He shows that trade-related variables do not affect job creation only within their sectors but also across sectors.

In this chapter, we focus on the impact of Turkey's GVCs' participation on labor productivity using the World Input-Output Tables and Socio-Economic Account released in 2016 (Timmer et al 2016). Specifically, this study examines the effects of backward and forward linkages on labor productivity at the sector level. There is a growing literature on the impact of trade openness on productivity in Turkey. Filiztekin (2004) shows that trade liberalization is significantly associated with productivity in manufacturing sectors. In particular, increasing import and export penetrations enhance productivity at the sector level. Ozler and Yilmaz (2009) convey that a reduction in trade barriers is significantly associated with productivity improvement in manufacturing sectors.

However, there are no studies that examine the impact of GVCs participation on labor productivity at the sector level in Turkey. The present paper is the first study to examine this to the best of our knowledge. Furthermore, this study empirically examines Balassa's (1961) hypothesis using Input-output relations. That is, we argue that a stochastic shock in labor productivity in one sector is likely to transmit to the other sectors through the input-output relations and that changes in GVCs indicators in one sector affect not only that sector's productivity ("direct effects") but also all the other sectors' productivities ("indirect effects"). The interdependence between sectors, as will be explained in detail in the following sections, is modeled using a row-standardized input-output weight matrix.

Our findings confirm Balassa's (1961) hypothesis, showing that the changes in productivity progress beyond its sectors and significantly transcend to sectors via input-output linkages with magnitude impacts depending on the degree of connectivity. Moreover, changes in GVCs backward and forward linkages affect productivities both within and across sectors. Manufacturing backward linkages are negatively associated with productivity, suggesting that the imported intermediates act as a substitute for domestically produced goods leading the share of value-added to declines and so does the productivity. The impact of backward linkages in manufacturing sectors transcends to the sectors linked through the input-output weight matrix. We find that the productivity of service sectors rises with forward linkages both within and across sectors. This supports learning by exporting assumptions (De Loecker, 2012).

2. Data

2-1. WIOD and SEA data

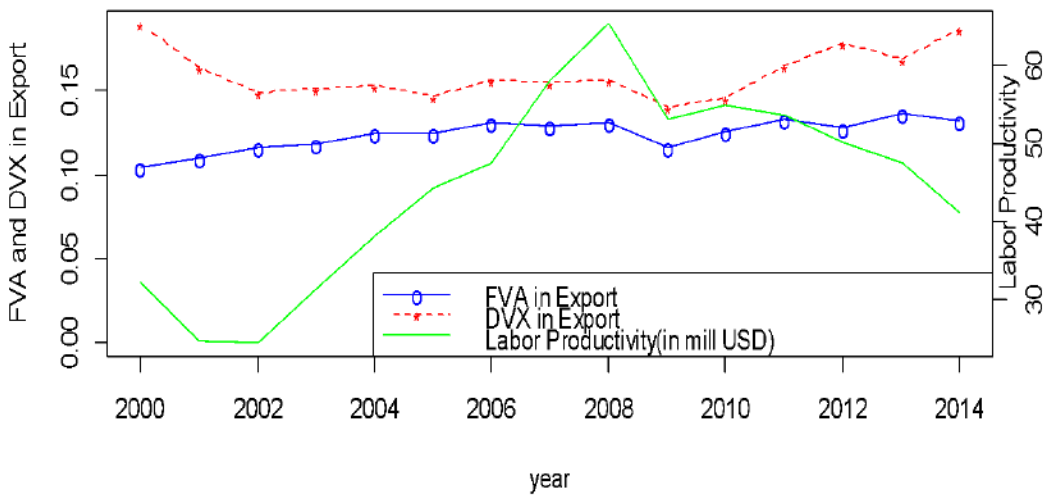
This study relies on the 2016 version of the WIOD (World Input-Output Data) and the SEA (Socio-Economic Accounts, which are compiled by Timmer et al., 2016. The WIOD covers 43 countries and a model for the rest of the world for the period of 2000-2014 for 56 sectors. The SEA contains information on employment and stock of capital. We construct our main GVCs variables as backward and forward linkages. We calculate labor productivity as the share of value-added by employees. We restrict our sample and variables to Turkey's industrial sectors. A summary statistic of the main variables is reported in Table 1.

