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PORTER-TYPE REGIONAL AGGLOMERATIONS, EXPORT PERFORMANCE, AND INCLUSIVE REGIONAL POLICY: AN EMPIRICAL ASSESSMENT OF TURKISH MANUFACTURING SECTOR

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Abstract

This study aims to evaluate the medium-term impact of regional agglomerations in the manufacturing sector of Turkey on export performance. To this end, we identified Porter-type agglomerations in ISIC two-digit manufacturing sectors for 58 NUTS-3 regions and the 2008-2019 period. In the empirical analysis section, we used a two-way fixed effects panel data model to analyze the effects of these agglomerations on sectoral export performance. The findings indicate that the advantages of Porter-type agglomeration are limited to certain mid-tech sectors. Also, labor-intensive low-tech manufacturing sectors are found to have no agglomeration advantages in export performance compared to mid-tech sectors. The findings indicate a technology policy need and an inclusive smart specialization strategy (3S) to enhance productivity and export competitiveness.

Keywords: *agglomeration economies, export performance, manufacturing sector, Turkey*

JEL Classification: *F16, O14, R12, R58*

1. Introduction

Turkey has been pursuing an export-led economic growth strategy since liberalization in the 1980s. One of the critical points in this direction is the adoption of the Customs Union Agreement (CUA) in 1996. With the opening of the Turkish economy to the European market, there was a steady increase in the productivity of manufacturing and the export volume of especially textile and automotive sectors. Yet, the low-hanging fruits of the agreement were consumed in a short time (Özatay and Sak 2002). The transformative impact of integration did not last long, and a kind of developmental trap emerged. The international division of labor has become low and medium-technology sectors for Turkey. Towards the second half of the 2000s, economic policy began to turn towards alternative markets as well as the domestic market (See Figure 1).

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After three decades of export-led growth experience, one of the main results of international integration has been the deepening of regional agglomerations (Akkemik and Göksal 2014; Kaygalak and Reid 2016). Essentially, this has been a global phenomenon since the 1980s due to the liberalization of international trade and increasing competition in global markets (Hanson 1998; Scott and Storper 2003; Sjöberg and Sjöholm 2004).

On the theoretical background of regionalization, Porter (1990) laid out a new perception of international competitiveness. Instead of analyzing nation-level factor endowments and technology spillovers, his proposal was an analysis of industry-level dynamics (Porter 1990). Regarding the economic performance of regions and agglomerated industries, Porter (2000) claimed that specialized regions are expected to perform better than other regions. Many studies illustrated such impacts for creative and innovative industries (Ferreira et al. 2012; Gülcan et al. 2011; Gong and Hassink 2017).

From the practitioner's perspective, economic geography has come into prominence in policy making (Krugman 1998; Brenner 1999; Martin and Sunley 2011; Vanhove 2018). In line with globalization and economic integration policy of the EU, regional economies have become the key element of harmonization in the European periphery. The CUA and more recent smart specialization strategy (3S) approach in the EU cohesion policy have highlighted local dynamics in international competition for regions.

Considering both the need for a coherent regional policy strategy and national comparative advantages in manufacturing sectors, an inclusive assessment of regional agglomerations must embrace broader sectoral advantages and employment priorities (Christoperson et al. 2010; Hassink 2010; Boschma 2015). For a medium-size country like Turkey, regional policy strategy's transformative capacity and practicality necessitate focusing on existing relative dynamics and technology level instead of creating comparative advantages by specializing in niche smart sectors.

In the literature, one of the problems is the heterogeneous identification of regional priorities (Kemeny and Storper 2015; Di Cataldo, Monastiriotis, and Rodriguez-Pose 2022). For single-region cases, regional priorities are developed through region-based and absolute specialization methods. In this paper, we will conduct a relative sectoral analysis to capture national comparative advantages and inclusiveness. In this way, employment and export-related indicators will add inclusiveness to the analysis. Yet, the findings should be thought of as complementary to region-based identification rather than an alternative. Also, the paper will give methodological insight for policymakers and researchers by focusing on employment-related priorities which must be concerted with national export-led growth dynamics. Turkish case in this paper constitutes an example of a mid-size country that is dependent on exports in low and mid-tech manufacturing sectors for sustainable economic growth.

For such a developmental aim, we evaluate export performance of Turkish regions for ISIC Rev. 4 two-digit manufacturing sector agglomerations. Using panel data for 58 NUTS3 regions and for 2008-2019 period, we examine variation of agglomerated sectors in terms of export performance. We aim to uncover the sectors with agglomeration advantages and to show the nexus between regional agglomerations, technology level, and export competitiveness.

This paper is organized as follows. The second section summarizes the literature review on agglomeration economies and stylized facts on Turkish manufacturing industry from a regional perspective. The third section explains dataset and identifies agglomeration structure of Turkish manufacturing. The fourth section presents the econometric model and preliminary tests. The fifth section assesses the findings, and the last section concludes.

2. Literature review

2.1. Regional agglomeration and economic performance

The main idea of spatial specialization can be taken back to Alfred Marshall's "Principles of Economics" published in 1890. Marshall focuses on the advantages of concentrating firms in certain regions that compete in similar industry branches. Marshallian positive externalities which lead to economic advantage can be summarized with the following 3 points:

- Knowledge diffusion: the concentration of firms operating in similar industries supports knowledge diffusion within the industry.

- Labor Pool: The concentration increases the presence of skilled and educated workforce in that region and/or sector and facilitates the access of companies to skilled workforce.
- Cost advantages: It provides cost advantages for firms within an industry, such as the effective use of production resources, the formation of supply chains, and innovation ecosystems.

