THE EFFECT OF IMPORT ON EXPORT GROWTH AND CONVERGENCE: A SPATIAL ANALYSIS IN TÜRKIYE

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ABSTRACT

Recent studies tend to scrutinize the convergence and growth patterns of various socioeconomic variables among countries or regions, as well as their per capita income. This study as a new approach examines the growth rate and convergence inclination of real per capita exports among the 81 provinces of Türkiye for the period 2004–2021. The role of imports and their subcategories (intermediate, capital, and consumer goods) is also considered in this context. The results of the non-spatial panel model show that real per capita exports converge among provinces in both absolute and conditional terms. On the other hand, while total imports as well as imports of intermediate goods and capital goods contribute to export growth and convergence of the provinces, imports of consumer goods have no effect. According to the results, spatial interaction among provinces is notable. The results do not change significantly depending on the estimates of the DSAR model (Dynamic Spatial Autoregressive Model), identified as the appropriate specification.

KEY WORDS

spatial econometrics, convergence, export, import

JEL CODES

C31, O47

1 INTRODUCTION

Türkiye has been implementing an open trade policy for the last 30 years in order to both increase the domestic income and reduce regional development disparities. Following the export-led growth model adopted since the 1980s, the Turkish state has firmly encouraged exports across the country through various funding and support programs. As a result, in the country goods have become exportable from all provinces, per capita exports and imports have increased by 3.8% and 3.0% respectively in real terms for the last two decades. For this reason,

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we believe that exports should be considered as a determinant of economic growth and the convergence in income.

In this context, the aim of this study is to explore the effect of Turkish imports on its export growth and convergence between 2004 and 2021. For this purpose, we propose two major hypotheses based on the results obtained from previous income convergence studies for Türkiye. First, exports per capita in the country are supposed to be converged with spatial interaction. In studies, income convergence is commonly observed with spatial interaction between regions or provinces. Consequently, this convergence should also be expected for exports, which is a component of income. Moreover, trade figures show that Turkish exports and imports have advanced gradually and closely together for the last three decades, which confirms their adjacent dependence. Therefore, we should expect an impact of imports on the growth and convergence of exports. Accordingly, our study also examines the spatial convergence of exports and its dependence on imports as well as its sub-categories (intermediate, capital, and consumer goods) on the basis of provincial heterogeneity.

To test our suggestions, this study basically follows the model and method used by Kremer et al. (2022) to estimate absolute and conditional convergence on the basis of provisional heterogeneity. Following the model proposed by Barro and Sala-i-Martin (2004), they empirically re-examine the forms of inter-country convergence in the 1960–2017 period and use trade variables such as tariffs as well as income and fiscal variables. The fact that their research is one of the studies that rarely use trade variables in convergence analysis is among the most important reasons for us to follow them. In our study, however, real exports per capita are supposed as a factor that determines income in addition to the variables specified by them. On the other hand, the factor of imports is assumed to contribute to the growth and convergence of exports, which means that one of the major control variables that affect exports might be imports. Unlike Kremer et al. (2022), we don't consider the effect of exports on income growth and convergence. Their non-spatial study examines convergence between countries, whereas this spatial exercise explicitly emphases on the export growth and convergence across regions in Türkiye.

The study has several major findings. The results indicate absolute and conditional convergence in exports. Export-poor provinces show faster export growth than the rich. Accordingly, the poor provinces will catch up with the rich in terms of real per capita exports in approximately three decades. Second, the estimated models show that exports display spatial interactions among provinces. Third, the results show that imports of total, intermediate, and capital goods are effective for export growth and convergence. However, the exports or imports of neighboring provinces affect the exports of the province in question. In summary, there is spatial dependence in addition to the dependence of exports on imports.

This paper has several important contributions to literature. First of all, this is the first spatial study of export convergence on a provincial basis in Türkiye. Moreover, the spatial dependence of exports between provinces is estimated for short and long periods using both static and dynamic models. Unlike previous studies that focused on the country in general, this is the pioneer spatial study that measures the dependence of exports on imports on the basis of provincial heterogeneity.

The study is planned as follows: in the next section we explain theoretical background and our methodology; Section 3 presents the data and descriptive statistics; Section 4 section provides the results; the final section concludes with additional discussion.

2 THEORETICAL BACKGROUND AND METHODOLOGY

Concerning global trade, empirical exercises on the neoclassical growth model largely consider the factor of trade openness in income growth and convergence. For example, Frankel and Romer (1996) suggest that trade openness has a positive influence on per capita income and growth due to economies of scale and the diffusion of knowledge across various economies. Caselli et al. (1996) demonstrate that terms of trade is a determinant of income and growth across countries. Michelis and Neaime (2004) display that openness to international trade is the most statistically significant variable for sustained economic growth in the Asia-Pacific region. Cabral and Mollick (2012) find that trade has a positive influence on growth in the Mexican States. Andreano et al. (2013) test income convergence for the Middle East and North Africa (MENA) countries by using trade openness (i.e. exports and imports/GDP) and terms of trade (i.e. export price index/import price index) as control variables. Barro (2012) and Barro (2016) show in their long-term studies that openness and terms of trade are important variables for income convergence. Chapsa et al. (2015) verify that trade openness is one of the strong drivers of growth for the EU-15.

One of the few studies dealing with export convergence, Radiměřský and Hajko (2016) examine the convergence of trade volumes in EU countries for the period 2002–2014 by SITC (Standard International Trade Classification) sub-categories. They estimate both absolute and conditional convergence of about 5–6% and 14–16% respectively, depending on the subcategory in per capita exports. Another exceptional exercise by Kremer et al. (2022) considers global convergence trends in income and growth apart from the factors of determinants or the correlates of growth such as human capital, policies, institutions, and culture. Unlike other studies, they also explore whether there are changes or convergence in each of these growth variables. For this purpose, they gather more than 30 variables under different categories and examine the convergence of tariffs across countries under the heading of fiscal policy. They estimate an annual convergence rate of about 3.5% across countries for tariff rates (equal-weighted and value-weighted).

According to the literature, spatial (Gezici and Hewings, 2004; Yıldırım 2005; Yıldırım et al., 2009; Çelebioğlu and Dall'erba, 2010; Akçagün, 2017; Doğan and Kindap, 2019; Ursavaş and Mendez, 2022; Yamanoğlu, 2022) and non-spatial studies (Canova and Marcet, 1995; Filiztekin, 2018; Tansel and Güngör, 1998; Karaca, 2004) on Türkiye mostly focus on income convergence and income inequality at the regional level. Their majority determine the finding of convergence, while cases of divergence are also detected. The results might depend on the periods in which the study is conducted and the different methodologies used. This extensive literature review, however, reveals that there is no convergence study on trade variables for Türkiye.

Following Kremer et al. (2022), we employ the income convergence model framed by Barro and Sala-i-Martin (2004) in the economic growth literature. This model assumes that the growth in real per capita exports depends on the value of the previous period. We use a panel data set with fixed effects to measure absolute and conditional convergence dynamics. Then, our main model is extended by adding total imports and their subcomponents (i.e. intermediate, capital, and consumer goods) as control variables to explain the contribution of imports to export growth convergence on a provincial basis. In the final stage, the most appropriate panel specification is selected among SAC (Spatial Autocorrelation Model), SAR (Spatial Lag Model), SEM (Spatial Error Model), and SDM (Spatial Durbin Model) in order to estimate the spatial dependence of export convergence among provinces.