Table 1. Summary Statistics of the Variables

VARIABLES	Description	MEA	SD

		N	
	All sectors		
Labor productivity	Ratio Value added per employee (in millions of US$)	44.43	45.55
FVA in EXP	Ratio of Foreign value added Exports	0.124	0.120
DVX in EXP	Ratio of Indirect Domestic value-added and Exports	0.16	0.241
Capital Stock	Capital stock by Sector (in millions of US$)	20,493	39,797
Wages	Labor Compensation (in millions of US$)	2,339	4,082
	Agriculture	MEAN	SD
Labor productivity	Value added (in millions of US$)	83.56	30
FVA in EXP	Ratio of Foreign value added Exports by Sector	0.07	0.034
DVX in EXP	Ratio of Indirect Domestic value-added and Exports by sector	0.20	0.26
Capital Stock	Capital stock by Sector (in millions of US$) by Sector	21,975	27,565
Wages	Labor Compensation by Sector (in millions of US$)	2,288	2,692
	Manufacturing	MEAN	SD
Labor productivity	Value-added (in millions of US$) by Sector	30.45	41.07
FVA in EXP	Ratio of Foreign value added Exports by Sector	0.24	0.11
DVX in EXP	Ratio of Indirect Domestic value-added and Exports by sector	0.12	0.12
Capital Stock	Capital stock by Sector (in millions of US$) by Sector	14,819	20,376
Wages	Labor Compensation by Sector (in millions of US$)	1,651	2,169
	Service	MEAN	SD
Labor productivity	Value-added (in millions of US$) by Sector	47.73	13,787
FVA in EXP	Ratio of Foreign value added Exports by Sector	0.06	0.120
DVX in EXP	Ratio of Indirect Domestic value-added and Exports by sector	0.17	0.241
Capital Stock	Capital stock by Sector (in millions of US$) by Sector	23,580	39,797
Wages	Labor Compensation by Sector (in millions of US$)	2,740	4,082

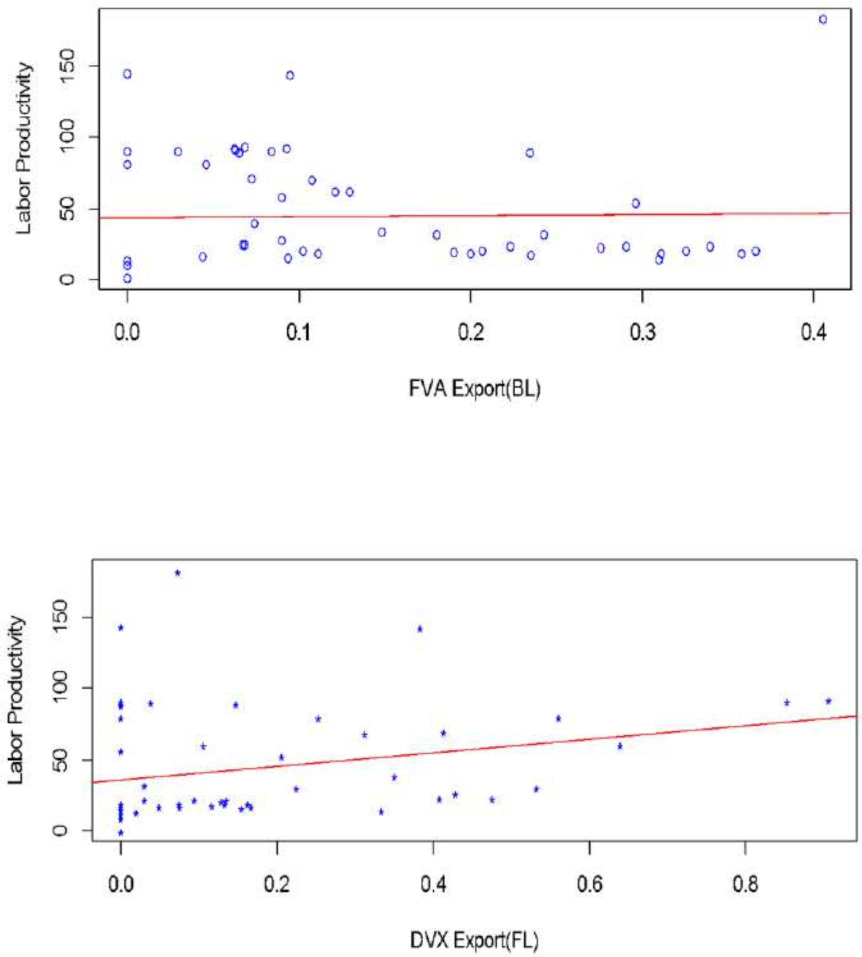
Figure 1. FVA, DVX in Export and Labor Productivity



Source: Author's calculation based on the WIOD and SEA 2016.

Figure 1 depicts the averaged time trends of labor productivity, backward linkages (FVA export), and forward linkages (DVX export) variables throughout 2000-2014. The productivity had been declining to reach its bottom in 2001 as a result of the economic crisis in Turkey in 2001 before it significantly rebounds in 2002 and continues to ascend. The 2008 financial crisis put an end to the increasing trend in productivity which substantially declined in 2009 and continued to decline after that. Following the fall in the value-added, the forward linkages continued to decline during 2000 and 2002 and stabilized from then till 2008 where it slightly declined before the ascendant trend after that. The industry-averaged backward linkages have mildly increased and slightly declined because of the 2008 financial crisis before it continued to increase.

