PANOECONOMICUS, 2024, Vol. 71, Issue 2, pp. 265-293
Received: 11 October 2020; Accepted: 09 January 2022.

UDC 330.1(560)"1995/2009" "2000/2009"
https://doi.org/10.2298/PAN201011010Y
Original scientific paper

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This work was sponsored by the Economic Research Forum (ERF) and has benefited from both financial and intellectual support. The contents and recommendations do not necessarily reflect ERF's views.

The Impacts of Openness and Global Value Chains on the Performance of Turkish Sectors

Summary: Regarding the dynamics of the contemporary world economy, success in a domestic economy cannot be achieved without effective integration policies for goods/services and capital flows. To evaluate this proposition, we utilize many openness measures for two periods, 1995-2009 and 2000-2014, for the Turkish sectors. The empirical findings suggest that domestic value added in export is a major driver of sectoral value added. While import and backward linkages appear to be stimulators for total factor productivity (TFP) in manufacturing industries, they have no significant impact on sectoral value added. Trade barriers in the form of tariff rates, which primarily stemmed from manufacturing industries, have a considerable detrimental impact on Turkish sectoral performance. Higher tariffs not only make it more difficult for Turkish businesses to enter overseas markets but also raise the costs for importers. The initial impact of this protection is inexorably exacerbated by global value chains (GVCs), with negative consequences felt in nearly every economy. Given the increased backward GVC involvement of some manufacturing industries, such as machinery and equipment, Turkish sectors should be prepared for external shocks by diversifying importer origins, stocking up, and boosting transparency in their operations. Overall, designing and implementing trade policies to effectively integrate into the GVCs is an important task for Turkey.

Keywords: Openness, Sectoral total factor productivity, Value added, GVC participation, Turkey.

JEL: F14, F21, O14, O24, O47.

The global economy has been highly integrated *via* the product, service, financial, and labor markets owing to improvements in information and telecommunication technologies. Indeed, production processes are fragmented across countries to specialize in a specific segment of production and utilize relatively cheap resources across borders. Trade-in tasks and outsourcing are the new trade activities, which make products or services difficult to be differentiated in terms of where the product is made in. Indeed, two-thirds of international trade is composed of intermediate goods and services (Robert C. Johnson and Guillermo Noguera 2012b).

In these interdependent world economies, traditional trade statistics are inadequate to shape a proper picture regarding the actual comparative advantage of countries or sectors in the international market. The gross trade statistics contain information on

the foreign value added of many other countries in trade with one or another country (Robert Koopman, Zhi Wang, and Sahng-Jin Wei 2014). On the contrary, the indicators related to global value chains (GVCs) focus on actual value added allocation in production chains. GVCs thus provide important opportunities for countries to specialize in a specific segment of production system according to their comparative advantages. Intermediate good importers could have the potential to increase their productivity levels *via* backward linkages and technology spillovers. Hence, regarding the dynamics of the contemporary world economy, success in export markets for various sectors cannot be possible without effective integration policies for products and capital flows.

In this paper, we analyze the effects of openness by employing several measures on the total factor productivity (TFP), value added, and export for thirty sectors, including manufacturing, services, agriculture, mining, construction, and electricity, gas, and water for the period of 1995-2014 in Turkey. March J. Melitz and Gianmarco I. P. Ottaviano (2008) emphasize the importance of sector-level analysis rather than firm-level analysis because the productivity gains from resource allocation across firms can be only caught up through sectoral analysis. Therefore, we employ several different measures of openness such as sectoral trade measures, backward and forward GVC participation rates, input tariff rate, and inward and outward foreign direct investment (FDI) flows.

Understanding the effects of openness on sectoral TFP, value added, and export performances of sectors is highly crucial for effective integration with the international markets. To the best of our knowledge, there is not such a comprehensive sectoral study regarding GVCs and sectoral productivity/export performance for Turkey. Another novel part of this study is the fact that we make our analysis based on both previous and new versions of datasets such as the World Input-Output Database (WIOD) (2014, 2016) and the World Integrated Trade Solution (WITS). Thus, this enables us to observe longer periods and compare the results. Moreover, employing final demand-based forward and backward GVC participation indices in our empirical analysis is an important dimension of our paper because this is the first study utilizing these indices in an empirical model for Turkey. Since widely used GVC participation indices for some industries are much higher than 100% according to conventional measures as a result of the indirectly exported value added of these industries embodied in the exports of other industries (Wang et al. 2017a), the Organization for Economic Cooperation and Development (OECD) staff recommend us to employ final demand-based measures in sectoral analysis based on our communication with them on this issue as well. Furthermore, we calculate GVC length and distance to final demand from the WIOD database for subcategories of the main sectors.

The estimation results based on the first dataset imply that increasing domestic value added in export enhances sectoral value added. The faced input tariff is adversely associated with the TFP and export, implying that Turkish goods and services are becoming less competitive in international markets owing to these types of trade barriers. In addition, imports appear to play a significantly positive role in Turkey's export performance. Moreover, the faced input tariff reduces export in the second dataset. Because of the higher tradability of industrial products, these results from the full sample

are mostly in line with the results from the manufacturing sample. Import is the crucial element boosting both the sectoral TFP and the export of manufacturing industries.

This study is organized as follows. The next section discusses the relevant literature. The second section describes the datasets and measures used in this study. The third section explains the methodology and estimation strategy. The fourth section summarizes the empirical results. The final section presents the concluding remarks and policy recommendations.

1. Literature Review

Gains from trade are largely discussed in the literature, suggesting that countries are able to specialize in the products with which they have comparative advantages, as suggested by Ricardo's framework. Gene M. Grossman and Elhanan Helpman (1991) also emphasize the dynamic gains from trade, such as enhanced knowledge and technology and increased investment, which are eventually transmitted into economic growth. Many studies investigate the trade-productivity nexus for Turkey. For instance, Ömer Faruk Altunç and Celil Aydın (2015) find the positive productivity effect of the export of skill and technology-intensive goods for most countries, including Turkey, between 1995 and 2010. Dilek Temiz Dinç et al. (2017) also confirm a positive relationship between trade and economic growth from 1990 to 2011. However, these studies utilize gross export statistics, which prevents researchers from analyzing the exact situation of the country in GVCs.

Over the last decades, technological improvements have led to declining coordination problems and transportation costs in the international markets. This occurrence alters the geographical locations of production and labor market requirements so that the nature and patterns of trade have been changed. Gary Gereffi and Leslie Sklair (1994) develop a term called "global commodity chains" to express competent fragmented production and distribution systems across borders in a global world. Many researchers have pointed out the inefficiency of traditional trade data and started to compile their datasets, including demanding and supplying industries utilizing the Global Trade Analysis Project (Koopman et al. 2010; Daniel Trefler and Susan Chun Zhu 2010; Johnson and Noguera 2012a, b; Koopman, Wang, and Wei 2014).

Trefler and Zhu (2010) track the intermediate good flows to calculate the factor content of international trade. Utilizing the same technique, Johnson and Noguera (2012b) calculate the value added content of trade from bilateral trade statistics and input-output (IO) data. They figure out that value added trade statistics are significantly different from gross trade statistics. Koopman, Wang, and Wei (2014) examine the value added exports of several countries in 2004. One of the interesting findings of their study is that both China and India have a strong comparative advantage in terms of gross exports. However, when the ranking is based on the exports of domestic value added, the rankings of these countries decrease notably. The GVC participation index is proposed by Koopman et al. (2010) and then adopted by many researchers in subsequent studies (Chiara Criscuolo and Jonattan Timmis 2017; Wang et al. 2017a). Criscuolo and Timmis (2017) propose that GVCs could prompt productivity growth through specialization in core tasks, knowledge spillovers, and access to imported inputs.

The studies investigating the association between GVC participation and productivity are growing. Victor Kummritz (2016) finds that higher value in backward and forward GVC participation indices create higher domestic value added and labor productivity at the industry level. Cristina Constantinescu, Aaditya Mattoo, and Michele Ruta (2019) assert that backward GVC participation is a significant driver of labor productivity. Cecilia Jona-Lasinio and Valentina Meliciani (2019) figure out that the positive effect of GVC participation on productivity growth is higher in industries having greater intangible capital intensity for nine European countries. Stefan Pahl and Marcel P. Timmer (2020) find the positive productivity effects of GVC participation for manufacturing industries in a large set of countries.

Regarding the GVC literature, Thibault Fally (2011) introduces the concept of an average number of production stages and distance to final demand; many authors then explore these concepts by utilizing international IO tables. Pol Antràs et al. (2012) define the number of production stages as backward linkages and define distance as forward linkages with GVCs. In many studies, these concepts are analyzed with descriptive graphs and statistics (Koen De Backer and Sébastien Miroudot 2013; Jan Hagemejer and Mahdi Ghodsi 2017; Davide Del Prete, Giorgia Giovannetti, and Enrico Marvasi 2018; Xin Li, Bo Meng, and Zhi Wang 2019).