Marshallian approach highlights supply-side factors and industrial relatedness within a spatial context (Glaeser et al. 1992). After Marshall, literature branches into two core directions: technological relatedness and industrial dynamics (Boschma, Balland, and Kogler 2015). While the first direction splits from the Marshallian idea and draws on the benefits of diversity (i.e., Jacobian externalities), the second direction expands agglomeration and spillover effects (Van der Panne 2004; Frenken and Boschma 2007).

A more recent substantial contribution to the literature is Porter's (1990) approach that practices both types. So far, Porter's contribution has also evolved from Marshallian supply-side externalities and clustering model to an export-oriented, and hence demand-side, explanation of competitive power (Porter 2003; Simmie 2008). With his explanation of industrial agglomeration, clusters are defined as industrial groups concentrated in a certain geographical region, connected both vertically and horizontally, sharing common resources such as technology and human capital (Porter 1990, 2000; Feser 1998; Feser and Bergman 2000).

Although some recent absolute measures of agglomeration focus on the scale of an industry in a geographical region (for a detailed discussion, see Kemeny and Storper 2015), Porter-type relative measuring gives the ability to capture relative changes, i.e. in terms of employment share, between sectors in a specific region. So that in-time common effects can be eliminated by this analysis. About international competition, Porter's approach to regional agglomeration distinguishes three types of industries as traded, resource-dependent, and local industries (Porter 2003). If specialization increases with export performance, this confirms Porter-type agglomeration economies that lead to specialized clusters and indicate an overall national competitiveness.

Many studies amplify Porter's approach to economic performance of agglomerated industries. Spencer et al. (2010), for instance, shows the impact of location on economic performance whether the cluster is in an urban region or not. The study positively differentiates city-region clusters from others in terms of various economic performance indicators.

Two recent studies examine Porter-type impact of agglomeration for the US and European cases. Firstly, Slaper, Harmon, and Rubin (2018) investigate the impact of industrial diversity, specialization strength, and growth of employment on several economic performance indicators in both local and traded industries for the US metropolitan areas. The indicators have a solid impact especially on per employee growth and per capita income growth. Yet, the study is essentially based on employment data and does not reflect monetary dynamics. The second study by Ketels and Protsiv (2021) reviews the European Cluster Observatory dataset for 28 countries. The economic performance indicators in this study are sectoral wages and regional GDP per capita. For that matter, the study assesses cluster-level impact of sectoral wages and region-level effects by economic growth. While wage-effect is found to be valid, regional effect is not so straightforward and is dependent on the quality of business environment.

Several other studies in the literature also choose definite performance indicators other than economic growth-related variables. Falcıoğlu and Akgüngör (2008) explore the evolutionary nature of industrial concentration. Their study investigates whether regional disparities in terms of industrial concentration have deepened through time. Wennberg and Lindqvist (2010) analyze the impact of clustering on new firms' performances. Similarly, Delgado, Porter, and Stern (2010), using firm-level data, examine entrepreneurship performance by focusing on start-ups.

The literature on Turkish case shows an increasing concentration pattern, especially after the 2000s (Akgüngör 2006; Kirankabeş and Arik 2014). For further analysis, productivity increase and reorganization of the Turkish manufacturing sector with export-oriented industrial policies necessitate an evaluation of the performance of regional industries in terms of international competition and sectoral resilience. For this aim, our paper focuses on the export performance of Porter-type agglomerations with a broader sectoral perspective.

2.2. Road to international competition in Turkish manufacturing

Considering the rapid liberalization process in the 1980s, the transformative impact of export-led growth strategy on the structure of the Turkish economy became limited in the next two decades (Arıcanlı and Rodrik 1990; Müftüler 1995). The CUA which was put into effect in 1996 is considered as a reference point in Turkey's international trade policy after the 1980s switch from import-substitution developmentalism (Togan 2015). Reforms in both national and regional level economic policy-making shaped Turkey's integration objective in this route. Due to the available protection spectrum in agriculture, the agreement is supposed to push specifically manufacturing industries to competition.

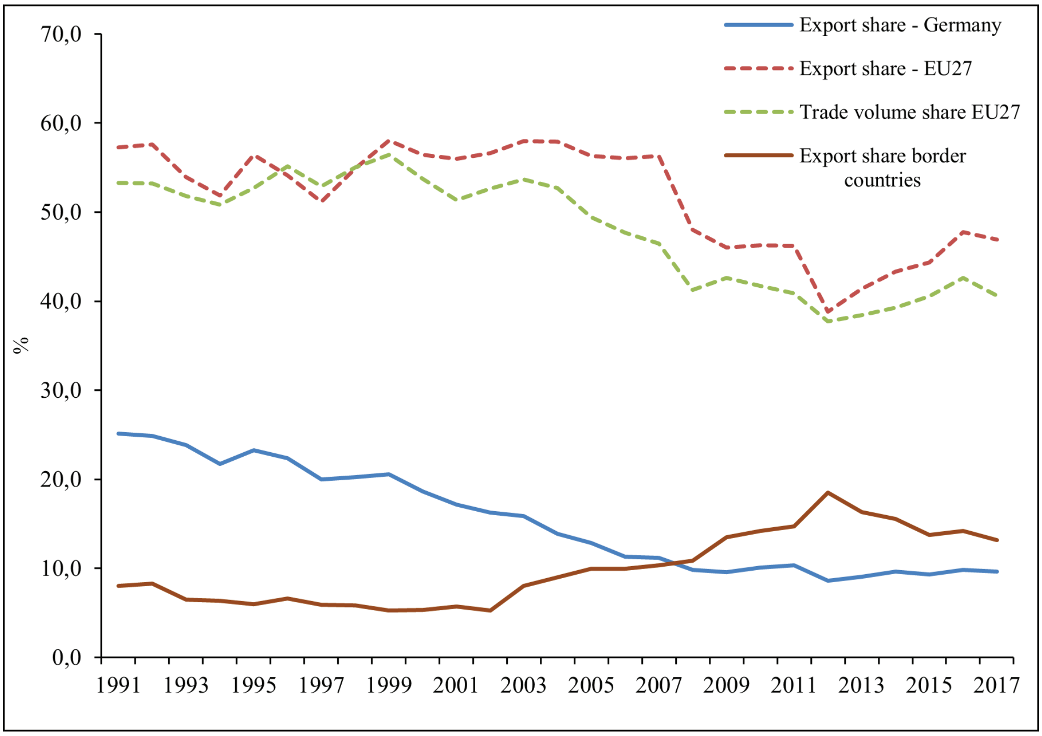
Early literature focuses on the trade and productivity effects of the agreement on the Turkish side. Neyaptı (2007) finds a positive effect of the CUA in both total export and import volumes while controlling macroeconomic determinants of international trade. According to the findings of the study, the income elasticity of trade decreased after 1996 which tied a stronger trade relationship with the EU.