Figure 3. Scatterplots of Labor Productivity, FVA and DVX Export



Source: Author's calculation based on the WIOD and SEA 2016.

Figure 3 illustrates a scatterplot of labor productivity, backward (FVA), and forward (DVX) linkages in the averages throughout 2000-2012. The fitted line is added to the figure. There seems to be no virtual evidence supporting the association between labor productivity and the foreign value-added in export (backward linkages) with an insignificant correlation coefficient. On the other hand, the association between labor productivity and indirect value-added export (forward linkages) appears positive with a significant correlation coefficient.

Although the associations depicted in Figure 3 are hardly suggestive of significant relationships between the variables, this may be driven by the simple correlation without considering observed and unobserved determinants of productivity. That is, a proper econometric framework should be set forth to analyze the relationships. For example, sectors have heterogeneous characteristics in technologies and labor inputs. Therefore, it is essential to account for these heterogeneities among sectors to assess the magnitude of the effects of the GVCs on productivity. Moreover, time-variant shocks that simultaneously impact all the sectors to the same extent need to be considered in the model. In the next section, we establish an empirical framework to examine the impact of the GVCs participation indicators on labor productivity.

2-2. Input-output weight matrix

In this study, we model the Interdependences between sectors using input-output relations. Specifically, we use the average use of intermediates over the studied period as a proxy for the extent to which each sector depends upon the other in terms of intermediates supply used in its production of goods and services. Therefore, the time average use of intermediates is calculated inter-industries and a weight matrix, which column's entries stand for the average purchase of intermediates by sector j sourced from sector *i*. This yields a 56 x 56 matrix that we row-standardize to get rid of units' measurement disturbances and for adequate implementation in the spatial model's specifications. The resultant row-standardized weight matrix captures the interdependence between sectors through the input-output linkages. Table 2 summarizes the input-output weight matrix.

Table 2. Summary of Row-Normalized weight Matrix

Weight Matrix	Normalization	Dimension	% nonzero weights	Av No of Links	Symmetry

Input-Output Weight Matrix	Row-Standardized	56 × 56	64.63	36.19	No symmetrical

3. Methodology and Empirical Models

3-1. Methodology

This study follows Hummels et al (2001) to calculate GVCs participation indicators of backward and forward linkages. The indicator of backward linkages[1] is calculated as the share of foreign value-added in export to export, that is, the import of intermediates used in a country's export as a share of gross export. The indicator of forward linkages is calculated as the share of export of intermediates used in the export to third countries to gross export. The World Input-Output Database provides information on the export and import of goods with respect to their end of use (intermediates and final goods and origin-destination (import and export). This enables us to trace back the source of the value-added content in exports and imports.

3-2. Empirical Models

The econometric approach follows Constantinescu et al. (2019) and rests on a production specification as a function of the inputs of capital stock K and labor L as following:

$$V_{it} = A_{it}(\sigma_1, \sigma_2 \ldots \sigma_n)F(K_{it}, L_{it})$$

[1] Also known as vertical specialization.

where A_{it} stands for a technology shifter of sector i in time t, which is assumed to be by trade-related variables. We assume that the effects originate from import and export channels, which is captured by the backward and forward linkages, respectively[2].

Dividing the production function by the labor input, assuming a Cobb-Douglass production function, and taking the logarithm yield the following model specification:

$$log(P_{it}) = a + \mu_1 log(BL_{it}) + \mu_2 log(FL_{it}) + \alpha log(K_{it})$$

Where P_{it} stands for the labor productivity variable. We control for sectors' heterogeneity and time-variant components by adding sector and time fixed effects parameters. Finally, adding a stochastic error term, the model can be written as:

$$log(P_{it}) = a + \mu_1 log(BL_{it}) + \mu_2 log(FL_{it}) + \alpha log(K_{it}) + \varphi_i + \tau_t + \epsilon_{it} \quad (1)$$

We augment the model with the wage variable and argue that higher levels of wages tend to motivate higher productivity. The microeconomic theory links wages and productivity. A plausible assumption is that higher productivity may lead to higher levels of wages. However, in developing countries, monopsony power tends to dominate, that is, employers pay workers less than their marginal productivity (Van Biesebroeck, 2015). Therefore, changes in labor productivity are unlikely to affect the level of wages.

We expect that the dependent variable reacts to changes in the explanatory variables with delay. Consequently, this study includes time-lagged explanatory variables on the right-hand side of the regression equation. This also diminishes the potential problem of simultaneity bias.