Regarding trade liberalization, tariff rates are also significant variables indicating to what extent sectors are protected from competition in the international market. In theory, it is widely discussed that domestic firms or sectors are likely to increase their productivity through an opening to international markets. This boosts production scales and decreases cost, which is also defined as the scale effect (Paul R. Krugman 1979). In addition, positive turnover can be realized if inefficient firms or sectors leave the market as a result of not competing in the international area. Furthermore, James R. Tybout and M. Daniel Westbrook (1995) also see learning by doing and technical innovation as benefits of participating in trade activities. For instance, JaeBin Ahn et al. (2019) find that a decrease in input tariffs increased the sectoral TFP of eighteen advanced countries between 1991 and 2012. Przemyslaw Kowalski et al. (2015) also provide evidence that a low level of tariffs plays a significant role in participating in both backward and forward GVCs. The story can be different concerning the GDP *per capita* income of countries. Many developing countries may not observe the scale effect owing to some institutional characteristics. For instance, employing firm-level data from Ghana, Kenya, and Tanzania during the 1990s, Lauren Bresnahan et al. (2016) confirm that negative TFP growth among exporters is attributable to a reduction in external tariff rates.

FDI is also another crucial determinant for the market success of industries. Tetsunori Koizumi and Kenneth J. Kopecky (1977) assert that technology-induced FDI has some spillover effects on countries like the imitation effect. The benefits of FDI can be realized if the absorptive capacity and ability of firms are high enough. İbrahim Arısoy (2012) finds the positive contribution of FDI on TFP in Turkey for the period 1960-2005. Syeda Tamkeen Fatima (2016) also confirms positive productivity spillovers from FDI employing Turkish firm-level data over the period 2003-2010. Hence, we contribute to the existing literature by analyzing the impact of both trade openness

and GVC participation on sectoral TFP, value added, and export in a developing country, Turkey.

2. Data

We employ three main databases - the WIOD 2014/2016, the WITS, and the Central Bank of the Republic of Turkey (CBRT) - containing data on manufacturing, services, and other sectors. Note that since WIOD 2014 and 2016 are not compatible with each other, we choose to have two sets of variables. In the first one, the period of this dataset is between the years 1995 and 2009. In the second one, the period of this dataset is between the years 2000 and 2014. The industries in both the CBRT and WITS are compatible with these two composing samples. The matching strategy of industry codes is given in Table A1 in the Appendix. In the WIOD and the Socio-Economic Accounts (SEA) databases, the output, value added, capital compensation, labor compensation, capital stock, and number of employees are the variables we used in our analysis[1]. The variables in the national local currencies are converted into U.S. dollars.

By utilizing IO tables in WIOD, the sectoral gross exports, domestic content of export, imports, GVC participation, length, and distance measures are calculated. Regarding GVC participation indices, the Organisation for Economic Co-operation and Development - OECD (2016) starts to use new participation indices based on final demand different from previous indices based on value added shares in gross exports (Koopman et al. 2010). In the OECD (2016), the share of foreign value added in domestic final demand and the share of domestic value added used in production for foreign final demand are employed as backward and forward GVC participation indices, respectively. These new indices are superior to common indices, which are calculated as percentages of gross exports, especially in industry-level analysis, since the previous participation indices may be very high (much higher than 100%) if a sector has very few direct exports.

The length of GVCs is introduced and calculated as an index for the number of production stages by Fally (2011). The index takes the value of one if there is a single production stage and otherwise takes the value higher than one depending on how many stages are passed or how many inputs are used regardless of domestic or foreign value added (see the Appendix for the calculation). It is defined as the column sum of the Leontief inverse matrix (Johnson 2018). Distance to final use - that is, the distance index - is also proposed by Fally (2011). It is defined as the row sum of the Ghosh inverse matrix (Antràs et al. 2012; Johnson 2018). It means the forward linkages and measures the number of stages before the goods or services are attained by the final consumers. The sectors producing raw materials, doing research, and designing are located upstream, whereas services such as logistics, marketing, and branding are located downstream in the production stage. Distance is generally associated with higher value added and higher GVC participation, which requires knowledge and technology-based investments into the economy. In the literature, De Backer and Miroudot (2014) calculate the domestic and foreign portions of the length and distance of countries and

[1] **University of Groningen.** 2020. World Input-Output Database. http://www.wiod.org (accessed September 20, 2020).

then call them domestic and international length and distance. By applying their idea and the efforts of the OECD to divide value added into domestic and foreign parts, we further divide these measures into two parts as one represents a foreign portion and the other represents a domestic portion of these measures. We call them the external and internal length/distance for the foreign and domestic parts of length/distance, respectively. However, these two indices are not adequate to assess the positions of sectors in a GVC. Are they located upstream or downstream? To answer this question, we follow the idea of Wang et al. (2017b) about the calculation of the position index. They simply consider the ratio of the distance-to-length index to gauge the relative position of industries in a chain.

The effectively applied tariff rates are retrieved from the WITS (WITS-TRAINS) database (World Integrated Trade Solution 2020)[2]. The WITS database provides six-digit harmonized system tariff rates that Turkey imposed and Turkey faced with their corresponding trade values. We calculate the sectoral tariff rates of intermediate products utilizing the HS6-ISIC Rev. 3-BEC concordance table provided by the OECD. Sectoral FDI inflow and outflow variables are directly taken from the CBRT. The variables in the national local currencies are converted into U.S. dollars. All the nominal variables are deflated by using the price index taken from the WIOD database.

The matching strategy of these three datasets is based on official WIOD reports (University of Groningen 2020), WITS sectoral codes based on ISIC3 sector classification, and the CBRT data information documents. Overall, after carefully matching each industry one by one by utilizing three databases, we have thirty sectors for the first sample and thirty-six sectors for the second sample. For the first sample, one is agriculture, one is mining, one is construction, one is electricity, gas, and water utilities, fourteen are manufacturing, and twelve are service sectors. For the second sample, one is agriculture, one is mining, one is construction, two is electricity, gas, and water utilities, thirteen are manufacturing, and eighteen are service sectors (see Table A1 in the Appendix). The descriptive statistics of all the variables we use in the analysis are given in Table 1 for two separate datasets.

Before moving into an empirical analysis, we want to discuss GVC-related measures in a graphical framework. Figure 1 shows that the external length of industries ranges from 1.02 to 2.25 for the years 1995 and 2014. For example, the textiles and leather sector has almost twice as much internal length compared (2.12 in 2014) to external length (1.16 in 2014) for both periods. Relatively, the lower values of length suggest that Turkish industries sell goods or services with fewer production stages. The external length index follows a very stable path over two data points across all sectors with a slight increase. The internal length ranges from 1.20 to 3.71, which is higher than the external length for all sectors for the same period. Industries such as textiles and leather, wood, and food and beverages have a relatively larger number of domestic production stages in 1995, while financial services and electricity, gas, and water have relatively higher internal production stages in 2014. Industries such as real estate activities, education, and the mining and quarrying sectors have a lower number of domestic production stages compared to other sectors.

[2] **World Integrated Trade Solution.** 2020. Tariff and Trade Analysis Database. https://wits.worldbank.org/ (accessed September 20, 2020).

Comparing backward GVC participation with the length provides us with important clues about how the Turkish economy participates in GVCs. Figure 1 also shows the relationship between the length and backward GVC participation for the years 1995 and 2014. Although there are considerable increases in backward GVC participation for almost all manufacturing industries except for the textile and leather sector, we do not observe any significant changes in their external lengths. This can be the result of increases in the volumes of value added imports rather than increases in the number of production stages. Thus, the relative stability of lengths implies no significant changes in the complexity of products. Meanwhile, the same sectors with higher backward GVC participation (based on final demand) have relatively lower external lengths compared to internal ones. This indicates that these sectors excessively utilize foreign products with fewer stages. Indeed, it seems that they choose to employ less domestic intermediate goods rather than foreign intermediates.

Figure 2 indicates that compared to their sales in international markets, Turkish sectors sell relatively more intermediates in the domestic market. In other words, the products sent to the international markets are mostly final goods. Sectors such as electricity, gas, and water supply, financial services, mining and quarrying, wood, paper, textile and leather, coke, and refined petroleum are relatively more distant from domestic final consumers. Industries such as education, health and social work, and construction have the lowest distance to the final demand index, which suggests that goods provided by these downstream sectors are utilized as final goods in the markets. For almost all industries, the index has followed an increasing trend from 1995 to 2014, which implies that these industries are more specialized in intermediate inputs and positioned upstream of the production chains. The same figure also presents the relationship between the distance and forward GVC participation for the years 1995 and 2014. While the machinery and equipment, electrical and optical equipment, and transport equipment sectors have relatively higher forward GVC participation rates, the external distance indices for these sectors are mostly close to one. This suggests that the goods produced by these sectors are used abroad mostly as final goods rather than intermediate goods. For the electricity, gas, and water supply and financial services sectors, higher values of both length and distance indices mean that these sectors are at the middle of the whole production chain. Furthermore, this could be an exact example of the hypothesis that sectors with a higher number of backward production stages are more likely to be located in an upstream position in a GVC (Fally 2012). In other words, the complexity of forward linkages may also depend on the complexity of backward linkages.