After adjusting the equation proposed by Barro and Sala-i-Martin (2004), we use the following model to examine the existence of export convergence on the basis of provincial heterogeneity:

$$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] = \partial + \beta \ln \exp_{i(t-1)} + \mu_i + \eta_t + \upsilon_{it}. \tag{1}$$

The model suggests that provincial export growth depends on the value of the previous period. In the equation, exp stands for real per capita export value, υ_{it} is the error term varying according to provinces and time periods with a mean of zero, and μ_i and η_t represent unit and time fixed effects, respectively. The equation aims to capture convergence dynamics around the steady state. Consistent with recent studies, a panel data set with fixed effects is appropriate to capture the dynamics occurring at successive time intervals. The model allows us to obtain the estimate results for absolute and conditional convergence, which shows whether real exports per capita converge across provinces.

To examine the impact of imports on the convergence in export growth, we first extend the main equation (1) to include the total import variable:

$$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] = \partial + \beta \ln \exp_{i(t-1)} + \delta \ln \mathrm{imp}_{i(t-1)} + \mu_i + \eta_t + \upsilon_{it}. \tag{2}$$

Afterwards, the sub-categories (intermediate, capital, consumer goods[1]) of imports are included in the main equation (1):

$$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] = \partial + \beta \ln \exp_{i(t-1)} + \delta_1 \ln \mathrm{int}_{i(t-1)} + \delta_2 \ln \mathrm{cap}_{i(t-1)} + \delta_3 \ln \mathrm{con}_{i(t-1)} + \mu_i + \eta_t + \upsilon_{it}. \tag{3}$$

The models include the lagged values of the variables to eliminate the endogeneity problem. In the equations, imp stands for total per capita imports; int for per capita imports of intermediate goods; cap for per capita imports of capital goods; con for per capita imports of consumer goods. After finding estimated β values, the convergence rate (λ) can be calculated as follows (K is the lag-length):

$$\lambda = -\ln(1+\beta), \tag{4}$$

where

$$\beta = -\left(1 - e^{-\lambda K}\right) \quad \text{and} \quad K = 1. \tag{5}$$

The next step is to examine the presence of convergence in exports between provinces, if any, along with spatial dependence. Therefore, the most appropriate spatial model should be selected by estimating the SAC, SAR, SEM and SDM panel specifications. In the model selection, we apply the methods used by LeSage and Pace (2009) and Elhorst (2010), by starting with the general specification SDM and subsequently testing other models. SDM and dynamic SDM models are given below respectively:

$$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] = \partial + \beta \ln \exp_{i(t-1)} + \rho \sum_{j=1}^{N} \omega_{ij} \ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] + \delta_i \ln X_{i(t-1)} + \theta \sum_{j=1}^{N} \omega_{ij} \ln \exp_{i(t-1)} + \phi_i \sum_{j=1}^{N} \omega_{ij} \ln X_{i(t-1)} + \mu_i + \eta_t + \upsilon_{it}, \tag{6}$$

$$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] = \partial + \psi \ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] + \beta \ln \exp_{i(t-1)} + \rho \sum_{j=1}^{N} \omega_{ij} \ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right] + \delta_i \ln X_{i(t-1)} + \theta \sum_{j=1}^{N} \omega_{ij} \ln \exp_{i(t-1)} + \phi_i \sum_{j=1}^{N} \omega_{ij} \ln X_{i(t-1)} + \mu_i + \eta_t + \upsilon_{it}. \tag{7}$$

[1] The classification is according to the System of National Accounts (2008 SNA).

The symbol X expresses the control variable (total imports and their subcomponents of intermediate, capital, and consumer goods) that changes over time in the models. For the estimation of the models, we construct the weighted matrix of 81×81 based on the number of provinces, and then use the standardized matrix. In the matrix, neighboring provinces and non-neighboring provinces take the value 1 or 0, respectively.

The model selection is conducted according to the following restrictions: we choose the SAR model if $\theta = 0$, $\phi = 0$ and $\rho \neq 0$ whereas the SEM model if $\theta = \phi = -\beta\rho$. If both hypotheses are rejected, then we select the SDM model. If the first hypothesis cannot be rejected, the SAR model should be preferred, provided that the robust LM tests also point to the SAR model. Similarly, if the second hypothesis cannot be rejected, the SEM model best describes the data, provided that it is also indicated by the robust LM tests. If both hypotheses are rejected, the most appropriate model can be decided using an information criterion, since the SAC and SDM models are not nested.

3 DATA

The existence of convergence in exports for 81 provinces in Türkiye is tested by panel data analysis using spatial models for the period 2004–2021. Each lagged value included in our convergence model (Equation 1) obviously results in the loss of one observation (i.e. 2004) in the estimation sample. Therefore, the statistical analysis is made for 81 provinces and 17 years, which consists of 1,377 observations. All variables are in real per capita values. We obtain the export and import data from the "Foreign Trade Database" in dollars and the population data from the "Address Based Population Registration System (ADNKS)" published on a provincial basis by the Turkish Institute of Statistics (TurkStat). Nominal trade values are adjusted to real values by choosing 2010 as the base year. Since the data are in dollars, the U.S. consumer price index from the World Bank database is used for the conversion. The real values are divided by the population of each province to calculate real per capita exports and imports.

After taking the natural logarithms of the trade values, we create a short and balanced panel data set for the study. Tab. 1 presents descriptive statistics of the variables in the panel data, which consist of 1,377 observations for the period 2004–2021. According to the statistics, the variability in imports is slightly higher than that in exports whereas imports of intermediate goods have the highest variability.

3.1 Export Growth

As a result of the export-led growth model since the early 1980s, Türkiye's exports have grown faster than the national income so that the share of exports in the GDP has risen steadily. Between 1980 and 2021, Türkiye

Tab. 1: Descriptive Statistics

Variable	Observation	Mean	Std Error	Min	Max
$\ln \exp_{i(t-1)}$	1,377	5.3219	1.7922	0	8.9186
$\ln \text{imp}_{i(t-1)}$	1,377	5.0038	1.8496	0	9.1620
$\ln \text{int}_{i(t-1)}$	1,377	4.5755	2.0678	0	9.7766
$\ln \text{cap}_{i(t-1)}$	1,377	3.0774	1.6159	0	7.5156
$\ln \text{con}_{i(t-1)}$	1,377	2.2295	1.6005	0	7.4143
$\ln \left[\dfrac{\exp_{it}}{\exp_{i(t-1)}}\right]$	1,377	0.0818	0.4873	−4.5199	5.4178

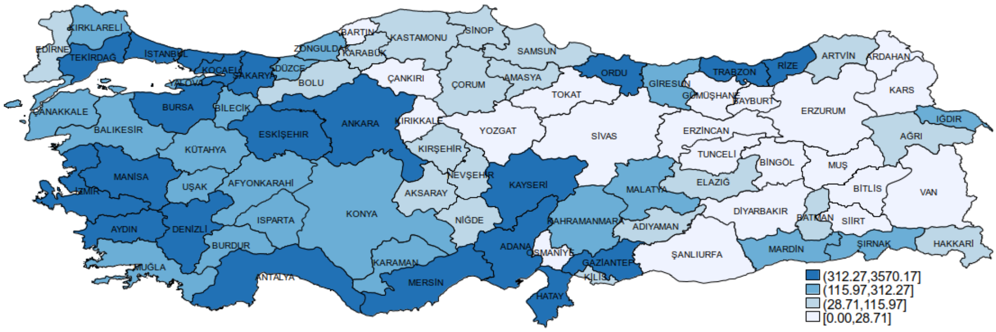

Fig. 1: Real Per Capita Exports (2004)