[2] Constantinescu et al (2019) discard the forward linkages in the model specification. One justification is that there exists a high multicollinearity between GVCs variables. In our study, the multicollinearity between forward and backward linkages is weak and it is not a problem in the estimation.

$$log(P_{it}) = a + \mu_1 log(BL_{it-1}) + \mu_2 log(FL_{it-1}) + \alpha log(K_{it-1}) + \beta log(W_{it-1}) + \varphi_i + \tau_t + \epsilon_{it}$$

(2)

The parameters estimate of this specification can be interpreted as elasticities. That is, the coefficients are interpreted as percentage changes in the dependent variable caused by percentage changes in the corresponding explanatory variable.

One central contribution of the present study is the control for the spillover effects that may arise from changes in the dependent variable across sectors. To see this, consider sectors ***a*** and ***b***, where sector ***a*** significantly relies on the intermediates sourced from the sector ***b*** to produce goods (and vice versa). Assume that there is a stochastic shock that boosts the productivity level in sector ***b***. This shock in productivity is likely to transmit to the sector ***a*** via input-output channels triggering a rise in its productivity as well via intermediates use and/or knowledge spillovers. Hence, this study attempts to provide some evidence that there are significant knowledge spillover effects across sectors both within and across economies (Amiti and Konings. 2007).

However, it is unlikely that variables included in equation 2 are readily able to capture these types of latent influences. That is, the spillover effects can arise as a result of the omitted variables that are not included in the econometric specification (LeSage & Pace, 2009). One way of modeling the spillover effects is including the dependent variable, into explanatory variables weighted with the input-output weight matrix that accounts for the interdependence between sectors as in the following specification.

$$log(P_{it}) = a + \rho \sum_{j=1}^{N} wijlog\ (P_{it}) + \mu_1 log(BL_{it-1}) + \mu_2 log(FL_{it-1}) + \alpha log(K_{it-1})$$

$$+ \beta log(W_{it-1}) + \varphi_i + \tau_t + \epsilon_{it}\ (3) \qquad (3)$$

Or in matrix form:

$$lo(P) = a + \rho W log(P) + \mu_1 log(BL) + \mu_2 log(FL) + \alpha log(K) + \beta log(W) + \varphi + \tau + \epsilon \quad (4) \qquad (4)$$

In this specification, changes in explanatory variables in one sector do not influence productivity only in that sector, which are referred to as "direct effects," but potentially all the other sectors, which are referred to as "indirect effects." Furthermore, a shock in productivity in one sector transmits to connected sectors through the input-output weight matrix, with the magnitude average effect captured by a dependence parameter ρ. Moreover, with the specification of Equation 4, we can also address problems related to endogeneity arising from the omitted variables that are correlated with the dependent variable across sectors such as the level of GVCs integration via backward, forward linkages, and other determinants. Consequently, the coefficients of the variables do not stand for marginal effects, because the partial derivative of the dependent variable to a given explanatory variable is not equal to its marginal effect (it coefficient). This can be seen if we write the model of Equation 4 as a data generating process:

$$log(P) = (I - \rho W)^{-1}[a + \mu_1 log(BL) + \mu_2 log(FL) + \alpha log(K) + \beta log(W) + \varphi_i + \tau_t + \epsilon] \qquad (5)$$

In Equation 5, a change in one explanatory variable does not affect labor productivity only within the sector but also across the other sectors. Therefore, the interpretation of the partial derivative is separated into "direct effects" within own sectors and "indirect effects" on other sectors, whose distributions can be simulated by drawing from a multi-normal distribution of the point estimates (LeSage and Pace, 2009). Moreover, a significant dependence parameter ρ would indicate "global spillover effects," where the changes in productivity in one sector set in motion a sequence of adjustments affecting all the sectors with feedback effects. We test whether the spillover effects are, rather, local in nature, that is, confined within sectors having similar characteristics by allowing an autoregressive process in the error term. The specification is as follows:

$$log\ (P) = a + \mu_1 log\ (BL) + \mu_2 log\ (FL) + \alpha log\ (K) + \beta log\ (W) + \varphi_i + \tau_t + \epsilon$$

$$\epsilon = \lambda W\epsilon + \varepsilon \quad and \quad \varepsilon \sim N(0, \sigma^2 I) \qquad (6)$$

The latter specification of Equation 6 is known as the Spatial Error Model (hereafter, referred to as SEM) and the coefficients are straightforwardly interpreted as marginal effects because the dependence parameter in the error term does not come to play when the partial derivative is computed. We also aim at clarifying the nature of spillover effects arising from the sectors' interdependence utilizing Wald and Likelihood tests.