Taymaz and Yılmaz (2007), in their study on the Turkish manufacturing sector, examine the productivity impact of the CUA. They found that productivity increases were largest in import-competing sub-sectors compared to export-oriented and non-tradable sub-sectors. Akkoyunlu-Wigley and Mihci (2006) considers import-export rates to sectoral outputs and concentration indexes to evaluate the change in pricing, competition, and efficiency in manufacturing industry. Their study provides evidence for decreasing price cost mark-ups and concentration ratios for import sectors in the manufacturing industry.

In brief, the customs union agreement conduced to a more competitive manufacturing sector in Turkey. The findings in the early literature demonstrate an increase in competition and accordingly increase in efficiency and welfare (See also Müftüler 1995; Yılmaz 2011; Togan 2015 for trade effects of the CUA).

Figure 1 shows the evolution of export shares of main trade partners for the last 30 years. The period from the first years of the 2000s to today has become the years of export diversification attempt (See Erguzel et al. 2016). From Figure 1, it is seen that the share of the EU-27 countries in total trade volume, still the

Figure 1. Percentage share of total exports and trade volume in manufacturing - main trade partners



Source: Turkish Statistical Institute (2024) largest trade partner, declined from 59 percent in 1999 to 39 percent in 2013. The export share of Germany, still Turkey's leading trade partner at the country level, also followed a similar trend to that of the EU-27. In the same period, the export share of the border countries climbed from 5 percent to 17 percent. Iraq, Georgia, and Russia emerged as new trade partners.

As shown by the studies in literature and international trade data, the productivity and competitive impact of the Customs Union Agreement resulted in a structural change in the composition of trade partners' shares. The period after the first years of the 2000s shows a trend of trade expansion with non-EU border countries.

2.3. Regionalization dynamics in manufacturing

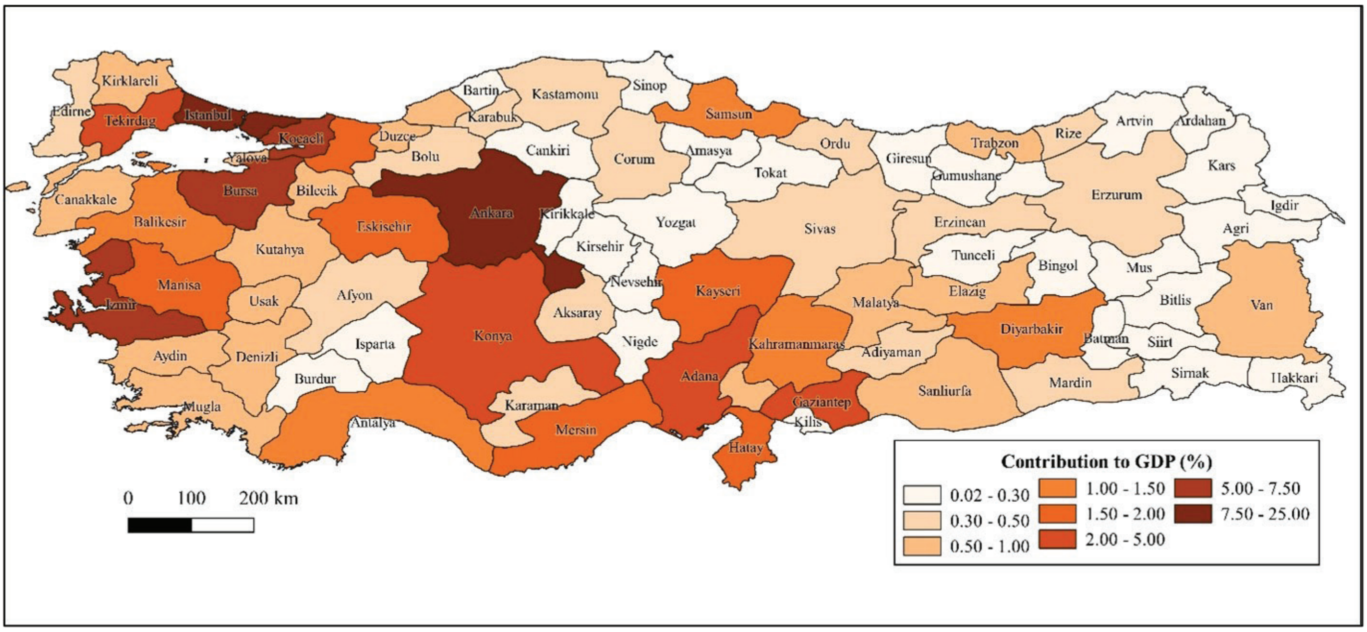
Prior to the 2000s, Turkey's regional policy had focused on regional disparities, especially the east-west differentiation of the country. Since the establishment of the State Planning Organization in 1960, infrastructural investments have been the main instrument of regional planning agenda (Ertugal 2018). The EU cohesion policy became the main factor that brought a reform initiative for Turkish regional policy.