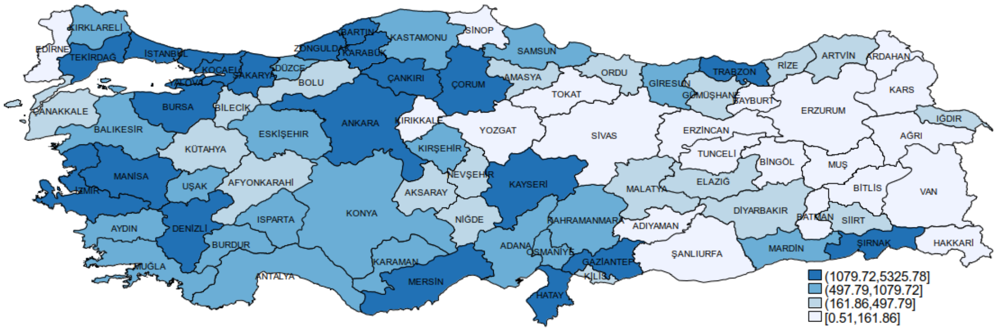

Fig. 2: Real Per Capita Exports (2021)

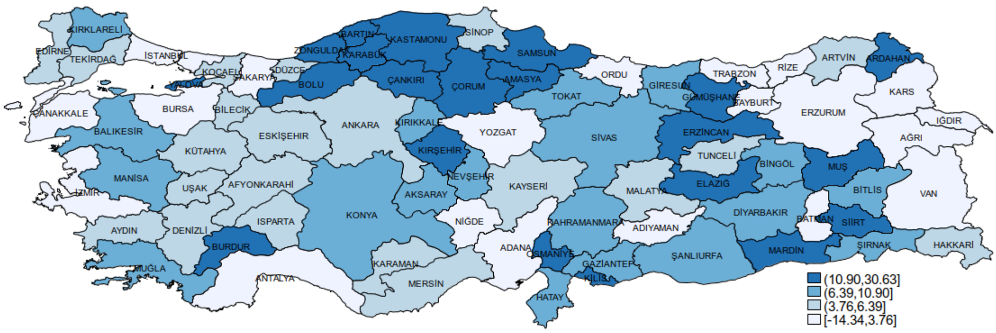

Fig. 3: Growth of Real Per Capita Exports (Average %, 2004–2021)

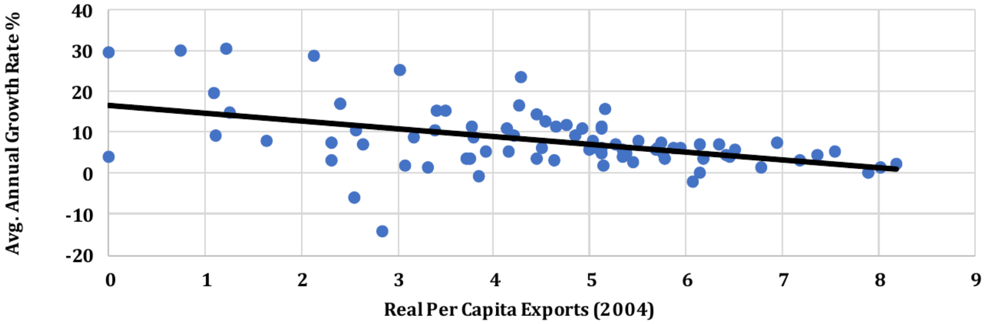

Fig. 4: Dispersion Diagram of Exports

almost doubled its real per capita income from 4,130 to 7,719 dollars whereas its real per capita exports skyrocketed from 175 to 2,030 dollars. Based on the data in our sample from 2004 to 2021, the real per capita exports yearly grew by an average of 3.8%, increasing from 1,072 to 2,030 dollars.

The growing trend, however, varies across the provinces during the same period. For instance, the number of provinces with real per capita exports above 1.000 dollars increased from 7 to 24. The number also grew from 16 to 31 for the provinces having real per capita exports between 250–1000 dollars. On the contrary, the number decreased from 58 to 26 for those with real per capita exports below 250 dollars. The real per capita exports of only 4 provinces (Ordu, Bayburt, Kars, and Ağrı) in northern and eastern parts of the country shrunk by between 6.6 and 130.2 dollars.

Fig. 1 and Fig. 2 are given to show how real exports per capita changed during the sampling period by province. They illustrate the real per capita export values for the beginning year (2004) and the ending year (2021) of the sampling period, respectively. Despite the general upward trend, both maps reveal that the country is divided into two parts by per capita exports. The provinces with the highest real per capita exports are generally situated in western and middle parts of the country, such as Istanbul, Kocaeli, Çorum, Sakarya, Denizli, Bursa, Yalova, Izmir, Hatay, and Kayseri. The eastern part, however, has the provinces with the lowest exports, such as Tokat, Ardahan, Ağrı, Erzurum, Bitlis, Van, Bingöl, Kars, Tunceli, and Bayburt. On the other hand, this figure developed faster in central northern and eastern provinces of the country than those western and central southern (Fig. 3). In other words, there is a general tendency for the per capita exports to increase faster in provinces with low export levels than in provinces with high export levels.

Fig. 4 shows the average annual growth rate of exports as a function of per capita export incomes over the period 2004–2021. In other words, the figure exhibits the average annual growth rate relative to real exports per capita in the initial year (i.e. 2004), since the starting level of income is important in the convergence process of the growth model. The figure actually confirms the above results: the growth rate decreases as the level of per capita real exports increases. For example, the average growth rate in provinces with lower exports reached 30% in 2004, growing about fourfold faster than in provinces with higher exports. These developments provide visible evidence of convergence in real per capita exports across the country.

3.2 Import Growth Relative to Exports

In the relevant period, per capita imports increased overall by 2.8% which is slightly slower than exports, though it expanded from 1,477 to 2,477 dollars, exceeding per capita exports (Fig. 5 and Fig. 6). Compared to exports, there are more provinces experiencing a decrease in their real per capita imports. However, the amount of decrease was 346.2 dollars for Bursa and 239.3 dollars for Artvin, while below 100 dollars for other provinces mostly in eastern and northern regions (Erzincan, Isparta, Ordu, Trabzon, Giresun, Bartın, Şırnak, Tokat, Kars, Bayburt, and Ardahan). The number of provinces having real per capita imports over 500 dollars increased from 13 to 26 while from 22 to 29 for the provinces with per capita imports between 100 and 500 dollars. On the contrary, the number of provinces with less than 100 dollars per capita imports decreased from 46 to 26. It is safe to say that the transition of provinces from lower groups of real imports per capita to upper groups is slower compared to real exports per capita.

The real per capita imports have been lowered in eastern regions since 2004. Moreover, the provinces in middle and western parts of the country such as Istanbul, Kocaeli, Karabük, Yalova, Hatay, Zonguldak, Sakarya, Bursa, Ankara, and Denizli continue to have the highest per capita imports. Located in the middle and eastern regions, Şırnak, Tokat, Tunceli, Erzincan, Gümüşhane, Bitlis, Kars, Bingöl, Bayburt, and Ardahan are among the provinces with the lowest imports. These re-

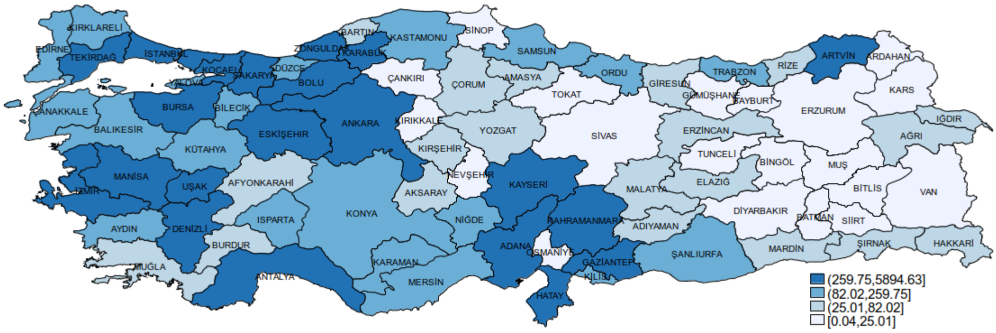

Fig. 5: Real Per Capita Imports (2004)