Overall, there are significant increases in value added imports and exports as measured in participation rates. However, these patterns do not coincide with considerable increases in the complexity of products and distance. In other words, the increases in length and distance are mainly derived from the increase in domestic length and distance rather than improvements in their foreign counterparts. This may also imply the preferences of multinationals in constructing local supply chains within Turkey, which leads to increases in lengths and distances within the country. More importantly, it is also a sign of failure in the significant upgrading in GVCs. The impacts of GVC participation should not be assessed without considering the length and

distance measures since, as in Turkey, described below, higher backward GVC participation may not lead to satisfactory gains from GVCs.

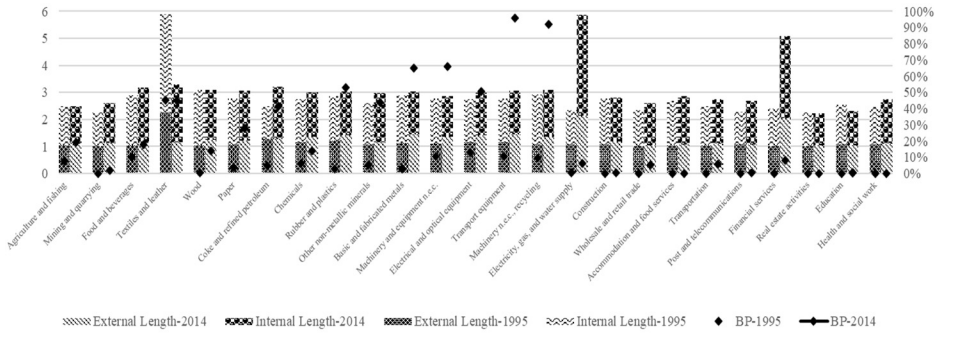
The last figure demonstrates the relative distance of industries - that is, the positions of industries by utilizing both internal and external portions. For the external positions, all manufacturing sectors follow a stable path around the one over the two decades. In other words, these sectors can be classified neither upstream nor downstream in the international market. Given the neutrality regarding external positions and higher backward GVC participation in textile and leather, basic and fabricated metals, and machinery and equipment n.e.c. as well as electrical and optical equipment, transport equipment, and machinery n.e.c. (recycling sectors), the positive effect of currency depreciation on exports may not be realized because increased competitiveness caused by the depreciation is mostly offset by the higher imported intermediate content of products. For the internal position, we have substantial variations across sectors. For instance, the electricity, gas, and water sector has the highest internal position, implying that it is engaged in upstream activities where most domestic buyers and sellers are involved. Furthermore, some industries such as construction and food and beverages are located at the downstream parts of the internal value chains - that is, they are mostly traded within the domestic market. Given the internal downstreamness of these sectors, one can suggest that they can benefit more from participating in foreign trade activities and the utilization of imported goods or services.

Table 1 Descriptive Statistics

	First dataset						Second dataset					
	Total		Manufacturing		Service		Total		Manufacturing		Service	
	# Obs.	Mean	# Obs.	Mean	# Obs.	Mean	# Obs.	Mean	# Obs.	Mean	# Obs.	Mean
Total factor productivity index	422	95.40	210	93.31	152	95.74	512	96.97	195	93.07	242	96.08
ln(value added)	450	20.00	210	19.73	180	20.16	525	22.73	195	22.44	255	22.73
ln(export)	450	16.03	210	19.20	180	12.16	525	19.73	195	22.48	255	17.24
ln(capital per worker)	450	8.09	210	8.07	180	7.65	510	11.32	195	11.29	240	10.89
ln(value added per worker)	450	7.68	210	7.79	180	7.48	525	10.82	195	10.34	255	11.03
Import_VA	450	0.33	210	0.62	180	0.05	525	0.38	195	0.87	255	0.06
Value added export_VA	450	0.12	210	0.22	180	0.03	525	0.17	195	0.29	255	0.10
Backward GVC participation rate	450	0.11	210	0.23	180	0.00	522	0.18	192	0.39	255	0.05
Forward GVC participation rate	450	0.11	210	0.19	180	0.03	525	0.16	195	0.28	255	0.09
iTariff rates Turkey imposed	240	0.03	210	0.03			240	0.03	195	0.02	15	0.00
iTariff rates Turkey faced	240	0.04	210	0.03			237	0.03	195	0.03	15	0.03
FDI inflow_VA	150	0.04	70	0.02	60	0.07	330	0.18	130	0.03	150	0.36
FDI_outflow_VA	150	0.01	70	0.00	60	0.00	330	0.05	130	0.01	150	0.09

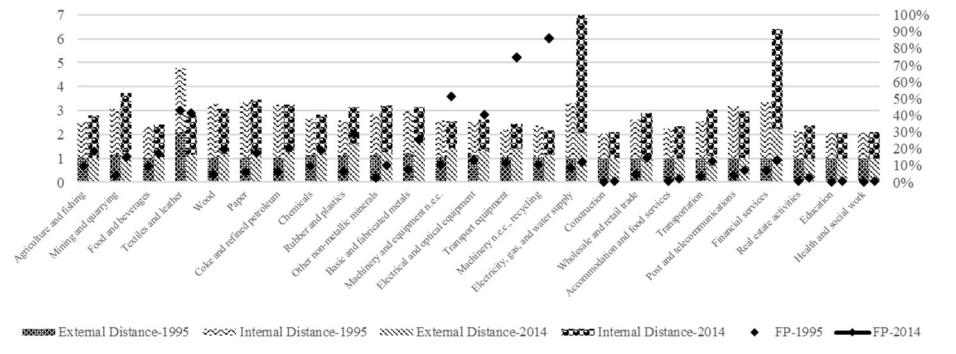
Notes: The first dataset includes the period 1995-2009, and the second dataset includes the period 2000-2014. The coverage of the manufacturing and service sectors is given in Table A1. ln(value added), ln(export), ln(capital per worker), and ln(value added per worker) stand for the natural logarithms of sectoral value added, gross export, capital stock per employees, and value added per worker, respectively. Import_VA and Value added export_VA stand for the shares of intermediate input and domestic value added in export in sectoral value added, respectively. iTariff rates Turkey imposed and iTariff rates Turkey faced are tariffs that Turkey imposes on intermediate imports and tariffs that Turkey faces in the export of intermediates, respectively. FDI_inflow_VA and FDI_outflow_VA mean the share of FDI inflow and outflows in sectoral value added, respectively.

Source: Authors' calculations.



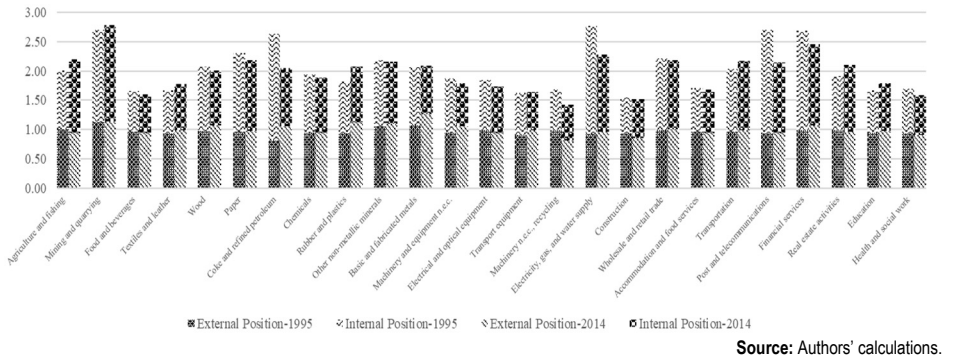
Source: Authors' calculations.

Figure 1 Sectoral Length and Backward GVC Participation, 1995 and 2014



Source: Authors' calculations.

Figure 2 Sectoral Distance and Forward GVC Participation, 1995 and 2014



Source: Authors' calculations.

Figure 3 Internal and External Positions, 1995 and 2014

Industry-level productivity growth accounting is first introduced by Dale Weldeau Jorgenson and Zvi Griliches (1967) and then developed by many other authors. To calculate sectoral TFP growth, we follow the sectoral model of Timmer, Marry

O'Mahony, and Bart Van Ark (2007). According to their article, the sectoral production function is given as follows:

$$Y_i = i\ (X_i, L_i, K_i, T),$$

where Y stands for gross output, X stands for an index of intermediate inputs, L is an index of labor service flows, K stands for an index of capital service flows, and T indicates time. Under the constant returns to scale assumption, we define the growth rate of TFP in terms of the weighted growth rate of the inputs:

$$\Delta lnA_{i,t} = \Delta lnY_{i,t} - v^{K}_{i,t}\,\Delta lnK_{i,t} - v^{L}_{i,t}\Delta lnL_{i,t} - v^{X}_{i,t}\,\Delta lnX_{i,t},$$

where v is the two-period average share of the input in the value of output. Then we employ the TFP growth rate to construct the TFP index for the two datasets by setting the value of TFP indices of the initial years of each set as a hundred.

3. Empirical Methodology

For both samples, the following empirical models are estimated utilizing both the difference generalized methods of moments (D-GMM) and fixed effect (FE) estimation techniques for all sectors, manufacturing industries, and service sectors separately to investigate the association between sectoral performance and trade/capital openness in a detailed framework.