With the establishment of Regional Development Agencies (RDAs) in 2006, Turkey has acceded to regional policy-making amenable to EU cohesion standards, though with severe limitations (Lagendijk, Kayasu, and Yasar 2009; Sobaci 2009). To reform the governance of regional policymaking, RDAs were thought of as bottom-up policy institutions. However, as Young-Hyman (2008) showed, Turkish RDAs have been dependent on the central government for financial resources with limited contributions from local administrations. To comply with the EU harmonization process, NUTS2-level regions have been the primary unit of regional policymaking in the last two decades (Young-Hyman 2008; Ertugal 2018). Yet, in addition to the relative scarcity of NUTS2-level data, this spatial standardization is criticized for functionality and local administration capabilities. Since these NUTS2 regions mostly do not coincide with local governance entities, RDAs have limited autonomy in the decision-making process.

Though regional policymaking is *de jure* based on NUTS2 level classification, for especially 3S and investment planning agendas, NUTS3 level provinces, with local administrative capability and distinctive historical developmental paths, appear to be a more proper regional unit for analyzing regional development dynamics (Sat 2018; Sezgin 2018).

Figure 2 shows the contribution shares of 81 NUTS3 regions to total manufacturing production

Figure 2. Contribution to total manufacturing GDP (2002-2017 average) – NUTS3 regions



Source: Authors' computation

in Turkey for the 2002-2017 period. Istanbul, Ankara, Kocaeli, Bursa, and Izmir (top five regions) constitute nearly 50% of total production in the manufacturing industry. There are 20 regions out of 81 that exceed 1%. The aggregated contribution of these regions is 78%. Considering this fact, the geographic distribution of manufacturing production exhibits an uneven and highly concentrated pattern between regions.

Moreover, the manufacturing industry has become highly tradable for Turkish regions for the last two decades. Nearly half of the regions export 10% or higher rates of their total manufacturing production. Table 1 shows export intensities of some NUTS3 regions for the 2008-2019 period. Export orientation has been rising in each region during the period.

Considering the literature on agglomeration and economic performance of regions, internationalization of Turkish manufacturing, and increasing concentration of manufacturing production, this paper contributes to the literature with three main points. Firstly, the paper assesses agglomeration dynamics from a broader perspective by using ISIC Rev. 4 two-digit sectors. Secondly, by using comparative assessment through three-star measurement of agglomeration advantages, the paper presents a complementary method, if not alternative, to absolute and single-region based specialization approaches to capture national inclusiveness priorities. Thirdly, the findings are thought to give insight to policymakers in terms of the nexus between industrial agglomeration, technology level of sectors, and export performance. In the next section, we outline the regional agglomeration structure of manufacturing sectors.

3. Dataset

3.1. Data sources

The empirical part of our study relies on two separate datasets. Firstly, regional sectoral employment and firm statistics are compiled from the official statistical yearbooks of the Social Security Institution of Turkey (SSI 2023). The earliest available series in this source goes back to 2008. Before this date, there were three

Table 1. Export intensities of NUTS3 regions in manufacturing

Region	2008	2014	2019	2008-2019 average
Gaziantep	31.46	42.33	54.88	41.42
Sakarya	33.14	25.57	58.98	32.39
Bursa	33.91	24.37	33.08	30.29
Kocaeli	30.32	26.72	35.81	30.01
Istanbul	31.55	28.46	36.71	29.43
Denizli	24.78	26.39	34.73	27.30
Hatay	17.62	18.27	31.27	20.10
Trabzon	14.86	18.58	21.81	18.08
Manisa	7.67	13.3	19.74	17.09
Izmir	16.31	17.04	21.86	16.86
Kayseri	9.48	13.67	20.42	13.11
Karaman	6.9	13.09	12.77	11.16
Karabük	1.71	11.68	22.61	10.97
Kırşehir	6.75	11.69	15.47	10.75
Kahramanmaraş	5.82	11.81	13.17	10.64
Adana	8.55	10.29	13.27	10.34

Source: Turkish Statistical Institute (2024)

Note: Table gives regions only over 10% on average. Export intensities are calculated as (regional export value)/(regional GDP).

Table 2. Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
id	696	-	-	1	58
year	696	-	-	2008	2019
GDP (million TL, 2009 prices)	696	35702.7	101707.8	738.5	132630
Manufacturing GDP (million TL, 2009 prices)	696	6355.2	16248.2	32.98	197938
Total export (million TL, 2009 prices)	696	6831.9	32056.5	9.16	486916
Real exchange rate (TL/$)	696	2.64	1.34	1.29	5.67
Total employment in (selected) manufacturing sectors	696	201,727	493,338	5,073	4,130,578
Total number of firms in (selected) manufacturing sectors	696	26,317	62,623	721	537,982

distinct official social security institutions in Turkey: *SSK* for private sector employees, *Bağ-Kur* for private sector employers, and *Emekli Sandığı* for public sector employees. In 2006, these institutions were merged under the Social Security Institution of Turkey. Hence, NUTS3-level aggregated sectoral data is only available from 2008 onwards. Appendix 1 summarizes sectoral employment, firm number, and export data statistics according to the two-digit ISIC Rev4 classification.