4. Results

Table 4 reports the estimation results of the models. We start with estimating the non-spatial models and then we provide the estimation results accounting for the Spillover effects. In Column 1, the estimation of the pooled ordinary least square (OLS) indicates that the backward linkages indicator is negatively associated with labor productivity with the elasticity of -0.29. This suggests that a higher volume of imports of intermediates, used in the export of goods, diminishes labor productivity. Labor productivity rises with forward linkages, that is, the export of inputs used in the export of another country's export to the third countries. This stands for an important channel through which trade affects productivity. This is consistent with the concept of learning through exporting by which firms with higher export orientations tend to be more productive (De Loecker, 2013).

Table 4. Estimation of spatial and non-spatial models

	Dependent Variable: Employment (Log of productivity by employee)			
	Models without Spillovers		Models with Spillovers	
Variables	OLS	Two-ways FE	SAR	SEM
FVA	-0.29***	-0.087	-0.08*	-0.12**
	(0.031)	(0.053)	(0.047)	(0.05)
DVX	0. 10***	0.056**	0.062***	0.072***
	(0.030)	(0.026)	(0.023)	(0.022)
K	0.62***	0.47***	0.41***	0.44***
	(0.018)	(0.022)	(0.021)	(0.021)
W	0.026*	0.16***	0.06**	0.12***
	(0.014)	(0.026)	(0.026)	(0.030)
Rho/Lambda			0.35***	0.77***
			(0.039)	(0.034)
R-squared	0.81	0.50	0.246	0.227
Time FE	No	YES	YES	YES
Sect FE	No	YES	YES	YES
LM test (Honda) (Two-ways effects)	64.99***			
LM test for Lag dependence	196.57***	10.15***		
LM test for error dependence	43.65***	6.6**		
LL			517.5	498.24
AIC			-885	-846.49
BIC			-535.16	-496.66

Robust Standard errors are in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

As expected, we find that productivity increases with both the capital stock and wages. However, the pooled OLS estimation is likely to suffer from a substantial overestimation bias as it cannot control sufficiently for sector heterogeneity and time-specific effects. In fact, according to Honda's Lagrange Multiplier Test, we should include sector and time fixed effects into the estimation model, which is reported in Column 2. After controlling for sector and year fixed effects in the Two-way fixed effects model, the estimate on backward linkages indicators on productivity (FVA), becomes insignificant. In contrast, the coefficient of the forward linkages (DVX) remains positive and significant at the five percent level. That is, labor productivity is positively associated with forward linkages indicator, with the coefficient size of 0.056. We can find significant estimates on capital stock and wages, supporting a natural interpretation of production function: labor productivity increases with both capital stock and wages.

While the model with the two-way fixed effects presents a significant improvement compared to the pooled OLS estimation, in the sense that it accounts for sector heterogeneity and time fixed effects, its estimates may be biased in the case when the errors have strong interdependences through input-output connections. That is, ignoring this interdependence may lead to erroneous inferences. We verify this by testing the existence of interdependencies between sectors in the disturbances of the fixed effects models using Moran's *I* and the input-output weight matrix.

Table 3. Monte-Carlo simulation of Moran's I statistics

p-value	Statistic	Year	p-value	Statistic	Year
0.008991	0.099086	2001	0.023976	0.086131	2008
0.007992	0.142183	2002	0.421578	-0.00559	2009

0.976024	-0.112	2003	0.292707	0.007934	2010
0.92008	-0.08219	2004	0.140859	0.039491	2011
0.824176	-0.05465	2005	0.466533	-0.01334	2012
0.347652	0.005042	2006	0.625375	-0.03138	2013
0.01998	0.086741	2007	0.285714	0.011301	2014

As discussed above, the study models the interdependence between sectors using an input-output weight matrix. The Moran's I^3 statistics are generated for each year using a Monte Carlo randomization technique to construct the distributions. The results of this procedure are reported in Table 3. According to Table 3, several Moran's *I* statistics are significant at a 10 percent significance level, implying that the two-ways fixed effects still suffer from a problem of interdependencies in the error term, which nature must be sorted out. Lagrange Multiplier tests lend support to a significant interdependence arising from the inclusion of either the dependent variable or the error term. This indicates that it is important to specify the model correctly to account for the interdependencies across sectors.

We estimate the Spatial Autoregressive Model (hereafter, referred to as SAR model) accounting for the weighted dependent variable with the weight matrix and the Spatial Error Model

[3] The null hypothesis is that there are no spatial correlations. The Moran's *I* statistic asymptotically follows a normal distribution.