The FE model can remove the effects of unobserved sector characteristics, but the endogeneity of explanatory variables can still be problematic. To overcome this endogeneity issue, time-invariant heterogeneity across sectors, the simultaneity bias, and further endogenous variables among both regressors and the control variables, the generalized method of moments (GMM) technique is employed (Manuel Arellano and Olympia Bover 1991). The GMM estimator is also capable of overcoming problems like FEs, over-identification, and validity. In this technique, the number of instruments should be less than or equal to the number of sectors, and the Hansen test checks the validity of instruments used in the model. In all the estimations, high p values are observed for the Hansen test, which proves the exogeneity and power of the instruments. In addition, autocorrelation is tested by the Arellano-Bond test (AR (1) and AR (2)). In the estimations, there is autocorrelation in AR (1), but there is no evidence for autocorrelation in the first difference levels of AR (2)[3].

We use TFP, value added, and export/domestic value added in export for sectoral performance outcomes by patterning Jong-Wha Lee (1995) in the following way:

$$TFP_{i,t} = \beta_0 + \beta_1 K_{i,t-1} + \beta_2 VA_{i,t-1} + \beta_3 Openness1_{i,t-1} + \beta_4 Openness2_{i,t-1} + \beta_5 T_t + e_{i,t}. \quad (1)$$

In the equation above, i represents sectors, and t represents time. $TFP_{i,t}$ is calculated as the TFP index. $K_{i,t-1}$ is the lagged value of the natural logarithm of capital stock per employee. $VA_{i,t-1}$ is the lagged value of value added per employee. $Openness1_{i,t-1}$ is the vector containing a set of variables. These are imports that are

[3] In some specifications, we also utilize a higher degree of AR tests to get rid of the autocorrelation problem. These specifications are indicated in the notes below the regression tables.

the ratio coming from dividing the import by the value added, backward GVC participation, input tariff rate that Turkey imposed, and FDI inflows, which are calculated by dividing the FDI inflow by the value added. $Openness2_{i,t-1}$ is the vector containing a set of variables. These are exports that are the share of domestic value added in value added, forward GVC participation, input tariff rate that Turkey faced, and FDI outflows, which are the share of FDI outflows in the value added. All these interest variables are one-year lagged values in the models to get rid of possible simultaneous bias in the model. T_t is the dummy variable for years. β_3 and β_4 capture the effects of different measures of trade/financial openness on TFP.

$$VAG_{i,t} = \beta_0 + \beta_1 K_{i,t-1} + \beta_2 Openness1_{i,t-1} + \beta_3 Openness2_{i,t-1} + \beta_4 T_t + e_{i,t}. \quad (2)$$

In Equation (2) above, $VAG_{i,t}$ is the natural logarithm of the value added of each industry. The meanings of other variables and coefficients are the same with Equation (1).

$$EXG_{i,t} = \beta_0 + \beta_1 K_{i,t-1} + \beta_2 VA_{i,t-1} + \beta_3 Openness1_{i,t-1} + \\ + \beta_4 Openness2_{i,t-1} + \beta_5 T_t + e_{i,t}. \quad (3)$$

$EXG_{i,t}$ stands for the natural logarithm of gross export/domestic value added in export in Model (3). Other covariates are the same with Model (1) except for export and domestic value added in export variables, which are taken as independent variables in Model (1). Now we treat these variables as dependent variables in Model (3). In all the models, the lagged values of the dependent variables are also included in the models predicted by the D-GMM.

4. Results

To investigate the association between the sectoral performance outcomes and variables representing trade and financial openness, this paper employs the different GMM and FE estimation techniques for two separate samples in the period 1995-2009 and 2000-2014. Panels I and II in Tables 2, 3, and 4 present the results for the first and the second samples, respectively.

Table 2 provides the estimation results for the total productivity analysis. In the first panel, when we consider our control variables, we notice that lagged TFP has a positive but insignificant impact on current TFP. While the capital intensity and value added per worker have no impacts on TFP in the columns we estimate in our model using D-GMM, they are significant in the columns estimated with the FE. Indeed, capital intensity is negative, and the value added per worker is positively associated with TFP growth. However, since the estimations with the FE may suffer from the endogeneity bias, we rely on the results of D-GMM and interpret the coefficients estimated with the D-GMM method. The estimates of the main interest variables - that is, openness measures - suggest that the input tariff imposed on Turkish products may impede the productivity of the sectors (column 5). This may be explained by the lack of learning in supply chain operations (Paulo Bastos, Joana Silva, and Rafael Proença 2016) and signifies the importance of trade liberalization efforts for Turkish products. The other openness measures are not significant in the first panel. In Panel II, the estimated

Table 2 Total Factor Productivity Analysis, Full Sample

	D-GMM	FE	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import-export_dva		back-forward part.		itariff imposed-faced		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of TFP	0.202		0.180		0.332**		1.007***	
	(0.195)		(0.248)		(0.116)		(0.212)	
ln(capital)	−12.170	−20.020***	−9.614	−19.230***	−5.495	−16.266***	8.351	−8.483
	(9.116)	(2.243)	(10.053)	(1.824)	(4.245)	(1.401)	(5.274)	(6.039)
ln(value added)	13.946	21.631***	12.036	20.636***	7.072	18.056***	−9.711*	7.937*
	(10.163)	(2.281)	(10.996)	(1.715)	(4.263)	(1.063)	(5.440)	(3.989)
Openness1	2.577	1.299	75.505	21.607	14.886	19.254	-3.132	−0.983
	(1.720)	(0.932)	(60.752)	(15.564)	(14.759)	(11.323)	(4.001)	(2.100)
Openness2	43.158	−13.725***	−36.638	−48.115**	−54.157*	−24.275**	−4.242	−2.232
	(28.802)	(4.566)	(85.144)	(22.070)	(30.661)	(11.129)	(17.883)	(16.103)
Constant		−265.063		−173.709		348.293		1,615.254
		(433.416)		(432.175)		(253.035)		(1,169.320)
# of Obs.	364	392	364	392	208	224	84	112
R-squared		0.510		0.516		0.730		0.336
# of sector	28	28	28	28	16	16	28	28
# of instruments	31		31		16		31	
AR(2)	0.412		0.501		0.313		0.879	
Hansen test	0.392		0.385		0.315		0.453	
	import-export_dva		back-forward part.		itariff imposed-faced		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of TFP	1.269***		1.363***		0.566**		1.358***	
	(0.407)		(0.275)		(0.256)		(0.230)	
ln(capital)	13.987	−18.395***	16.568**	−18.062***	−2.104	−13.250***	18.598***	−16.216***
	(11.085)	(2.802)	(7.304)	(2.759)	(4.805)	(2.234)	(4.568)	(3.934)
ln(value added)	−16.906	18.353***	−20.358**	18.111***	−2.922	10.642***	−25.322***	17.519***
	(12.245)	(3.063)	(7.758)	(3.025)	(4.887)	(1.912)	(5.390)	(4.201)
Openness1	−2.262	1.925**	0.111	3.183	−0.642	−1.243	−0.297	1.152
	(1.656)	(0.932)	(4.262)	(1.940)	(3.335)	(3.605)	(0.730)	(1.853)
Openness2	3.420	17.741**	−10.311	16.133**	9.980*	10.710	−1.956	−3.318
	(21.057)	(6.964)	(14.465)	(7.914)	(5.611)	(8.546)	(3.572)	(3.441)
Constant		108.385		73.811		158.744		270.692
		(237.793)		(244.891)		(288.176)		(297.776)
# of Obs.	442	476	439	473	203	221	256	288
R-squared		0.469		0.466		0.801		0.392
# of sector	34	34	34	34	16	16	32	32
# of instruments	36		36		16		36	
AR(2)	0.144		0.127		0.583		0.842	
Hansen test	0.447		0.402		0.604		0.500	

Notes: Openness1 measures are import, backward GVC participation, tariff rates that Turkey imposed, and FDI inflows, whereas Openness2 measures are domestic value added in export, forward GVC participation, tariff rates that Turkey faced, and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. In Panel I, we use up to the sixth and third lags of instruments for columns 1, 3, and 7 and column 5, respectively. In Panel II, we use up to the seventh and third lags of instruments for columns 1, 3, and 7 and column 5, respectively.

Source: Authors' calculations.