The second source is Turkish Statistical Institute's database. NUTS-3 level statistics for GDP, manufacturing GDP, manufacturing export, and total export are derived from this source. Table 2 presents descriptive statistics for these indicators.

Based on our research to analyze regional dynamics of competitiveness, we conducted a preliminary elimination process. By calculating the export intensity of manufacturing sector for NUTS-3 regions, we excluded 23 provinces from the dataset which have intensity values below 0.5%. In the end, our final dataset is a panel of 696 observations with 58 cross-sectional units (NUTS-3 level provinces) and 12 years (2008-2019).

3.2. Identifying regional agglomeration and specialization

To conduct regression analysis, we first constructed some variables to represent regional specialization and agglomeration. In the literature, there are various methods to calculate such indicators based on employment, output, or export value data (See Nakamura and Paul 2009).

In this study, we follow the 3-star methodology of Sölvell, Ketels, and Linqvist (2008) on the EU regions. The study is an adaptation of Porter (2003) on the US clusters. As the name implies, three different criteria are calculated to determine Porter-type clusters/agglomeration. Specifically, these are size, dominance, and specialization. Table 3 shows how these criteria are calculated.

Table 3. Identification of Porter-type agglomeration

Criteria	Formula	Definition	Threshold
size	$\frac{emp_{ij}}{EMP_j}$	(Employment in sector *j* in region *i*) / (total employment in sector *j*)	2%
dominance	$\frac{emp_{ij}}{emp_i}$	(Employment in sector *j* in region *i*) / (total employment in region *i*)	5%
specialization	$\left[\frac{emp_{ij}}{emp_i}\right] / \left[\frac{EMP_j}{EMP_i}\right]$	(Ratio of employment in sector *j* in region *i* to total employment in region *i*) / (ratio of total employment in sector *j* to total employment in all regions)	2

Size measures the share of a region's employment in overall employment in a sector. *Dominance* represents the relative weight of a sector in a region, and *specialization* is the standard location quotient (LQ).

One of the issues in this methodology is the determination of threshold values for these criteria (See O'Donoghue and Gleave 2004; Tian 2013). If thresholds are set low, more stars will be detected than it is and vice versa. Such an inconsistency will lead to misleading implications. Considering previous studies and our dataset, we set the size threshold as 2%, the dominance threshold as 5%, and the specialization threshold as 2 (Sölvell, Ketels, and Linqvist 2008; Ketels and Protsiv 2021). By these threshold values, at least one star is given to the best 25% of each sector (See Table 3). We calculated these criteria for each year and each region. So, instead of attributing cluster quality for the whole period, we reflected possible yearly changes in these scores.

Table 4 shows the results of the 3-star analysis. A sector in a region that exceeds the threshold value in any one of the criteria receives one star, if exceeds in any two criteria receives two stars, and if exceeds in all three criteria receives three stars. According to the stars they received, sectors are called "mature cluster" if they received three stars, "potential cluster" if they received two stars, and "candidate cluster" if they received one star. We excluded highly concentrated and/or small-scale manufacturing sectors. These sectors either have a total employment number below 20,000 or are concentrated in 3 or lower number of regions. The cluster ratio is higher for the *manufacture of food products* and the *manufacture of non-metallic mineral products* (48% and 41%, respectively). These two sectors are more evenly distributed spatially than the others. Since this methodology is solely based on employment data, we do not interpret these labels as real clusters, i.e. as a hub of knowledge-intensive concentration, but as indicators of agglomeration level.

Table 4. Agglomeration in manufacturing sector

Sector (ISIC Rev4 classification)		No cluster	1-star	2-star	3-star	total
10 - Manufacture of food products	Freq.	361	92	142	101	696
	Percent	51.87	13.22	20.4	14.51	100
13 - Manufacture of textiles	Freq.	512	45	65	74	696
	Percent	73.56	6.47	9.34	10.63	100
14 - Manufacture of wearing apparel	Freq.	521	35	112	28	696
	Percent	74.86	5.03	16.09	4.02	100
20 - Manufacture of chemicals and chemical products	Freq.	549	71	76	-	696
	Percent	78.88	10.2	10.92	-	100
22 - Manufacture of rubber and plastics products	Freq.	539	81	69	7	696
	Percent	77.44	11.64	9.91	1.01	100
23 - Manufacture of other non-metallic mineral products	Freq.	406	180	58	52	696
	Percent	58.33	25.86	8.33	7.47	100
24 - Manufacture of basic metals	Freq.	488	128	36	44	696
	Percent	70.11	18.39	5.17	6.32	100
29 - Manufacture of motor vehicles, trailers and semi-trailers	Freq.	589	48	32	27	696
	Percent	84.63	6.9	4.6	3.88	100
30 - Manufacture of other transport equipment	Freq.	554	67	63	12	696
	Percent	79.60	9.63	9.05	1.72	100
31 - Manufacture of furniture	Freq.	568	99	19	10	696
	Percent	81.61	14.22	2.73	1.44	100

Source: Authors' calculation based on SSI (2023)

4. Econometric Model

The econometric analysis will be conducted based on a panel data model. The model considers Porter-type industrial agglomeration as explained by Simmie (2008). The model given by Equation 1 aims to test the hypothesis on sectoral export performance.

$$ln(EI)_{it} = \beta_0 + \beta_1 STAR_{it} + \beta_2 ln(GDP)_{it} + \beta_3 ln(RER)_t + \varepsilon_{it} \quad (1)$$

where i and t denote NUTS3 regions and year respectively. The dependent variable is the logarithm of sectoral export intensity. Sectoral export intensities are calculated by using Equation 2.

$$EI_{ij} = \frac{export_{ij}}{GDP_i} \quad (2)$$

$STAR_{ij}$ is a dummy variable that takes values from 0 to 3 and represents sectoral agglomeration level according to Porter's star approach explained in section 3. Significant coefficients will show whether regions with related sectoral agglomerations differ from non-agglomerated ones in terms of export intensities.