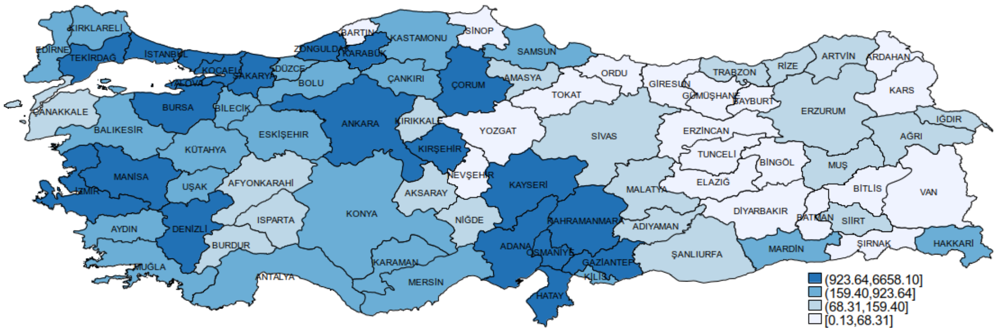

Fig. 6: Real Per Capita Imports (2021)

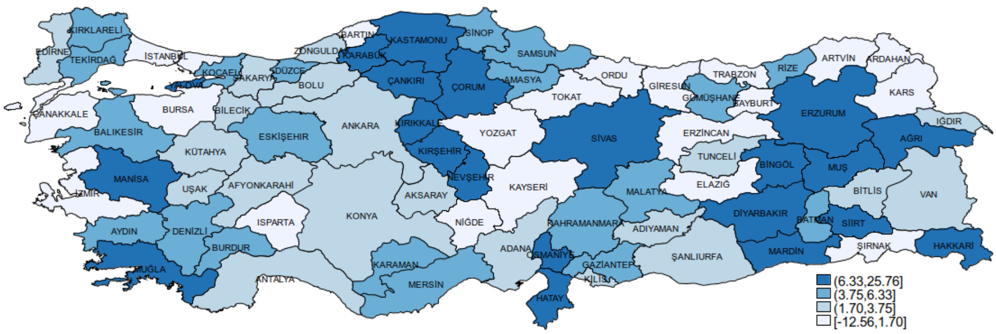

Fig. 7: Growth of Real Per Capita Imports (Average %, 2004–2021)

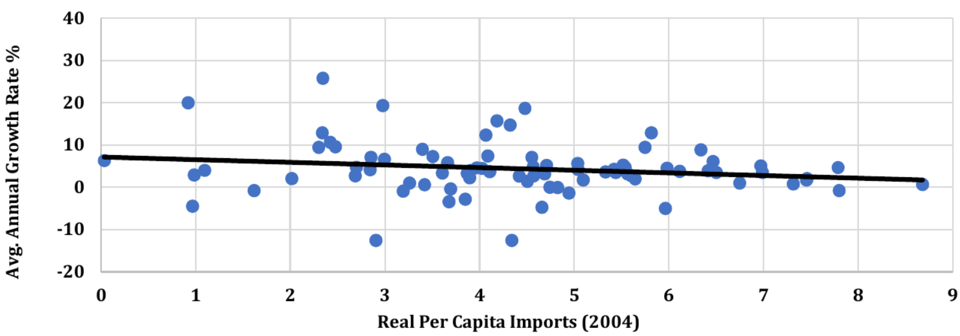

Fig. 8: Dispersion Diagram of Imports

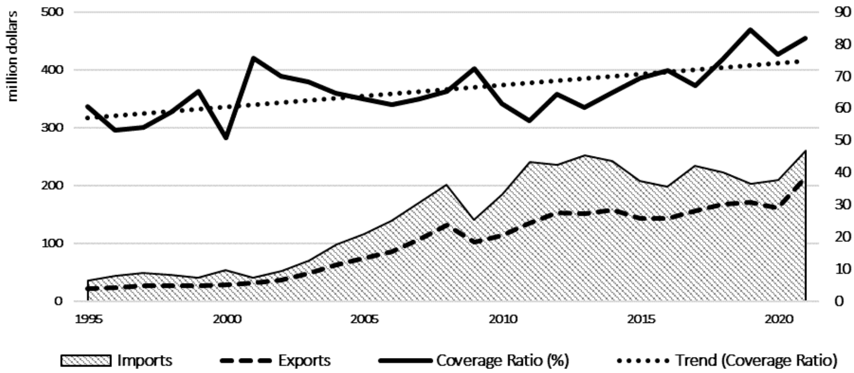

Fig. 9: Export and Import Coverage Ratio (%)

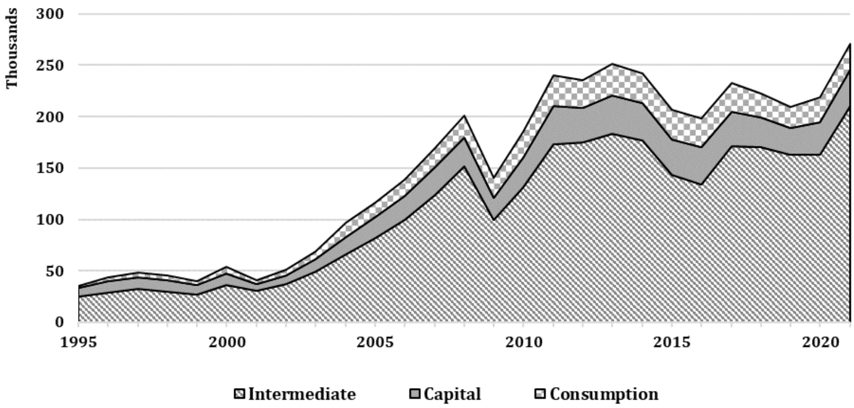

Fig. 10: Import Growth by Sub-Categories (1995–2021)

gions, however, experienced the fastest growth in per capita imports, such as Osmaniye, Muş, Bingöl, Çankırı, Çorum, Kırşehir, Erzurum, Karabük, Mardin, Kırıkkale, Siirt, Diyarbakır, Manisa, and Hakkari (Fig. 7). Fig. 8 confirms this progress by illustrating the existence of a negative relationship between the level of imports per capita and the average annual growth rate in per capita imports from 2004 to 2021. Nevertheless, the negative relationship is not as strong as in exports. All the evidence so far demonstrates a general tendency of convergence in the per capita imports.

Türkiye's exports and imports have moved together over the years, even though the ratio of exports to imports has improved since 1995 as a result of the faster growth of exports than imports (Fig. 9). We should therefore expect that the trade deficit will be closed in the future. This finding forms the source for the dependence of exports on imports, which is the second subject of our study. In the following sections, we also explore the existence of such dependence on a provincial basis.

Türkiye is administratively divided into provinces. However, there has been a rapid increase in the number of provinces over the years, which gradually reached 81 today after 2000s. Therefore, the study which is based on 81 provinces is able to use various data sets only for the period 2004–2021 due to their availability.