(SEM) accounting for the weighted error term with the weight matrix. We find that spillover coefficients (Rho/Lambda) in both SAR and SEM models are positive and significant. As we previously indicated, the SAR model indicates global spillover effects where a change in one explanatory variable affects productivity not only within that sector but also potentially among all other sectors (LeSage & Pace 2009). On the other hand, the spillover effects in the SEM model are confined only within sectors having non-null entries in the weight matrix via the disturbances. It is necessary to determine the nature of the spillover effects before engaging in interpreting the estimation.

Elhorst (2010) conveys that, in the case of strong dependencies, the goodness of fit criteria can be adequate for model selection. That is, one can choose the model exhibiting the highest goodness of fit values. According to the likelihood, AIC, and BIC (Table 4), the SAR model fits the data generating process best. That is, the spillover effects are global, and changes in explanatory variables are likely to affect not only the own sectors but also all the sectors via the input-output weight matrix. As previously discussed, the direct and indirect effects do not stand for marginal effects in the case of SAR models. Therefore, following LeSage & Pace 2009, we simulate the distribution of the direct and indirect effects drawn from a multivariate normal distribution of the point estimates based on Table 4.

Table 5. Monte-Carlo Simulation of the Direct, Indirect, and Total Effects

Variables	Direct	Indirect	Total
FVA	-0.081*	-0.043	-0.12*
	(0.047)	(0.026)	(0.073)
DVX	0.062***	0.033***	0.095***

	(0.024)	(0.014)	(0.037)
K	0.41	0.22	0.63
	(0.021)	(0.036)	(0.040)
W	0.06***	0.032***	0.092***
	(0.026)	(0.013)	(0.038)

Standard errors are in parenthesis, *** p<0.01, ** p<0.05, * p<0.1

The simulated direct, indirect, and total effects are reported in Table 5. First, one can sense the bias that arises from excluding the cross sectors spillovers effects in labor productivity. The coefficient of the backward linkages indicator becomes significant, suggesting that productivity decreases within the sector as a result of higher GVCs participation by the channel of import of intermediates used in the export of goods. Specifically, a 10 percent increase in the level of backward linkages decreases labor productivity by 0.8 percent. This implies that the imported intermediates, used in the country's exports, act as substitutes for the domestically produced goods, which leads the productivity to decline. Interestingly, labor productivity does increase with forward linkages not only within its sectors but also across sectors, supporting the existence of substantial spillover effects. In particular, a 10 percent increase in forward linkages indicator increases labor productivity not only in its sectors by 0.62 percent but also across sectors by 0.3 percent. And thus, a total impact on labor productivity becomes 0.95 percent. As a result, ignoring the interdependence between sectors leads to a downward bias in estimating the impact of GVCs' participation on productivity. While stock capital seems unassociated with labor productivity, the level of wages significantly boosts labor productivity both within and across sectors. This implies that higher wages in their own sectors stimulate productivity and that this effect is transcended to other sectors via the weight matrix.

Overall, these findings suggest that GVCs participation plays a key role in productivity's changes not only within their own sectors but also across sectors through the inputs-outputs linkages. However, and since the impact of the participation in the GVCs varies considerably among the different sectors as a result of heterogeneous technologies and labor skills, it is central to assess its impact on productivity for different sectors.

The distribution of the value-added is U-shaped (Baldwin, 2012) and changes with respect to the position of the sector in the supply chain. There is evidence that a significant value-added accrue pre- and post-manufacturing service, and that the distribution of value-added in the manufacturing sector changes from high-tech to small-scale sectors (Banga, 2018). As a result, we should examine the impact of GVCs' participation on productivity for different sectors. We limit our analysis to the service and manufacturing sectors because of the data limitations. Hence, we divide the sample into two subsamples of the service and manufacturing sectors and estimate our previously preferred model[4].

Table 6. Sectors GVC participation impact of Productivity

Dependent variable: log of Labor productivity

[4] We construct a sub-weight matrix for each category of sectors.

	1	2	3	4	5	6
	Manufacturing			Services		
Variables	Fixed Effects	SAR		Fixed Effects	SAR	
		Direct Effects	Indirect Effects		Direct Effects	Indirect Effects
FVA	-0.32***	-0.36***	-0.355***	0.002	0.020	0.004
	(0.078)	(0.071)	(0.12)	(0.074)	(0.068)	(0.017)
DVX	-0.082*	-0.065*	-0.064	0.11***	0.10***	0.026***
	(0.043)	(0.038)	(0.043)	(0.032)	(0.029)	(0.010)
LgK	0.36***	0.32***	0.32***	0.61***	0.58***	0.14***
	(0.039)	(0.035)	(0.090)	(0.029)	(0.029)	(0.038)
LgW	0.23***	-0.032	-0.031	0.082*	0.033	0.008
	(0.065)	(0.066)	(0.074)	(0.029)	(0.028)	(0.0067)
Rho		0.51***			0.20***	
		(0.063)			(0.045)	
LL		251.83			311.17	
AIC		-427.66			-518.35	
BIC		-291.48			-303.3	

Standard errors are in parenthesis. Monte-Carlo simulation of the direct and indirect effects are reported for the SAR models. *** p<0.01, ** p<0.05, * p<0.1

The estimation results of the fixed effects models are reported in columns 1 and 4 of Table 6.