$ln(GDP)_{it}$ and $ln(RER)_t$ are added as control variables. As in gravity modelling (Anderson, 2011), RER_t is added to the model to represent exchange rate related changes in competitiveness. Since RER_t is common to all regions of Turkey, cross-section indices are not added to the variable.

For estimating the econometric model consistently and efficiently, we should consider the panel structure of our dataset. The validity of econometric estimations depends on two conditions.

i. Heterogeneity among regions with various sizes and economic structures which can lead to region-specific time-invariant fixed effects,
ii. Spatial and/or temporal dependence of regions.

Accordingly, we will conduct some preliminary tests to choose a reliable estimation methodology. Firstly, we must decide whether region-specific fixed effects are valid or not. For this purpose, we conduct F-test to decide whether H_0 : individual estimates of intercept terms are equal (restricted pooled OLS) or H_1 : not (unrestricted FE). The null hypothesis assumes the validity of common effects while the alternative hypothesis shows the existence of different fixed effects among regions. F-test results for each regression are given at the end of related estimation results table in findings section.

For the second condition, we applied Pesaran's cross-section dependence test (Pesaran 2015). One of the advantages of this test over other residual-based tests, such as Friedman's FR test, Frees test, or Pesaran (2004) CD test, is that it can be applied to variable series instead of residuals (De Hoyos and Sarafidis 2006). The test statistic is given by Equation 3.

$$CD = \sqrt{\frac{2}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \sqrt{T \hat{\rho}_{ij}} \right) \quad (3)$$

where $\hat{\rho}_{ij}$ denotes pair-wise correlation coefficients of x_{it} regressors for the (i, j) units (Bailey, Holly, and Pesaran 2016). According to the results of cross-sectional dependence test, mean correlations between regions show a strong nature in general (See Appendix 2). So that, we must use spatial correlation robust standard errors.

Consider the model given by Equation 4.

$$y_{it} = x_{it}'\beta + \varepsilon_{it} \quad (4)$$

where x_{it} is vector of independent variables and β is vector of unknown coefficients. i and t denote cross-sectional units (NUTS3 regions) and time respectively. The error term ε_{it} is defined as given by Equation 5 to capture cross-sectional dependence of regions and time-invariant factors specific to each region.

$$\varepsilon_{it} = \alpha_i + \lambda_i f_t + v_{it} \quad (5)$$

In equation 5, $\lambda_i f_t$ and α_i constitute cross-section-specific components. f_t is unobserved factor common to all cross-sectional units and is assumed to cause correlated residuals. This factor can be any shock or policy change that all cross-sectional units are affected simultaneously. α_i represents unobservable time-invariant factors specific to each region that led group fixed effects. v_{it} is the regular error term.

In order to eliminate α_i from the equation, we subtract group averages of $\overline{y}_i$ and $\overline{x}_i$ in Equation 5. With this operation, we get the classical Within Group estimator given by Equation 6.

$$\tilde{y}_{it} = \tilde{x}_{it}'\beta + u_{it} \quad (6)$$

Heteroskedasticity and autocorrelation consistent (HAC) robust standard errors can be computed by nonparametric kernel variance-covariance matrix estimators for Equation 6 (Bramati and Croux 2007; Stock and Watson 2008). Yet, HAC estimators of the covariance matrix assume that the explanatory variables and the error terms must be independent across cross-section units (no cross-sectional dependency). If this assumption is not satisfied, HAC estimations of the covariance matrix will be inconsistent. By using cross-section averages of residuals and regressors, the variance-covariance matrix can be computed as in HAC method (Vogelsang 2012). In order to overcome cross-sectional dependence, we use Driscoll and Kraay (1998)'s spatial correlation robust HAC standard errors (See Hoechle 2007).

5. Findings and Discussion

Our findings on the export performance of Turkish regions for two-digit manufacturing sectors are given in this section. The regression results on the impact of agglomeration on sectoral export performance are given in Table 5.

Each column in Table 5 presents two-way fixed effects regression results for the given manufacturing sector. According to the results, agglomerations in the manufacture of chemicals, plastics, transport, and furniture sectors have a positive relation with sectoral export performance. For the chemicals sector, all levels of agglomeration are positively related to sectoral export intensity. Plastics, transport equipment, and furniture sectors do not have a statistically significant relation with one-star agglomeration but have with all higher levels. Positive coefficients of agglomeration level dummies show export orientation and adaptation to broader factors, while negative coefficients can be interpreted as internal market orientation. In this case, the manufacture of food products has a negative relation, indicating an internal market orientation. Exports of other manufacturing sectors do not have a statistically significant relation with sectoral agglomeration.