Despite the general trends in imports, the changes in the sub-categories of imports by the System of National Accounts (SNA 2008) have shown different characteristics. For example, per capita imports of intermediate goods rose

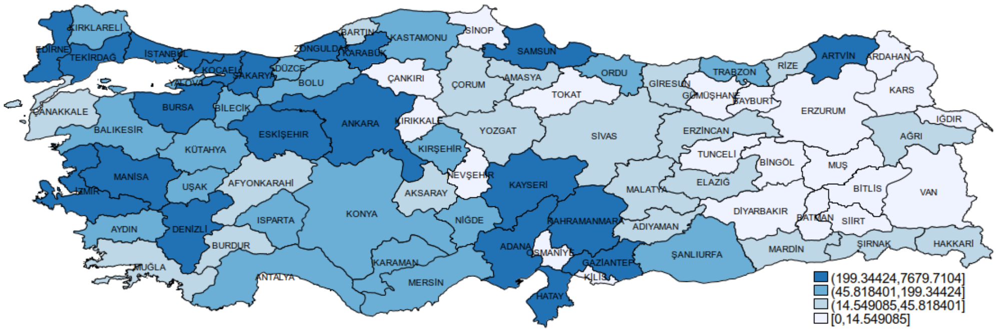

Fig. 11: Real Per Capita Imports (Intermediate Goods, 2004)

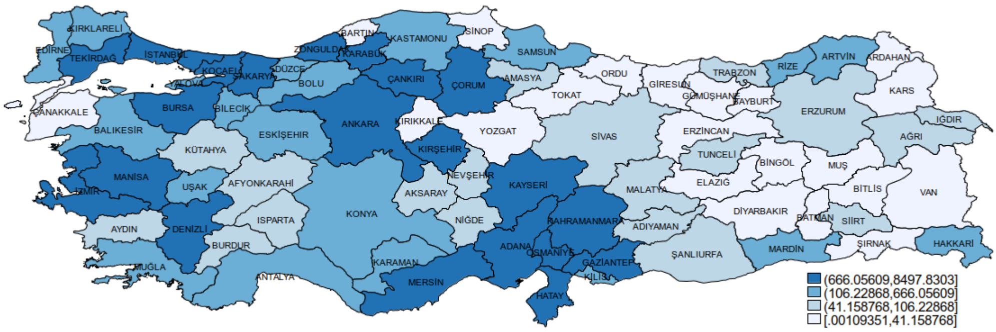

Fig. 12: Real Per Capita Imports (Intermediate Goods, 2021)

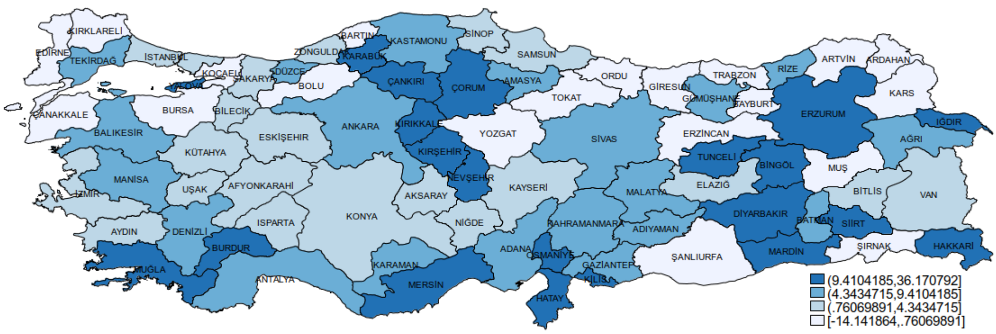

Fig. 13: Growth of Real Per Capita Imports (Average %, Intermediate Goods, 2004–2021)

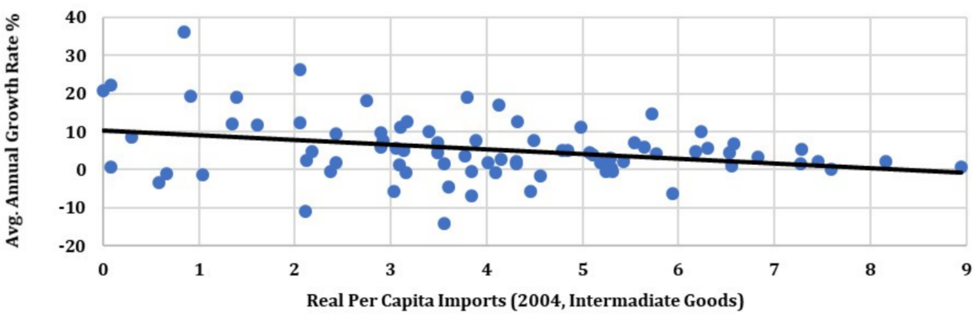

Fig. 14: Dispersion Diagram of Imports (Intermediate Goods)

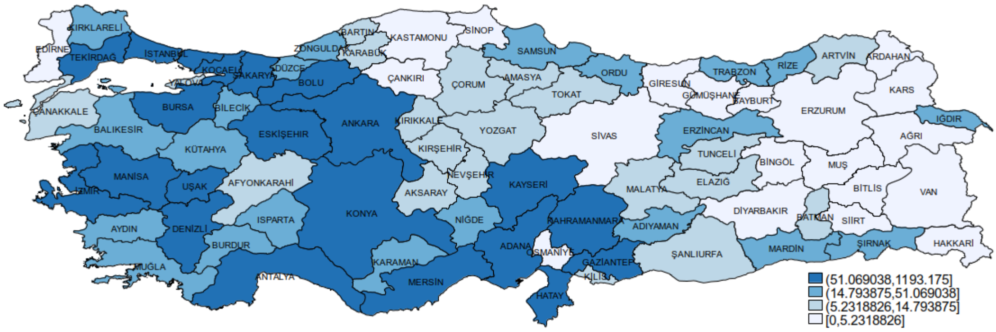

Fig. 15: Real Per Capita Imports (Capital Goods, 2004)

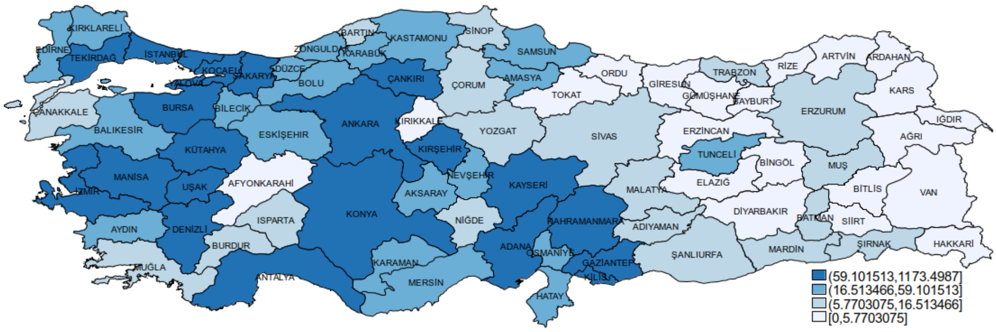

Fig. 16: Real Per Capita Imports (Capital Goods, 2021)

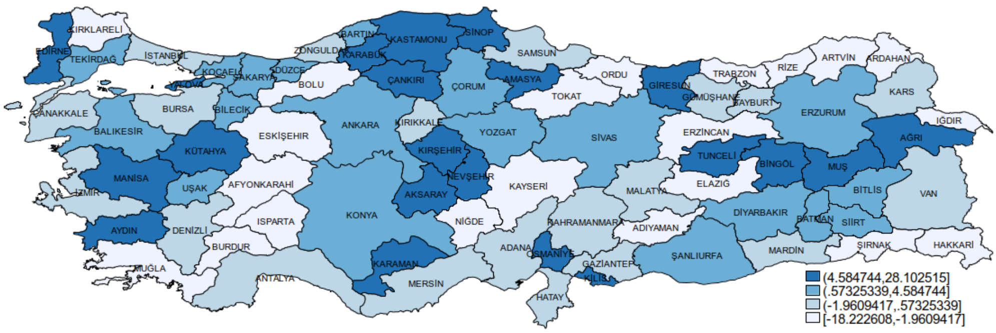

Fig. 17: Growth of Real Per Capita Imports (Average %, Capital Goods, 2004–2021)