In columns 2 and 3 the estimation results of the SAR are reported for manufacturing. The autoregressive parameter is significant and positive at the magnitude of 0.51, indicating a significant positive diffusion in productivity across manufacturing sectors through the input-output relations. Furthermore, the results reveal a negative association between the backward linkages and labor productivity in manufacturing industries. Specifically, a 10 percent increase in the backward linkages is associated with a 3.6 percent decline in labor productivity within its own sectors and a 3.5 percent decline across sectors, with a total decline of 7.1 percent. The negative association between backward linkages and productivity in previous results seems to be driven mainly by manufacturing backward linkages. That is, the import of manufacturing intermediates used in the country's export acts as a substitute for domestic goods, which decreases value-added and consequently the productivity. on the other hand, a 10 percent increase in forward linkages in a manufacturing sector yields a 0.65 percent decline in productivity at the 10% significance level.

In Columns 5 and 6, the autoregressive parameter is positive and significant with a magnitude of 0.2, suggesting a substantial positive transmission of the productivity across service sectors through input-output relations. That is, changes in labor productivity in one sector significantly affect productivity in that sector with magnitude decaying with the degree of connectivity. As discussed before, evidence shows that a substantial portion of value-added accrues in the service sector linkages to the value-added and productivity (Baldwin, 2012). In the case of GVCs participation in the Turkish service sector, the forward linkage is a key channel through which productivity is boosted in service sectors. Labor productivity significantly increases with the forward linkages both within and across service sectors. Specifically, a 10% increase in the forward linkages ratio is associated with 1% increase in labor productivity within its own sectors and 0.26% across sectors with a total increase in the productivity of 1.26%. These findings are consistent with the existing literature suggesting that export-oriented firms tend to be more productive compared to firms less involved in export activities. This can happen through learning by exporting and technology dissemination (De Loecker, 2012). However, the results provide evidence that the learning by exporting process is not confined within its own sectors but transcends to include other sectors through input-output interdependence, that is, spillover effects. Finally, labor productivity significantly rises with capital stock both within and across service sectors.

5. Concluding remarks

This study provides evidence that GVCs participation, through backward and forward linkages, is significantly associated with productivity at the sector level. Using a spatial econometric approach to model input-output dependence in productivity between sectors, the study provides evidence of significant spillover effects in productivity across sectors. The study also finds evidence that GVCs' participation not only affects productivity within their own sectors (direct effects) but also across sectors through input-output dependence (indirect effects). Particularly, the results suggest that productivity in manufacturing and service sectors is susceptible to a significant spillover effect across sectors and that change in productivity in one sector positively transmits to other economy’s sectors through the input-output relations. This is in line with Balassa’s (1961) assumption stipulating that linkages between sectors are key sources of productivity spillovers. Finally, a Monte Carlo simulation suggests that GVCs’ participation via backward linkages is negatively associated with productivity both within and across manufacturing industries lending support to the substitution hypothesis of the imported intermediates and that GVCs' participation, via forward linkages, boosts productivity within and across service's sectors. Importantly, this study sheds some light on the channels through which GVCs Integration affects productivity. It also empirically tests Balassa's (1961) hypothesis, that linkages between industries are a key source of productivity spillovers. Understanding these channels and mechanisms through which the spillovers take place across industries is central for tailoring efficient policies. An important area of future research is to model the input-output relations both across sectors and countries using the WIOD 2016.

References

Amiti, M. and J Konings. 2007. "Trade Liberalization, Intermediate Inputs, and Productivity." American Economic Review 97 (5): 1611-1638. Approach to Measure International Fragmentation," Journal of Regional Science 55 (2015):66–92.

Aqib A ., Natalija N ., and Fabiano R ., 2017. Calculating Trade in Value Added. IMF Working Papers.

Badinger, H,. and Egger, P. (2008). Intra- and Inter-Industry Productivity Spillovers in OECD Manufacturing: A Spatial Econometric Perspective.

Balassa, B. (1961). Towards a Theory of Economic Integration. Kyklos, 14(1), 1–17. doi:10.1111/j.1467-6435.1961.tb02365.x.

Baldwin, Richard, and Anthony J. Venables. "Spiders and snakes: offshoring and agglomeration in the global economy." Journal of International Economics 90, no. 2 (2013): 245-254.