Table 5. The effect of agglomeration on sectoral export performance

variable	food	textile	wearing	chemicals	plastics	nonmetal	metal	vehicle	transport	furniture
ln(GDP)	0.58***	0.61***	0.62***	0.65***	0.96***	0.58***	0.56*	0.96***	0.15	0.78***
	(0.15)	(0.01)	(0.22)	(0.23)	(0.14)	(0.12)	(0.31)	(0.24)	(0.39)	(0.12)
RER	0.04	0.05	-0.07	0.12*	0.02	0.15***	0.27***	0.21***	0.40***	0.12***
	(0.046)	(0.04)	(0.08)	(0.06)	(0.03)	(0.05)	(0.10)	(0.07)	(0.11)	(0.02)
star_1	-0.392**	0.11	-0.27	0.29***	0.20	0.16	0.17	-0.16	0.15	0.15
	(0.156)	(0.20)	(0.38)	(0.10)	(0.27)	(0.22)	(0.12)	(0.35)	(0.79)	(0.21)
star_2	-0.042	0.08	0.15	0.25*	1.16***	0.11	0.57	-0.01	0.93*	0.96**
	(0.034)	(0.42)	(0.27)	(0.14)	(0.29)	(0.29)	(0.42)	(0.16)	(0.47)	(0.38)
star_3	-0.12**	-0.55	-0.11	-	0.77**	0.20	1.25	-0.46	-	0.85**
	(0.045)	(0.61)	(0.17)	-	(0.30)	(0.29)	(1.32)	(0.30)	-	(0.34)
lag (1)	0.475***	0.34***	0.51***	0.45***	0.44***	0.27***	0.28***	0.09	0.11*	0.33***
	(0.069)	(0.06)	(0.10)	(0.03)	(0.07)	(0.06)	(0.05)	(0.07)	(0.06)	(0.07)
constant	-0.21	0.53	-2.41	-2.18	-6.84***	2.14	1.40	-2.27	8.27	-2.71*
	(2.56)	(2.15)	(4.01)	(3.20)	(1.81)	(2.03)	(4.81)	(3.19)	(6.05)	(1.14)
N	630	635	601	630	638	627	606	576	462	633
F	430	410	66.4	1017	1170	178	259	204	54.4	2742
R^2	0.54	0.30	0.29	0.56	0.52	0.36	0.32	0.26	0.14	0.44

Note: Values in parentheses are robust Driscoll-Kraay standard errors. The dependent variable is $ln(exp\,o\,rt\_int\,e\,nsity)$ of the given sector in each regression (See Equation 1). Chemicals and transport sectors do not have 3-star level agglomeration. ***, **, and * denote significances at 1%, 5%, and 10%, respectively.

These findings confirm the fact that the related sectors have resilience to integration and international competition. For the unrelated sectors, we cannot say that these are resource-dependent or local industries, according to Porter's classification (Porter 2003). However, as the manufacture of textile products, vehicles, metal products, and wearing apparels are respectively primary sectors of Turkish export (Gül 2021), it seems that these sectors have reached a developmental trap position. So much so that increasing trade opportunities do not contribute much to the expansion in these sectors. In other words, they have a stable market structure, and new challenges must be overcome for further expansion.

The findings from the analyses provide several implications related to the sectoral differentiation of Turkish manufacturing. Returning to our research question on agglomerated industries' regional export performance, we confirm the hypothesis for only several sectors of the manufacturing industry. For two-digit broad manufacturing sectors, the Porter-type impact of agglomeration is found to be limited to chemicals, plastics, metal, transport, and furniture industries. Previous studies on Turkish manufacturing have already illustrated this for creative and import-competing sectors (Akkoyunlu-Wigley and Mihci 2006; Taymaz and Yılmaz 2007; Gülcan et. al 2011). Also, Özsarı et al. (2022) and Emirhan and Turgutlu (2023) amplifies positive impact of exports on labour demand in manufacturing industries for the Turkish case. Their findings are stronger for low-tech and mid-tech subsectors.

Table 6 summarises the findings of our research. Turkish ISIC Rev4 two-digit classification manufacturing sectors can be grouped into three according to regional agglomeration characteristics. Each group is given in a row in Table 6.

The first group consists of only the food products sector. Agriculture-based food production shows local/resource-oriented characteristics. Hence, agglomeration and specialization dynamics are not sensitive to international trade. The sector is also one of the few sectors that were not fully liberalized during the CUA with the EU. This policy choice created a subsidized agricultural resource base for food products and, at least, prevented possible larger trade flows within the EU area (Larch, Schmeisser, and Wanner 2021).

The second group of manufacturing sectors are the ones that have Porter-type agglomeration structure. Except for furniture, all sectors in this group are medium-tech. Positive employment response to export is higher in this group compared to the two other groups of manufacturing sectors. Due to potential trade and cluster opportunities, these sectors are open to regional economic policy making and regional development strategies based on, for instance, 3S (See Abay and Akgüngör 2023 for 3S potential of Turkish regions). Compared to labour-saving high-technology industries, these sectors have the potential of application of inclusive regional development agenda that calls upon labour employment.

The third and last group consists of manufacturing sectors that have high export shares in Turkey's overall export volume and have a mature industrial structure.

Table 6. Summary of agglomeration effects analysis

sector (tech-level)	export impact	evaluation
food products (low-tech)	(-)*	Local/resource dependent industry; domestic market orientation
chemical products (med-tech) plastics products (med-tech) transport (med-tech) furniture (low-tech)	(+)*	Traded industry; Porter-type agglomeration; Trade and cluster opportunities
textiles (low-tech) wearing apparels (low-tech) basic metals (med-tech) non-metal (med-tech) vehicle (med-tech)	No impact	Mature industry; possible labor-substituting technological progress; global value-chains

Especially textiles and wearing apparels sectors have been the main sectors of the export-led economic growth policy of Turkey since the 1980s liberalization movement. The vehicle sector, which consists automotive subsector, also has been one of the main export items targeting the EU market since the adoption of the CUA in 1996. So far these sectors have been the locomotive of Turkish exports and have gained a steady market. In overall evaluation, these sectors are highly competitive, and it is hard to expand production and increase productivity without gaining technological competitiveness or a creative clustering agenda.