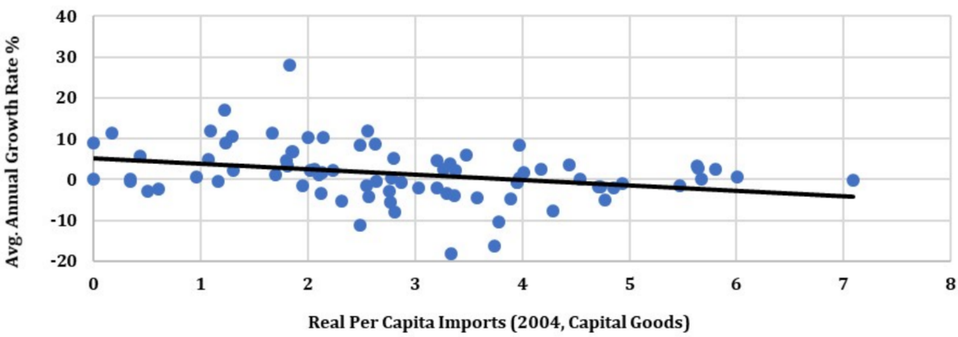

Fig. 18: Dispersion Diagram of Imports (Capital Goods)

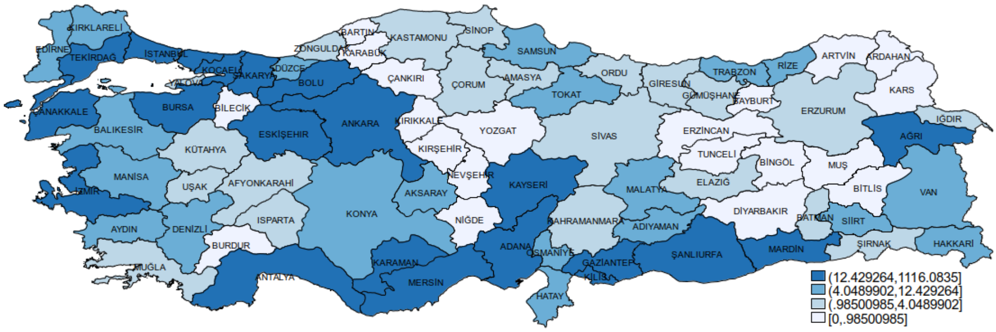

Fig. 19: Real Per Capita Imports (Consumer Goods, 2004)

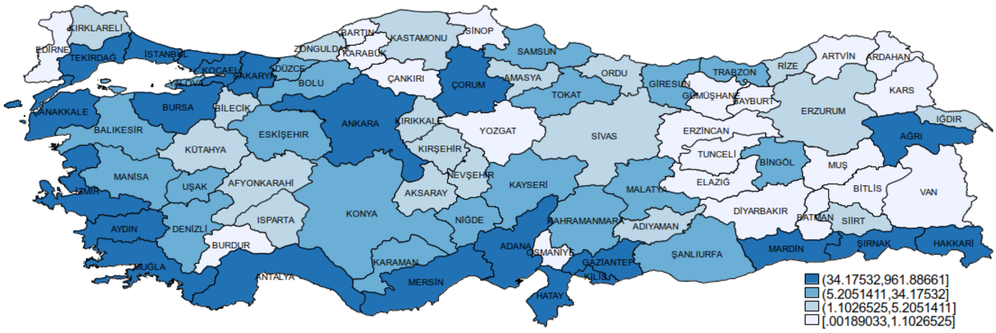

Fig. 20: Real Per Capita Imports (Consumer Goods, 2021)

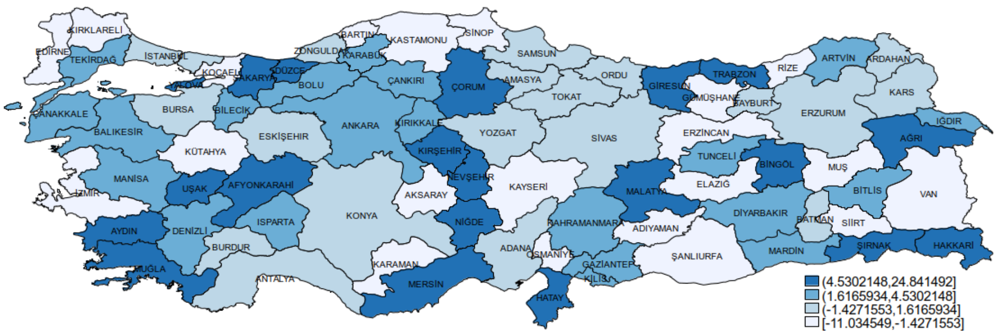

Fig. 21: Growth of Real Per Capita Imports (Average %, Consumer Goods, 2004–2021)

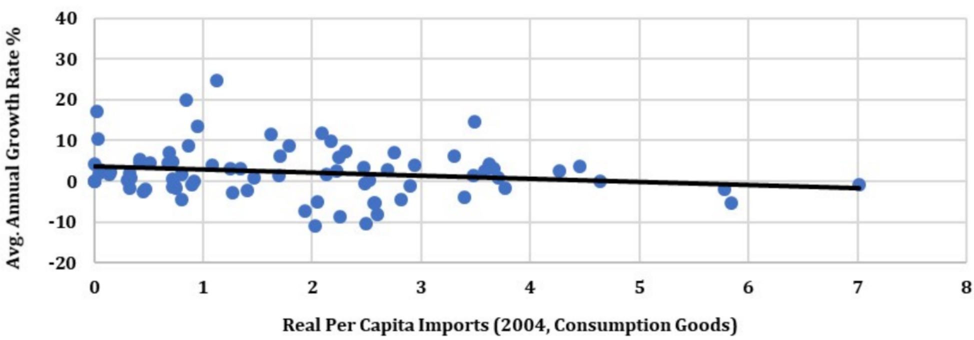

Fig. 22: Dispersion Diagram of Imports (Consumer Goods)

the fastest (3.4%), while the growth rate was slower (0.9%) for capital goods and almost none for consumer goods. By provinces, the per capita imports ranged between 1,115 and 1,997 dollars for intermediate goods, whereas they remained stable between 295 and 342 dollars for capital goods and the same (237 dollars) for consumer goods. For that reason, the share of intermediate goods in total imports has gradually increased from 70.3% in 1995 to 77.7% in 2021 (Fig. 10). The share also rose from 6.9% to 9.2% for consumer goods, while declining from 22.8% to 13.3% for capital goods in the relevant period. Fig. 10 also approves the direct relationship between Türkiye's exports and imported intermediate goods.

The per capita imports by the SNA subcategories are not similar across provinces. In general, per capita imports of intermediate goods have remained higher in western and central regions such as Kocaeli, Istanbul, Bursa, Zonguldak, Ankara, Sakarya, Izmir, Kayseri and Tekirdağ (Fig. 11 and Fig. 12). Located mostly in the eastern part of the country, Artvin, Ordu, Bartın, Erzincan, Trabzon, Giresun, Bolu, Edirne, Yozgat, Şanlıurfa, Bayburt, Çanakkale, Şırnak, Ardahan, Tokat, Kars and Muş have the lowest real per capita imports of intermediate goods. At the same time, they experienced the fastest growth in their per capita imports between 2004 and 2021 (Fig. 13). Fig. 14 reveals the correlation that the average annual growth rate by provinces slows down as real per capita imports of intermediate goods increase.