Table 3 Value added Analysis, Full Sample

	D-GMM	FE	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import–export_dva		back–forward part.		itariff imposed–faced		inflow–outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of value added	1.430***		1.146***		1.255***		−1.153**	
	(0.176)		(0.350)		(0.195)		(0.446)	
ln(capital)	0.186	0.775***	0.183	0.784***	-0.113	0.762***	0.050	-0.031
	(0.149)	(0.041)	(0.409)	(0.043)	(0.198)	(0.044)	(0.312)	(0.090)
Openness1	0.085*	−0.413***	0.439	−0.509	3.524**	-1.255	0.056	0.223**
	(0.046)	(0.020)	(2.158)	(1.133)	(1.480)	(1.684)	(0.117)	(0.093)
Openness2	2.649***	-0.261	2.885	0.109	−0.395	−5.606*	−2.356	−0.659
	(0.946)	(0.816)	(3.479)	(1.634)	(1.372)	(3.027)	(1.608)	(1.127)
Constant		−25.897		−10.229		55.646		32.867
		(23.188)		(27.658)		(52.146)		(27.126)
# of obs.	330	420	330	420	176	224	90	120
R-squared		0.856		0.819		0.792		0.025
# of sector	30	30	30	30	16	16	30	30
# of instruments	33		33		21		31	
AR(4)	0.580		0.825		0.640		0.359	
Hansen test	0.275		0.281		0.329		0.350	
	import–export_dva		back–forward part.		itariff imposed–faced		inflow–outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of value added	0.023		0.014		0.451		0.024	
	(0.108)		(0.113)		(0.326)		(0.087)	
ln(capital)	0.195**	0.153***	0.262***	0.158***	−0.032	0.206***	-0.055	0.074**
	(0.078)	(0.029)	(0.081)	(0.030)	(0.142)	(0.029)	(0.064)	(0.036)
Openness1	0.520	0.114***	−0.070	−0.047	-0.036	−1.045***	0.013	0.052
	(0.403)	(0.039)	(0.155)	(0.135)	(0.626)	(0.179)	(0.028)	(0.035)
Openness2	−2.049	−0.641	−0.883	-0.462	−1.057	−3.413**	−0.059	0.004
	(1.279)	(0.542)	(1.092)	(0.650)	(1.534)	(1.392)	(0.104)	(0.063)
Constant		−21.031***		−23.174***		−8.562		61.251***
		(6.685)		(7.212)		(8.810)		(6.121)
# of obs.	442	476	439	473	156	221	256	288
R-squared		0.315		0.303		0.468		0.295
# of sector	34	34	34	34	16	16	32	32
# of instruments	37		37		21		35	
AR(2)	0.978		0.172		0.177		0.962	
Hansen test	0.383		0.384		0.267		0.311	

Notes: Openness1 measures are import, backward GVC participation, tariff rates that Turkey imposed, and FDI inflows whereas Openness2 measures are domestic value added in export, forward GVC participation, tariff rates that Turkey faced, and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. In Panel I, we use up to the eighth and fifth lags of instruments for columns 1, 3, and 7 and column 5, respectively. We also utilize the first three lags of value added through all specifications to get rid of the autocorrelation problem and report AR(4) instead of AR(2). In Panel II, we use up to the nineth and fifth lags of instruments for columns 1, 3, and 7 and column 5, respectively.

Source: Authors' calculations.

Table 4 Export Analysis, Full Sample

	D-GMM	FE	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import		backward part.		itariff imposed–faced		inflow–outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of export	0.471***		0.444**		0.072*		−0.050	
	(0.165)		(0.174)		(0.035)		(0.159)	
ln(capital)	0.316	0.540	0.364	0.653**	1.368*	0.810***	−2.742*	−2.157*
	(0.519)	(0.352)	(0.514)	(0.313)	(0.732)	(0.159)	(1.426)	(1.142)
ln(value added)	0.280	0.478	0.199	0.368	−0.537	0.027	2.112	1.432
	(0.400)	(0.345)	(0.568)	(0.265)	(0.579)	(0.154)	(1.472)	(1.340)
Openness1	0.188**	0.234	−2.330	1.306	2.245	−4.402	−2.744**	−2.471**
	(0.087)	(0.168)	(2.263)	(0.776)	(2.300)	(2.977)	(1.122)	(1.066)
Openness2					-4.667	−1.673	21.569**	23.638**
					(6.267)	(3.437)	(9.599)	(9.005)
Constant		−345.390***		−339.458***		−126.175*		−727.768***
		(72.755)		(72.592)		(59.927)		(180.854)
# of obs.	390	420	390	420	208	224	90	120
R-squared		0.171		0.173		0.226		0.364
# of sector	30	30	30	30	16	16	30	30
# of instruments	33		33		16		31	
AR(2)	0.488		0.496		0.352		0.905	
Hansen test	0.456		0.460		0.347		0.325	
	import		backward part.		itariff imposed–faced		inflow–outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of export	0.680***		0.509***		0.546***		1.062***	
	(0.092)		(0.179)		(0.107)		(0.218)	
ln(capital)	−0.413***	0.078	−0.331*	0.112	0.171	−0.019	0.332*	0.088
	(0.134)	(0.165)	(0.165)	(0.169)	(0.114)	(0.082)	(0.189)	(0.235)
ln(value added)	0.364**	0.207	0.358	0.222	−0.095	0.290***	−0.540*	0.205
	(0.169)	(0.196)	(0.233)	(0.202)	(0.076)	(0.097)	(0.286)	(0.285)
Openness1	0.281	0.326	−0.734	0.628	0.384	−1.371***	−0.017	0.210**
	(0.173)	(0.254)	(0.675)	(0.405)	(0.464)	(0.292)	(0.052)	(0.093)
Openness2					−1.150**	-0.179	0.082	-0.077
					(0.494)	(1.039)	(0.086)	(0.167)
Constant		−49.937*		−58.848**		−133.649***		−2.273
		(26.479)		(24.712)		(15.075)		(37.685)
# of obs.	442	476	439	473	203	221	256	288
R-squared		0.182		0.189		0.736		0.106
# of sector	34	34	34	34	16	16	32	32
# of instruments	37		37		16		36	
AR(2)	0.154		0.767		0.104		0.603	
Hansen test	0.397		0.478		0.265		0.518	

Notes: Openness1 measures are import, backward GVC participation, tariff rates that Turkey imposes, and FDI inflows whereas Openness2 measures are tariff rates that Turkey faced and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. In Panels I and II, we use up to the nineth and third lags of instruments for columns 1, 3, and 7 and column 5, respectively.

Source: Authors' calculations.

coefficients on the lagged productivity index turn out to be significant, which indicates a considerable persistency in TFP over the second period. Our estimates fail to find significant impacts of capital intensity and labor productivity on TFP growth as well as the main openness measures. One of the most interesting results is that the input tariffs faced have a positive coefficient in column 5. At this point, it is important to note that the tariff rates we obtained from the WITS are de jure measures, which are set ratios by the governments, not de facto measures. Furthermore, many governments (including Turkey since 1996) do not implement set tariff rates, and imported intermediates are tariff-free if they are exported as processed products under the framework of an inward processing regime (Şeref Saygılı et al. 2010). The inward processing regime - that is, an exemption of tariffs on imported raw materials and intermediate products to be used in the production of the exported products - encourages import, and as a result of these effects, we may inaccurately observe a positive effect of input tariff on TFP growth.

Table 3 presents the results of the value added analysis. The results of the first sample (Panel I) suggest that the value added mostly follows its lagged value. We observe the positive impacts of both imports and domestic value added in export (column 1). It is important to emphasize that the domestic content of gross export significantly raises the value added. This result points out the importance of efforts to boost the value added of Turkish sectors, thereby the growth of the Turkish economy (Jan De Loecker 2013). The results of the second sample (Panel II) imply that barriers preventing the access of Turkish sectors into GVCs and distortions in competition in the global market lower the value added of Turkish sectors. Table 4 displays the results of the export analysis[4]. We find a positive effect of import on the export performance of industries in the first period, we also observe the negative impacts of faced input tariffs on sectoral export in the second period. These results are in line with the scale effect idea of Krugman (1979) and the positive impact of GVC participation as in Kowalski et al. (2015)[5].

We redo our analysis by considering the manufacturing and service sectors separately. Because of space considerations, these results are presented in the appendix (Tables A2 to A7). For the manufacturing sectors, we find similar relationships between openness covariates and sectoral performance measures with some minor differences. Specifically, while import and backward participation appear to be stimulators for sectoral TFP and export, the faced input tariff decreases sectoral value added. However, our results fail to find any consistent significant effects of openness measures on the sectoral performance of service industries. It seems that the D-GMM estimates for the full sample are mainly driven by the results for manufacturing sectors. Since the numbers of manufacturing and service sectors are nearly equal in our sample, we can interpret this difference by the sector-specific characteristics of both industries.

[4] We also rerun this model for using domestic value added in export. Since we find very similar results, we do not report the estimation results here, but they are available upon request.

[5] We also analyze the impacts of the gross export, length/distance, and output tariff as the other measures for the domestic value added in export, GVC participation, and input tariff, respectively. They are not reported here, but they are available upon request. We find almost identical results for these variables, with some variations among the periods.

These results are quite expected because manufacturing industries produce mostly tradeable goods compared to service industries, and they are more likely to be influenced by openness measures.

Overall, domestic value added in export is the significant driver of sectoral value added in Turkey. For manufacturing industries, even if import and backward linkages also seem to be significant stimulators for TFP, there is no significant effect on sectoral value added. Since we employ annual datasets, one may argue that the realization of the productivity effects of imports on sectoral value added may require a longer period. Moreover, given the higher backward GVC participation for some manufacturing industries such as machinery and equipment, Turkish sectors should prepare themselves for any external shocks by diversifying the origins of importers, keeping stocks, and increasing transparency in their operations. Resulting mainly from the manufacturing industries, trade barriers in the form of tariff rates have a significantly negative impact on Turkish sectoral performance. Higher tariff rates not only inhibit a market entrance decision of Turkish sectors but also lead to higher costs for foreign markets. The initial impact of this intervention is inevitably intensified through GVCs, and negative repercussions are realized in almost all economies. Finally, when the insignificant and somewhat inconsistent signs of the FDI variables in the empirical analysis are considered, the importance of the absorptive capacity of Turkish sectors to realize the benefits of financial flows emerges.