6. Conclusion

This paper assesses Porter-type regional industrial dynamics for Turkey's ISIC Rev. 4 two-digit manufacturing sectors. Using panel data for 58 NUTS3 regions and for the 2008-2019 period, we examine sectoral resilience to international competition and variation of agglomerated sectors in terms of export performance.

The findings reveal three groups of manufacturing sectors. The first group is uniquely composed of the food products sector which depends on highly protected agricultural production. Regional agglomeration in this sector has no positive impact on export performance. The second group of sectors are the ones that have Porter-type trade advantages and clustering opportunities. Namely, chemical products, plastics products, basic metals, transport equipment, and furniture are in this group. The third and the last group consists of mature manufacturing sectors that also have been the leading export sectors for Turkey. Regional agglomerations in the production of textiles, wearing apparels, non-metal products, and vehicles have no statistically significant relation with export performance.

Taking into account both the need for a coherent regional policy strategy and national comparative advantages in manufacturing sectors, it appears that regional agglomeration of certain sectors does not have a direct path towards agglomeration advantages. For a medium-size country like Turkey, regional policy strategy should focus on increasing transformative capacity in the second group of manufacturing sectors which have agglomeration advantages in trade, instead of creating comparative advantages by specializing in niche smart sectors. The findings illustrate the need for technological upgrades in the mature low-tech sectors in the third group of manufacturing sectors. At this stage, a combination of national and regional economic policy also becomes decisive. On the one hand, these are low and mid-tech sectors that are open to technological progress. This can be accomplished through either targeted technology policy or partnerships within global value chains in these sectors. In this way, these mid-tech sectors can break down such path dependency. On the other hand, regional redistribution of these sectors, especially textiles and wearing apparels, to the regions with clustering and labor-cost advantages can contribute to export competitiveness.

Lastly, the implications of the paper are dependent on the assumption of the status quo of labor mobility and determined regional policy. Both points are crucial to executing inclusive regional policy and sustaining the resilience of regional agglomerations accompanied by 3S potentials.

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Appendices

Appendix 1. Summary of manufacturing sector data

Sector – ISIC Rev4 classification		Total Employment					Number of Firms					Export (million TL)				
Division Code	Definition	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max	Obs	Mean	Std. Dev.	Min	Max
10	Manufacture of food products	696	6650.05	9255.41	164	68172	696	661.7	952.57	29	7355	690	442	1360	224	171000
13	Manufacture of textiles	696	6875.13	15499.4	1	81379	696	279.73	900.47	1	7584	694	627	2820	245	379000
14	Manufacture of wearing apparel	696	7603.61	32518.88	0	278769	696	545.36	2905.01	0	24437	672	568	3840	140	57000
20	Manufacture of chemicals and chemical products	696	1295.13	3277.26	1	23317	696	75.51	208.96	1	1770	690	360	2020	211	34800
22	Manufacture of rubber and plastics products	696	2989.47	8067.61	4	62766	696	201.21	616.24	2	5127	696	303	1410	421	20300
23	Manufacture of other non-metallic mineral products	696	3259.66	3788.67	41	25105	696	209.87	304.68	8	2397	689	183	755	205	11900
24	Manufacture of basic metals	696	2564.14	4685.61	0	29075	696	128.52	328.85	0	2819	673	852	4990	210	61900
29	Manufacture of motor vehicles, trailers and semi-trailers	696	2329.72	8026.73	0	69614	696	52.48	122.99	0	782	650	1070	5550	23	81300
30	Manufacture of other transport equipment	696	798.37	2146.07	0	19229	696	21.01	64.55	0	869	562	141	599	39	6730
31	Manufacture of furniture	696	2138.89	5343.5	0	35962	696	295.21	732.97	0	5638	693	298	1860	247	28200

Appendix 2. Cross-sectional dependence test results

Variable	CD-test	p-value	mean $\hat{\rho}$	mean abs ($\hat{\rho}$)
ln(GDP)	140.26	0.000	1.00	1.00
ln(EXP_M)	118.98	0.000	0.84	0.84
ln(GDP_M)	138.37	0.000	0.98	0.98
ln(RER)	140.84	0.000	1.00	1.00
ln(EI10)	89.55	0.000	0.64	0.72
ln(EI13)	41.39	0.000	0.29	0.46
ln(EI14)	12.16	0.000	0.08	0.42
ln(EI20)	84.42	0.000	0.60	0.64
ln(EI22)	81.33	0.000	0.58	0.62
ln(EI23)	66.36	0.000	0.47	0.53
ln(EI24)	57.04	0.000	0.42	0.50
ln(EI29)	52.69	0.000	0.40	0.48
ln(EI30)	17.95	0.000	0.13	0.36
ln(EI31)	70.88	0.000	0.50	0.56
SPEC10	-0.62*	0.531	0.00	0.46
SPEC13	4.33	0.000	0.03	0.43
SPEC14	-0.27*	0.788	0.00	0.52
SPEC20	-2.03	0.041	-0.01	0.49
SPEC22	16.02	0.000	0.11	0.55
SPEC23	0.07*	0.946	0.00	0.39
SPEC24	-0.24*	0.813	0.00	0.49
SPEC29	15.06	0.000	0.11	0.52
SPEC30	14.60	0.000	0.10	0.40
SPEC31	4.95	0.000	0.04	0.50

Note: Under the null hypothesis of cross-section independence, CD ~ N(0,1).
p-values close to zero indicate data are correlated across panel groups.
* indicates insignificant test statistics.