The provinces with the highest per capita imports of capital goods are usually concentrated in western and central parts of the country (Fig. 15 and Fig. 16). However, we can't easily say that the provinces with the lowest per capita imports for this sub-category have the most rapid growth in the relevant period (Fig. 17). Although Fig. 18 illustrates a negative relationship between real per capita imports of capital goods and the average annual growth by provinces, this association is not as strong as for intermediate goods imports.

The trends in imports of consumer goods differ from both intermediate and capital goods. First of all, real per capita imports of consumer goods increased not only in western and central parts of the country, but also in the southeastern region (Fig. 19 and Fig. 20). The provinces with the highest or lowest increase in per capita imports of consumption goods are not concentrated in certain regions. Fig. 21 shows, for example, that there are provinces with the fastest growth in per capita imports in every region of the country. Moreover, the negative relationship between real per capita imports of consumer goods and the average annual growth rate is not as clear as for intermediate and capital goods (Fig. 22).

3.3 Exploratory Spatial Data Analysis

The Global Moran's I values, calculated to measure the spatial correlation of the variables in the model, are shown in Tab. 2. The Moran's I values for all years are positive and statistically significant at the 1% level. In the period 2004–2021, the correlation value for exports varies between 0.27–0.47, though it increases from 0.36 to 0.38. For imports, the value ranges between 0.43–0.57, rising from 0.43 to 0.49. The results reveal that the spatial correlation is higher for imports than for exports. The correlation coefficient for intermediate goods changes between 0.42 and 0.55 while increasing from 0.42 to 0.44 in the relevant period. However, it is estimated between 0.36 and 0.57 for capital goods, which increased significantly from 0.38 in 2004 to 0.57 in 2021. On the contrary, the estimated value for consumer goods declined from 0.33 to 0.27. This is the lowest value of the correlation coefficient, varying between 0.22 and 0.33.

However, the yearly growth in correlation coefficients is completely different than the values of exports and imports. For instance, the spatial correlation is statistically significant only in 2005, 2007, 2008, 2010, and 2017. Moreover, the correlation coefficients are generally not high or mostly negative and statistically significant. In conclusion, we find spatial dependence on the level values of exports and imports, whereas no such sound evidence is found for the growth rate of exports. Gezici and Hewings (2007) find similar results for the income variable according to their spatial exploratory analysis for Türkiye.

Tab. 2: Global Moran's I Values by Variables

Year	$\ln \mathbf{exp}_{i(t-1)}$	$\ln \mathbf{imp}_{i(t-1)}$	$\ln \mathbf{int}_{i(t-1)}$	$\ln \mathbf{cap}_{i(t-1)}$	$\ln \mathbf{con}_{i(t-1)}$	$\ln \left[\frac{\mathbf{exp}_{it}}{\mathbf{exp}_{i(t-1)}}\right]$
2004	0.363 (0.000)	0.432 (0.000)	0.425 (0.000)	0.383 (0.000)	0.333 (0.000)	
2005	0.297 (0.000)	0.446 (0.000)	0.426 (0.000)	0.425 (0.000)	0.313 (0.000)	0.175 (0.004)
2006	0.309 (0.000)	0.449 (0.000)	0.419 (0.000)	0.499 (0.000)	0.305 (0.000)	0.036 (0.233)
2007	0.268 (0.000)	0.467 (0.000)	0.445 (0.000)	0.447 (0.000)	0.257 (0.000)	−0.204 (0.001)
2008	0.318 (0.000)	0.472 (0.000)	0.478 (0.000)	0.403 (0.000)	0.250 (0.000)	−0.115 (0.050)
2009	0.287 (0.000)	0.439 (0.000)	0.490 (0.000)	0.364 (0.000)	0.305 (0.000)	0.064 (0.127)
2010	0.335 (0.000)	0.510 (0.000)	0.512 (0.000)	0.393 (0.000)	0.296 (0.000)	−0.128 (0.046)
2011	0.364 (0.000)	0.473 (0.000)	0.525 (0.000)	0.338 (0.000)	0.312 (0.000)	0.017 (0.330)
2012	0.335 (0.000)	0.444 (0.000)	0.459 (0.000)	0.355 (0.000)	0.159 (0.000)	−0.030 (0.393)
2013	0.336 (0.000)	0.509 (0.000)	0.487 (0.000)	0.397 (0.000)	0.262 (0.000)	0.042 (0.218)
2014	0.353 (0.000)	0.501 (0.000)	0.481 (0.000)	0.510 (0.000)	0.282 (0.000)	0.011 (0.368)
2015	0.380 (0.000)	0.568 (0.000)	0.552 (0.000)	0.541 (0.000)	0.265 (0.000)	−0.026 (0.423)
2016	0.407 (0.000)	0.526 (0.000)	0.512 (0.000)	0.487 (0.000)	0.257 (0.000)	−0.043 (0.318)
2017	0.413 (0.000)	0.477 (0.000)	0.476 (0.000)	0.440 (0.000)	0.270 (0.000)	−0.015 (0.010)
2018	0.467 (0.000)	0.529 (0.000)	0.520 (0.000)	0.488 (0.000)	0.231 (0.000)	0.066 (0.117)
2019	0.43 (0.000)	0.498 (0.000)	0.438 (0.000)	0.465 (0.000)	0.223 (0.000)	−0.068 (0.213)
2020	0.367 (0.000)	0.499 (0.000)	0.460 (0.000)	0.509 (0.000)	0.257 (0.000)	0.018 (0.319)
2021	0.379 (0.000)	0.486 (0.000)	0.441 (0.000)	0.572 (0.000)	0.266 (0.000)	−0.042 (0.297)

Note: The numbers in parentheses are p-values.

4 RESULTS

We initially carry out sigma convergence analysis in order to see whether real per capita exports converge within the sampling period and on the basis of provinces. For this purpose, their coefficients of variation for the period 2004–2021 are calculated. Secondly, beta convergence analysis, which considers the period as a whole, is done by starting with standard panel models and then moving to spatial models.

4.1 Sigma Convergence

Sigma convergence explains intra-period trends more clearly in the distribution of export incomes. Fig. 23 shows the values of sigma convergence for exports in the relevant period. The coefficient of variation decreases from 0.41 in 2004 to 0.29 in 2021, which implies that the differences in per capita exports by provinces have

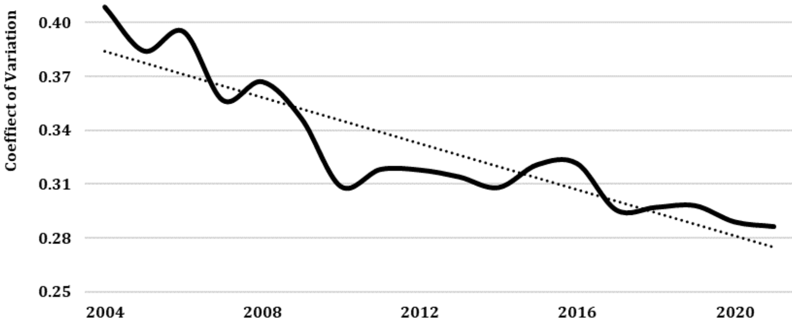

Fig. 23: Sigma Convergence

gradually declined over the period 2004–2021. The estimated values of the coefficient indicate that the gaps between export incomes at provincial level are closing as predicted by the regional economic approach based on the neoclassical growth model. In other words, it means a harmonization of regional economic output, or in our case, the export incomes at the provincial level in Türkiye.

According to Fig. 23, the trend of sigma convergence can be divided into two periods. The rapid convergence experienced between 2004 and 2010 has decelerated after 2010. This change in the convergence rate is generally attributed to the global financial crisis of 2009. In other words, provinces that are vulnerable to foreign markets due to their high export volume are expected to be more affected by the global crisis. Therefore, the growth rate of per capita exports by provinces with high export levels is likely to slow down due to such a crisis.