Baldwin, Robert E. 1994. The Effects of Trade and Foreign Direct Investment on Employment and Relative Wages. OECD Economic Studies 23: 7-54.

Bayar, G. (2002). Effects of Foreign Trade Liberalization on the Productivity of Industrial Sectors in Turkey. *Emerging Markets Finance & Trade.* Vol. 38, No. 5, Turkey in the Financial Liberalization Process (I) (Sep. - Oct., 2002), pp. 46-71.

Beltramello, A., K. De Backer, and L. Moussiegt. The Export Performance of Countries within Global Value Chains. OECD Science, Technology and Industry Working Papers. Paris: OECD Publishing, 2012.

Castelli F, and Wilson D J. 2004. Importing technology. Journal of Monetary Economics. Vol. 51, 2004, pp 1-32.

CerenGündoğdu&DürdaneŞirinSaracoğlu, 2016. "Participation of Turkey in Global Value Chains: An Analysis Based on World Input Output Database," ERC Working Papers 1610, ERC - Economic Research Center, Middle East Technical University, revised Sep 2016.

Constantinescu, C., Mattoo, A., & Ruta, M. (2019). Does Vertical Specialization Increase Productivity? The World Economy. doi:10.1111/twec.12801.

De Backer, Koen and Yamano, Norihiko, International Comparative Evidence on Global Value Chains (2011). Available at SSRN: https://ssrn.com/abstract=2179937 or http://dx.doi.org/10.2139/ssrn.2179937.

Elhorst, J.P., 2010. Applied spatial econometrics: raising the bar. Spat. Econ. Anal. 5 (1), 9–28.

Feenstra, R. C. and G. H. Hanson. 1996. "Globalization, Outsourcing, and Wage Inequality." American Economic Review 86 (2): 240-45.

Gene M. Grossman & Esteban Rossi-Hansberg, 2008. "Trading Tasks: A Simple Theory of Offshoring," American Economic Review, American Economic Association, vol. 98(5), pages 1978-97.

Hummels, David, Jun Ishii, and Kei-Mu Yi. 2001. "The Nature and Growth of Vertical Specialization in World Trade." Journal of International Economics 54(91): 75–96.

Ignatenko, A., Raei, F., and Mircheva, B. 2019. IMF Working Paper.

Johnson, Robert, and Guillermo Noguera. 2012. "Accounting for Intermediates: Production Sharing and Tarde in Value Added." Journal of International Economics 86(2012a): 224–236.

Jorgenson, D.W., F. M. Gollop, and B. M. Fraumeni, Productivity and U.S. Economic Growth, Cambridge, MA: Harvard University Press (1987).

Koopman, Robert, William Powers, Zhi Wang, and Shang-Jin Wei. 2010. "Give Credit Where Credit Is Due: Tracing Value Added in Global Production Chains." NBER Working Paper No. 16426, National Bureau of Economic Research, Cambridge, MA.

Koopman, Robert, Zhi Wang and Shang -Jin Wei. 2014. Tracing Value -Added and Double Counting in Gross Exports. American Economic Review 104 (2): 459-494.

Kummritz, V. 2016. “Do Global Value Chains Cause Industrial Development?” CTEI Working Paper No. 2016-01.

Nasser Dine, M,. 2019. Impact of Global Value Chains' Participation on Employment in Turkey and Spillovers Effects. *Journal of Economic Integration.* Vol. 34, No. 2, pp. 308-326

Ozler, S., & Yilmaz, K. (2009). Productivity response to reduction in trade barriers: evidence from Turkish manufacturing plants. Review of World Economics, 145(2), 339–360. doi:10.1007/s10290-009-0019-0.

Taglioni, Daria; Winkler, Deborah. 2016. Making Global Value Chains Work for Development. Trade and Development;. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/24426 License: CC BY 3.0 IGO.

Timmer, M., B. Los, R. Stehrer, and G. de Vries. 2016. “Research Memorandum Number 162: An Anatomy of the Global Trade Slowdown based on the WIOD 2016 Release.” Groningen, the Netherlands: Groningen Growth and Development Centre.

Timmer, Marcel P., Bart Los, Robert Stehrer and Gaaitzen J. de Vries. 2013. Fragmentation, Incomes and Jobs: An Analysis of European Competitiveness. Economic Policy 28 (76): 613-661.

Timmer, Marcel P., Erik Dietzenbacher, Bart Los, Robert Stehrer and Gaaitzen J. de Vries. 2015. An Illustrated User Guide to the World Input -Output Database: The Case of Global Automotive Production. Review of International Economics 23 (3): 575-605.

Yilmaz, K,.Ugur, A,. and Otyun, M,. (2019), Economic Research Forum. Working Paper No. 1283.