5. Concluding Remarks

Success in globally integrated production systems among countries, regions, and sectors is the key opportunity for better sectoral performance. This paper aims to understand how openness, including various GVC-related measures, affects the TFP, value added, and export of Turkish sectors for the periods of 1995-2009 and 2000-2014. For the first dataset, we find that domestic value added in export raises sectoral value added. The faced input tariff is negatively related to TFP and export, which points out the threat of decreasing competitiveness of Turkish goods and services in the international markets. In addition, import appears to be a significant factor in export performance in Turkey. The results derived from the full sample are mainly in line with the result of the manufacturing sample because of the higher tradability of these sectors. Specifically, import is the main factor that enhances both sectoral TFP and export. For the second dataset, the faced input tariff diminishes export.

Overall, our results have important policy recommendations regarding the performance of Turkish sectors, especially for the manufacturing industry. First, higher sectoral value added through increasing domestic value added content in gross exports should be achieved through tracking domestic value added in the global production system as well as implementing well-defined industrial policies. Even if the empirical parts fail to provide any evidence for the service sectors in general, it is still important to mention the financial services sector as well. The sectors with higher length and distance in 2014 (see Figures 1 to 2) are more likely to have lower backward and forward GVC participation compared to other manufacturing industries. Therefore, the Turkish government should not only focus on manufacturing industries but also follow servicification trends in the world and aim to boost the domestic value added in each

step of the financial sector. Second, given the observed positive effect of import on the TFP and export performances of sectors as well as higher backward GVC participation in some industries such as metals, machinery, electrical, and transport equipment, monitoring the trade activities of these sectors is important to mitigate the effects of external shocks and to improve the resilience of the Turkish economy. Increasing global interconnectedness and various spillovers *via* trade cause policymaking to be more difficult for developing nations. Thus, more coordination among countries is required, and international institutions should find efficient ways for reducing the vulnerability of developing countries like Turkey. Third, through structured regional and international trade agreements and negotiations, the barriers to Turkish products should be alleviated. Since participation in GVCs brings economies numerous benefits - such as the diversification of products, enhanced productivity, and increased competitiveness - countries, especially emerging economies like Turkey, should improve their ability to catch up with productivity and growth gains.

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Appendix

All the calculation methodologies of the indexes described below are conducted through methodology notes of Wang et al. (2017a, b) and OECD (2021), and the computation is done by utilizing Rstudio.

Calculation of GVCs Participation Index:

We utilize the domestic value added of partner countries (p) for each industry of origin (i) in the total final demand in the country (c) based on OECD calculation ($p \neq c$). It is shown as $DFD\_FVA_{c,p,i,t}$. When we divide this value by sectoral output, we get backward GVC participation indices.

We utilize the domestic value added of countries (c) for each industry of origin (i) in the total final demand in the country (p) based on OECD calculation ($p \neq c$). It is shown as $FDD\_DVA_{c,p,i,t}$. When we divide this value by sectoral value added, we get forward GVC participation indices.

Calculation of Length of GVCs:

In IO matrix form (G: the number of countries and N: the number of sectors), the length, that is, the number of production stages in backward linkages, is computed according to this formula:

$$A = t(t(AX)/X)$$
$$L = (I - A)^{-1}$$

where A is the intermediate consumption matrix with $GNxGN$ size, X is the gross output matrix with $GNx1$ size, I the identity matrix with $GNxGN$ size, and L represents the number of production stages in backward linkages with $GNxGN$ size. t stands for transpose function. L is also defined as the Leontief inverse matrix. We column-sum the Leontief inverse matrix to get the measure of length.

To calculate the internal portion of the length, we put zero in columns and rows which represent international trade in the intermediate consumption matrix.

$$L\_internal = (I - Ad)^{-1}$$

where Ad is the domestic intermediate consumption matrix with $GNxGN$ size.

To calculate the external portion of the length, we put zero in columns and rows which represent domestic transactions in the intermediate consumption matrix.

$$L\_external = (I - Af)^{-1}$$

where Af is the foreign intermediate consumption matrix with $GNxGN$ size.

Calculation of Distance to Final Demand:

In IO matrix form (G: number of countries and N: number of sectors), the distance to final demand, that is, the number of production stages in forward linkages, is computed according to this formula:

$$AX = t(t(A) * X)$$
$$D = (I - AX/X)^{-1}$$

where A is the intermediate consumption matrix with $GNxGN$ size, X is the gross output matrix with $GNx1$ size, I the identity matrix with $GNxGN$ size, and D represents the number of production stages in forward linkages with $GNxGN$ size. t stands for transpose function. D is also defined as the Ghosh inverse matrix. We row sum of the Ghosh inverse matrix to get the measure of distance.

To calculate the internal portion of the distance, we put zero in columns and rows which represent international trade in the intermediate consumption matrix.

$$D\_internal = (I - AXd/X)^{-1}$$

To calculate the external portion of the distance, we put zero in columns and rows which represent domestic transactions in the intermediate consumption matrix.

$$D\_external = (I - AXf/X)^{-1}$$

Table A1 Industry Matching

First dataset				Second dataset			
Sectors	**WIOD 2014**	**WITS**	**CBRT**	**Sectors**	**WIOD 2016**	**WITS**	**CBRT**
Agriculture and fishing	AtB	C01T05	TP.YD02	Agriculture and fishing	A01+A02+A03	D01	TP.YD02
Mining and quarrying	C	C10+C11+C12+ C13+C14	TP.YD04	Mining and quarrying	B	D05+D06+D07+ D08	TP.YD04
Food and beverages	15t16	C15+C16	TP.YD06	Food and beverages	C10-C12	D10+D11+D12	TP.YD06
Textiles	17t18	C17+C18	TP.YD07	Textiles and leather	C13-C15	D13T15	TP.YD07+ TP.YD08
Leather	19	C19	TP.YD08	Wood	C16	D16	TP.YD09
Wood	20	C20	TP.YD09	Paper	C17+C18	D17	TP.YD10
Paper	21t22	C21+C22	TP.YD10	Coke and refined petroleum	C19	D19	TP.YD11
Coke and refined petroleum	23	C23	TP.YD11	Chemicals	C20+C21	D20	TP.YD12
Chemicals	24	C24	TP.YD12	Rubber and plastics	C22	D22	TP.YD13
Rubber and plastics	25	C25	TP.YD13	Other non-metallic minerals	C23	D23	TP.YD14
Other non-metallic minerals	26	C26	TP.YD14	Basic and fabricated metals	C24+C25	D24T25	TP.YD15
Basic and fabricated metals	27t28	C27T28	TP.YD15	Electrical and optical equipment	C26+C27	D26T27	TP.YD17
Machinery and equipment n.e.c.	29	C29	TP.YD16	Machinery and equipment n.e.c.	C28	D28	TP.YD16
Electrical and optical equipment	30t33	C30T33	TP.YD17	Transport equipment	C29+C30	D29T30	TP.YD18
Transport equipment	34t35	C34T35	TP.YD18	Machinery n.e.c., recycling	C31-C32	D31+D32	TP.YD19
Machinery n.e.c., recycling	36t37	C36T37	TP.YD19	Electricity, gas, and air supply	D35	D35	TP.YD20
Electricity, gas, and water supply	E		TP.YD20+TP.YD21	Water supply	E36+E37-E39		TP.YD21
Construction	F		TP.YD23	Construction	F		TP.YD23
Wholesale and retail trade	50+51+52		TP.YD24	Wholesale and retail trade	G45+G46+G47		TP.YD24
Accommodation and food services	H		TP.YD26	Transportation	H49+H50+H51 +H52		TP.YD25
Transportation	60+61+62+63		TP.YD25	Accommodation and food services	I		TP.YD26
Post and telecommunications	64		TP.YD27	Broadcasting	J59-J60		
Financial services	J		TP.YD28+TP.YD29+ TP.YD30	Telecommunications	J61		TP.YD27
Real estate activities	70		TP.YD33	Consultancy	J62-J63		
Renting of m&eq	71t74		TP.YD31	Financial services	K64		TP.YD29
Public administration and defense	L		TP.YD36	Insurance and pension funding	K65		TP.YD30
Education	M		TP.YD37	Activities auxiliary to financial services	K66		TP.YD32
Health and social work	N		TP.YD38	Real estate activities	L68		TP.YD33
Other community and social services	O		TP.YD39+TP.YD42	Scientific research and development	M72		TP.YD34
Activities of households as employers	P		TP.YD41	Other professionals	M74-M75		
				Administrative and support services	N		TP.YD35
				Public administration and defense	O84		TP.YD36
				Education	P85		TP.YD37
				Health and social work	Q		TP.YD38
				Other service activities	R-S		TP.YD40
				Activities of households as employers	T		TP.YD41

Source: For the industry matching strategy, we use "WIOD Socio-Economic Accounts (SEA): Sources and Methods" (Abdul Azeez Erumban et al. 2012), "Employment and Compensation in the WIOD Socio-Economic Accounts (SEA): Revisions for 2008/2009 and new data for 2010/2011" (Reitze Gouma, Marcel Timmer, and Gaaitzen De Vries 2014), "WIOD Socio-Economic Accounts 2016: Sources and Methods" (Gouma et al. 2018), "Tariff and Trade Analysis Database" (WITS 2020) and "International Investment Position Statistics" (CBRT 2020).

Source: Authors' calculations.

Table A2 Total Factor Productivity Analysis, Manufacturing

	D-GMM	FE	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import-export_dva		back-forward part.		itariff imposed-faced		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of TFP	0.071		0.201		0.375**		−0.291	
	(0.298)		(0.272)		(0.161)		(1.142)	
ln(capital)	−10.084	−15.815***	−6.094	−15.950***	−7.094	−16.022***	−8.265	-2.943
	(7.235)	(1.190)	(5.386)	(0.893)	(4.791)	(1.513)	(12.557)	(2.125)
ln(value added)	15.011*	17.559***	9.383	17.650***	8.975	18.016***	12.124	3.890
	(8.066)	(0.933)	(5.977)	(0.413)	(5.394)	(1.169)	(15.218)	(2.263)
Openness1	2.654*	0.019	52.519	13.777	7.454	4.001	−5.745	1.202
	(1.457)	(0.316)	(45.117)	(8.527)	(29.282)	(8.391)	(12.600)	(5.013)
Openness2	43.647	−10.237***	−54.893	−32.350**	−46.638	−24.680	−78.226	-41.812
	(26.250)	(2.888)	(96.797)	(11.343)	(67.501)	(20.238)	(106.153)	(23.721)
Constant		150.685		247.975		342.533		2,501.044***
		(253.595)		(225.916)		(286.480)		(702.817)
# of obs.	182	196	182	196	182	196	42	56
R-squared		0.749		0.757		0.741		0.677
# of sectors	14		14		14		14	
# of instruments	16		16		16		16	
AR(4)	0.161		0.142		0.181		0.766	
Hansen test	0.577		0.538		0.423		0.406	
	import-export_dva		back-forward part.		itariff imposed-faced		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of TFP	0.401		0.298		0.174		−0.845	
	(0.406)		(0.218)		(0.223)		(0.639)	
ln(capital)	−1.866	−9.720***	−4.242	−10.026***	−6.874	−9.881***	−15.099	−7.798***
	(6.417)	(0.739)	(3.638)	(0.831)	(4.797)	(0.893)	(8.886)	(1.337)
ln(value added)	−2.258	7.521***	1.869	7.839***	3.209	7.848***	9.884	5.171**
	(7.205)	(0.787)	(2.666)	(0.898)	(5.639)	(0.898)	(8.575)	(2.045)
Openness1	−2.841*	−0.399	3.311**	4.048***	−80.064	−8.634	−1.963	−0.649
	(1.367)	(0.379)	(1.293)	(0.687)	(75.820)	(10.231)	(3.315)	(1.246)
Openness2	−6.102	−0.199	9.232	−5.755	−5.158	6.346	5.354	−10.877**
	(9.577)	(3.960)	(28.917)	(3.814)	(7.413)	(7.874)	(9.654)	(4.862)
Constant		647.047***		583.106***		634.186***		754.131***
		(118.915)		(109.633)		(128.844)		(185.783)
# of obs.	156	182	155	179	169	182	104	117
R-squared		0.887		0.901		0.887		0.823
# of sectors	13	13	13	13	13	13	13	13
# of instruments	16		16		16		16	
AR(4)	0.619		0.866		0.360		0.349	
Hansen test	0.488		0.685		0.458		0.265	

Notes: Openness1 measures are import, backward GVC participation, tariff rates that Turkey imposed, and FDI inflows whereas Openness2 measures are domestic value added in export, forward GVC participation, tariff rates that Turkey faced, and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. In both panels, we use up to the third lags of instruments for all columns.

Source: Authors' calculations.

Table A3 Value Added Analysis, Manufacturing

	D-GMM	FE	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import-export_dva		back-forward part.		itariff imposed-faced		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of value added	1.912***		1.890*		1.302***		−0.554	
	(0.626)		(0.990)		(0.212)		(1.254)	
ln(capital)	−0.333	0.702***	−0.209	0.728***	−0.084	0.735***	0.347	0.088
	(0.415)	(0.051)	(0.828)	(0.056)	(0.375)	(0.049)	(0.604)	(0.142)
Openness1	0.162	−0.440***	3.645	−0.659	6.718***	−0.000	0.598	−0.040
	(0.144)	(0.026)	(3.132)	(0.993)	(1.996)	(2.259)	(1.974)	(0.534)
Openness2	4.008	−0.419	−0.572	0.349	−0.535	−10.093***	−9.427	−5.527***
	(3.193)	(0.859)	(5.525)	(1.666)	(2.084)	(3.033)	(6.703)	(1.637)
Constant		−14.809		17.336		75.931		57.162
		(41.098)		(51.467)		(57.815)		(66.059)
# of obs.	154	196	154	196	154	196	42	56
R-squared		0.830		0.753		0.786		0.084
# of sectors	14	14	14	14	14	14	14	14
# of instruments	17		17		17		15	
AR(4)	0.904		0.712		0.673		0.226	
Hansen test	0.184		0.198		0.180		0.185	
	import-export_dva		back-forward part.		itariff imposed-faced		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of value added	0.048		0.053		0.477*		−0.279	
	(0.281)		(0.162)		(0.248)		(0.335)	
ln(capital)	0.227	0.198***	0.252*	0.214***	0.394***	0.189***	0.346**	0.151*
	(0.211)	(0.053)	(0.124)	(0.062)	(0.127)	(0.034)	(0.156)	(0.084)
Openness1	0.276	0.107***	−0.277	−0.203	8.734	1.292	0.295	0.064
	(0.198)	(0.033)	(0.205)	(0.195)	(14.287)	(0.743)	(0.434)	(0.102)
Openness2	0.410	−0.308	1.590	0.095	−3.406***	−6.573***	−0.318	−1.193*
	(1.486)	(0.604)	(1.220)	(0.723)	(0.838)	(1.440)	(2.720)	(0.550)
Constant		−14.282**		−13.587		−2.533		62.905***
		(5.045)		(7.918)		(8.685)		(3.835)
# of obs.	169	182	166	179	156	182	104	117
R-squared		0.404		0.396		0.575		0.219
# of sectors	13	13	13	13	13	13	13	13
# of instruments	17		17		17		17	
AR(2)	0.176		0.153		0.203		0.164	
Hansen test	0.410		0.463		0.649		0.452	

Notes: Openness1 measures are import, backward GVC participation, tariff rates that Turkey imposed, and FDI inflows whereas Openness2 measures are domestic value added in export, forward GVC participation, tariff rates that Turkey faced, and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. In both panels, we use up to the fourth lags of instruments for all columns. We also utilize the first three lags of value added through all specifications to get rid of the autocorrelation problem in the first panel and report AR(4) instead of AR(2).

Source: Authors' calculations.

Table A4 Export Analysis, Manufacturing

	D-GMM	FE	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import		backward part.		itariff imposed-faced		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of export	0.435		0.346		0.433		0.687	
	(0.296)		(0.377)		(0.326)		(0.985)	
ln(capital)	0.344	0.435***	0.742***	0.544***	0.553**	0.712***	0.738	0.071
	(0.282)	(0.124)	(0.215)	(0.101)	(0.212)	(0.096)	(0.574)	(0.404)
ln(value added)	0.027	0.233	−0.289	0.149	−0.251	−0.073	−1.154	0.058
	(0.157)	(0.147)	(0.223)	(0.119)	(0.181)	(0.092)	(1.213)	(0.294)
Openness1	0.159**	0.215**	0.862	1.691***	3.893**	−2.584	0.758	0.898**
	(0.057)	(0.093)	(0.967)	(0.374)	(1.425)	(3.838)	(1.069)	(0.379)
Openness2					−4.794***	−4.468**	−8.332	−4.552
					(1.183)	(1.517)	(8.556)	(2.823)
Constant		−97.911**		−81.263***		−64.545*		21.128
		(33.959)		(25.625)		(34.530)		(68.717)
# of Obs.	182	196	182	196	182	196	42	56
R-squared		0.745		0.811		0.746		0.099
# of sectors	14	14	14	14	14	14	14	14
# of instruments	17		17		16		16	
AR(2)	0.295		0.166		0.156		0.414	
Hansen test	0.333		0.393		0.278		0.195	
	import		backward part.		itariff imposed-faced		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag of export	0.332		0.199		0.423		0.043	
	(0.202)		(0.141)		(0.255)		(0.237)	
ln(capital)	−0.054	−0.070	0.058	−0.030	0.091	0.004	−0.308	−0.115
	(0.173)	(0.116)	(0.285)	(0.089)	(0.184)	(0.120)	(0.352)	(0.128)
ln(value added)	0.180	0.317**	0.151	0.312**	−0.043	0.202*	1.165**	0.321*
	(0.174)	(0.108)	(0.290)	(0.103)	(0.195)	(0.107)	(0.506)	(0.179)
Openness1	0.050	0.189*	−0.357	0.293	11.161	−0.326	0.478*	0.434**
	(0.143)	(0.098)	(0.333)	(0.179)	(7.394)	(1.442)	(0.267)	(0.172)
Openness2					−3.166	−1.916	1.322	0.473
					(2.021)	(1.399)	(8.572)	(0.894)
Constant		−131.571***		−137.850***		−126.793***		−106.764***
		(25.267)		(18.950)		(21.451)		(25.658)
# of obs.	169	182	166	179	169	182	104	117
R-squared		0.767		0.771		0.759		0.574
# of sectors	13		13		13		13	
# of instruments	17		17		16		16	
AR(2)	0.124		0.343		0.482		0.201	
Hansen test	0.583		0.707		0.321		0.309	

Notes: Openness1 measures are import, backward GVC participation, tariff rates that Turkey imposed, and FDI inflows whereas Openness2 measures are tariff rates that Turkey faced and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. In both panels, we use up to the fourth and third lags of instruments for columns 1, 3, and 7 and 5, respectively.

Source: Authors' calculations.

Table A5 Total Factor Productivity Analysis, Service

	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import-export_dva		back-forward part.		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)
Lag of TFP	0.800		0.961		5.950	
	(0.626)		(0.572)		(12.903)	
ln(capital)	2.002	−45.475***	−9.421	−44.372***	−158.631	−28.571
	(14.418)	(6.708)	(25.001)	(6.385)	(416.831)	(15.875)
ln(value added)	2.131	44.276***	15.242	42.863***	300.569	31.666
	(14.977)	(6.255)	(29.074)	(5.989)	(830.523)	(18.601)
Openness1	54.318	29.207	−1,274.022	274.653	3.006	1.744
	(125.870)	(36.439)	(1,077.263)	(302.176)	(17.656)	(3.608)
Openness2	652.331	−363.900**	710.512	−420.103**	−115.001	−31.917
	(914.963)	(126.980)	(1,071.767)	(155.057)	(330.553)	(37.468)
Constant		−852.661		−570.936		350.240
		(770.211)		(968.356)		(1,684.743)
# of Obs.	130	140	130	140	30	40
R-squared		0.521		0.525		0.398
# of sectors	10	10	10	10	10	10
# of instruments	11		11		11	
AR(2)	0.184		0.235		0.768	
Hansen test	0.681		0.579		0.442	
	import-export_dva		back-forward part.		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)
Lag of TFP	0.142		0.205		1.395**	
	(0.332)		(0.262)		(0.558)	
ln(capital)	−10.726	−22.419***	−7.316	−21.841***	45.422*	−18.883***
	(17.301)	(3.181)	(13.206)	(3.143)	(22.227)	(3.973)
ln(value added)	6.141	23.453***	3.995	23.233***	−45.110*	21.190***
	(17.803)	(3.908)	(13.453)	(3.994)	(21.734)	(5.021)
Openness1	69.117	53.020*	−28.451	−21.787	−3.547	0.917
	(106.907)	(29.054)	(52.494)	(20.710)	(3.231)	(1.563)
Openness2	−30.174	72.886***	5.569	106.968**	3.686	−1.871
	(87.478)	(18.612)	(178.767)	(43.836)	(4.004)	(2.968)
Constant		96.754		−106.689		1,015.622**
		(222.064)		(253.060)		(419.458)
# of obs.	208	224	208	224	112	126
R-squared		0.458		0.445		0.521
# of sectors	16		16		14	
# of instruments	16		16		16	
AR(2)	0.207		0.262		0.301	
Hansen test	0.142		0.174		0.477	

Notes: Openness1 measures are import, backward GVC participation, and FDI inflows whereas Openness2 measures are domestic value added in export, forward GVC participation, and FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. We use up to the second and third lags of instruments for all columns in Panels I and II, respectively.

Source: Authors' calculations.

Table A6 Value Added Analysis, Service

	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import-export_dva		back-forward part.		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)
Lag of value added	1.076***		0.972***		−2.424**	
	(0.202)		(0.249)		(0.980)	
ln(capital)	−0.152	0.799***	−0.049	0.813***	0.771	−0.226*
	(0.190)	(0.079)	(0.229)	(0.084)	(0.970)	(0.114)
Openness1	−0.275	0.815	−2.774	−6.938	−0.010	0.145**
	(1.619)	(1.773)	(14.834)	(5.305)	(0.305)	(0.058)
Openness2	−15.965***	−4.716	−8.623	−4.040	−3.166*	1.920*
	(5.156)	(4.548)	(8.543)	(4.966)	(1.454)	(1.029)
Constant		−32.903		−42.314		−5.350
		(24.559)		(27.645)		(16.485)
# of Obs.	156	168	156	168	36	48
R-squared		0.890		0.890		0.118
# of sectors	12	12	12	12	12	12
# of instruments	13		13		13	
AR(2)	0.668		0.257		0.787	
Hansen test	0.261		0.165		0.887	
	import-export_dva		back-forward part.		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)
Lag of value added	1.002*		0.112		0.465*	
	(0.486)		(0.154)		(0.245)	
ln(capital)	0.031	0.114*	−0.046	0.023	−0.307	0.059*
	(0.133)	(0.063)	(0.103)	(0.046)	(0.228)	(0.031)
Openness1	8.445	−0.859	4.122***	3.729***	0.001	0.044
	(7.366)	(1.083)	(0.832)	(0.495)	(0.049)	(0.032)
Openness2	7.937	−2.773**	−9.787***	−8.996***	−0.040	0.023
	(4.860)	(1.218)	(2.518)	(1.500)	(0.120)	(0.053)
Constant		−6.221		27.300**		64.724***
		(12.243)		(11.064)		(9.035)
# of obs.	160	224	208	224	112	126
R-squared		0.277		0.429		0.361
# of sectors	16		16		14	
# of instruments	17		17		17	
AR(2)	0.352		0.535		0.242	
Hansen test	0.129		0.271		0.243	

Notes: Openness1 measures are import, backward GVC participation, and FDI inflows whereas Openness2 measures are domestic value added in export, forward GVC participation, and FDI outflows. The robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. We use up to the third and fourth lags of instruments for all columns in Panels I and II, respectively.

Source: Authors' calculations.

Table A7 Export Analysis, Service

	D-GMM	FE	D-GMM	FE	D-GMM	FE
	import		backward part.		inflow-outflow	
Panel I First dataset	(1)	(2)	(3)	(4)	(5)	(6)
Lag of export	0.561***		0.565***		0.017	
	(0.083)		(0.083)		(0.403)	
ln(capital)	3.452	1.663	2.325	2.082	−2.130	−2.904
	(3.469)	(1.882)	(3.809)	(1.904)	(3.583)	(1.808)
ln(value added)	−3.020	−0.198	−1.712	−0.734	2.632	5.619*
	(3.552)	(1.545)	(3.983)	(1.568)	(4.273)	(2.741)
Openness1	3.194	4.478	−39.840	120.847**	−5.206*	−2.618***
	(4.488)	(14.280)	(123.208)	(52.580)	(2.816)	(0.626)
Openness2					73.436*	37.429***
					(36.609)	(9.370)
Constant		−599.526***		−486.121***		−959.063***
		(135.688)		(119.273)		(241.269)
# of obs.	156	168	156	168	36	48
R-squared		0.240		0.265		0.661
# of sectors	12		12		12	
# of instruments	13		13		16	
AR(2)	0.299		0.275		0.481	
Hansen test	0.827		0.409		0.790	
	import		backward part.		inflow-outflow	
Panel II Second dataset	(1)	(2)	(3)	(4)	(5)	(6)
Lag of export	0.756***		1.324***		1.084***	
	(0.181)		(0.132)		(0.189)	
ln(capital)	0.308	−0.083	−0.373	−0.572**	0.554	−0.151
	(0.349)	(0.245)	(0.539)	(0.213)	(1.137)	(0.273)
ln(value added)	−0.817**	0.093	0.111	0.642***	−0.665	−0.026
	(0.328)	(0.255)	(0.684)	(0.212)	(1.190)	(0.337)
Openness1	7.092	−3.829	0.942	6.090***	−0.123	0.197***
	(4.613)	(2.247)	(1.716)	(1.562)	(0.167)	(0.049)
Openness2					0.173	0.036
					(0.232)	(0.101)
Constant		39.683		−1.123		179.528***
		(28.331)		(29.786)		(39.770)
# of Obs.	208	224	192	224	112	126
R-squared		0.051		0.232		0.376
# of sectors	16		16		14	
# of instruments	17		17		16	
AR(2)	0.784		0.901		0.212	
Hansen test	0.211		0.234		0.396	

Notes: Openness1 measures are import, backward GVC participation, and FDI inflows whereas Openness2 measure is FDI outflows. The robust standard errors are in parentheses. *** $p < 0.01$, ** $p < 0.05$. * $p < 0.1$. Year dummies are included in D-GMM and FE estimates. We use up to the third and fourth lags of instruments for all columns in Panels I and II, respectively.

Source: Authors' calculations.

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