4.2 Beta Convergence

We estimate four different models for beta convergence and present their results in Tab. 3. The estimated beta coefficient from Model 1 in the first column of the Tab. 3 with only time effect represents absolute convergence. On the other hand, the betas calculated from three other models, which include time and unit fixed effects together, specify conditional convergence. Total imports and their subcategories are included in Model 3 and Model 4, respectively. F tests for time $(\sum \eta_t = 0)$ and unit $(\sum \mu_t = 0)$ fixed effects in all models give significant results at the 1% level.

According to the results from Model 1, we can conclude that per capita exports between provinces converge in absolute terms at a rate of 4% per year. At this rate of convergence, it would take about 33 years for the provinces to reach the same level of exports, which is two times the half-life period (i.e. 16.52).

The results in the second column of the table are obtained by including the unit fixed effects in Equation 1. In the model without any control variable, the convergence rate of per capita exports increases to 38%. It means that provinces are approaching their steady-state export levels at this average yearly rate. The panel data model in column 2 accounts for differences between provinces, after controlling the fixed effect term. Therefore, the estimation results provide enhanced evidence of conditional beta convergence. In consistent with recent studies, the results show that we should focus on conditional rather than absolute convergence when unit effects are included in the model. Moreover, convergence rates rise significantly after adding unit fixed effects to the model. As a result, provinces are expected to reach a steady state in 3.66 years, which is much shorter than absolute convergence.

After including the import variable in the model as shown in column 3 of Tab. 3, the convergence rate of exports increases to 41% and, on average, provinces are expected to reach their potential export levels in 3.4 years. However, if imports increase by 10%, provincial

Tab. 3: Models for Absolute and Conditional Beta Convergence

Explanatory Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Constant	0.4034* (0.0614)	1.6349* (0.1069)	1.6884* (0.1981)	1.6278* (0.2045)
$\ln \exp_{i(t-1)}$	−0.0411* (0.0072)	−0.3149* (0.0210)	−0.3359* (0.0225)	−0.3426* (0.0223)
$\ln \text{imp}_{i(t-1)}$			0.0630* (0.0241)	
$\ln \text{int}_{i(t-1)}$				0.0603* (0.0222)
$\ln \text{cap}_{i(t-1)}$				0.0409** (0.0180)
$\ln \text{con}_{i(t-1)}$				−0.0146 (0.0220)
Convergence Rate	4%	38%	41%	42%
Half-life Period	16.52	1.83	1.69	1.65
$\bar{R}^2$	0.072	0.162	0.166	0.171
Log-likelihood	−903.81	−791.17	−787.49	−782.59
AIC	1,843.63	1,778.35	1,773.00	1,767.19
BIC	1,937.72	2,290.66	2,290.53	2,295.19
Time FE	Yes	Yes	Yes	Yes
Unit FE	No	Yes	No	No
Test $\sum \eta_t = 0$	5.02 (0.000)	5.47 (0.000)	5.40 (0.000)	5.56 (0.000)
Test $\sum \mu_t = 0$		2.84 (0.000)	2.50 (0.000)	2.51 (0.000)
Moran I	−0.0508 (0.0047)	−0.0527 (0.0034)	−0.0527 (0.0034)	−0.0507 (0.0049)
LM_ρ	7.8184 (0.0052)	7.4563 (0.0063)	7.4563 (0.0063)	6.8636 (0.0088)
LM_ρ (robust)	262.4668 (0.0000)	1.5516 (0.2129)	1.5516 (0.2129)	1.5644 (0.2110)
LM_λ	11.1493 (0.0008)	10.0046 (0.0016)	10.0046 (0.0016)	9.6034 (0.0019)
LM_λ (robust)	265.7977 (0.0000)	4.0998 (0.0429)	4.0998 (0.0429)	4.3041 (0.0380)
$\text{LM}\rho\lambda$	273.6161 (0.0000)	11.5561 (0.0031)	11.5561 (0.0031)	11.1677 (0.0038)

Note: It is statistically significant at the * 1%, ** 5% and *** 10% level. Values in parentheses below coefficient estimates represent robust standard errors. Values in parentheses represent probabilities in F-test and spatial autocorrelation tests.

export growth increases by 0.63%. Then, we replace total imports with their sub-categories in the model as presented in column 4 of the table. This replacement enlarges the convergence rate of exports slightly to 42%. However, the estimated coefficients for both imports of intermediate and capital goods are statistically significant, whereas it is not for imports of consumer goods. According to the estimated values, the export growth of the province increases by 0.6% and 0.4% respectively, when the imports of intermediate and capital goods increase by 10%. Moreover, the expected time period of reaching their potential export levels almost remain the same (i.e. 3.3 years).

Tab. 4: Estimation of Spatial Models for Imports

Model	SEM	SAR	SAC	SDM	DSAR	DSDM
$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right]$					0.0513***	0.0575**
					(0.0282)	(0.0283)
$\ln \exp_{i(t-1)}$	−0.3301*	−0.3331*	−0.3330*	−0.3362*	−0.3362*	−0.3723*
	(0.0215)	(0.0215)	(0.0215)	(0.0216)	(0.0282)	(0.0254)
$\ln \text{imp}_{i(t-1)}$	0.0583*	0.0620*	0.0629*	0.0703*	0.0602**	0.0716*
	(0.0228)	(0.0230)	(0.0231)	(0.0236)	(0.0245)	(0.0251)
ρ		−0.1464*	−0.1989**	−0.1284*	−0.1623*	0.1391*
		(0.0412)	(0.0819)	(0.0430)	(0.0426)	(0.0446)
λ	−0.1285*		0.0128			
	(0.0432)		(0.0171)			
$\omega \ln \exp_{i(t-1)}$				0.0774		0.0999***
				(0.0491)		(0.0491)
$\omega \ln \text{imp}_{i(t-1)}$				−0.0712		−0.0856***
				(0.0492)		(0.0518)
Convergence Rate	40%	41%	40%	41%	41%	47%
Half-life Period	1.73	1.71	1.71	1.69	1.69	1.49
Log-likelihood	−783.05	−781.18	−780.93	−779.43	−747.22	−745.21
AIC	1,574.11	1,570.37	1,571.86	1,570.86	1,504.45	1,504.43
BIC	1,595.02	1,591.29	1,598.00	1,602.22	1,530.28	1,540.60

Note: It is statistically significant at the * 1%, ** 5% and *** 10% level. Values in parentheses below coefficient estimates represent robust standard errors.

The estimation results in the table show that total imports and its two sub-categories (intermediate and capital goods) have positive effects on export convergence and growth. The variables not only accelerate inter-provincial export convergence, but also contribute to export growth by provinces. Conversely, no such relationship is found for imports of consumer goods. In conclusion, the results suggest that there is no overall dependence of exports on imports. Instead, the relationship between exports and imports depends on the category of import. The model selection criteria in the Table, namely the Adjusted R-squared ($\bar{R}^2$), the log-likelihood value, the Akaike Information Criteria (AIC) and the Bayesian Information Criteria (BIC), suggest that control variables as well as time and unit fixed effects generally contribute positively to the model. Tab. 3 also provides results whether spatial models are needed to test our hypotheses. The calculated Moran I and LM test values at the bottom of Tab. 3 enable us to examine the presence of spatial autocorrelation for all alternative models. The reported values indicate the presence of spatial errors and spatial lags in the models. Therefore, the next step will be the estimation of spatial models (i.e. SEM, SAR, SAC, SDM, DSDM, and DSAR). However, we follow the method used by LeSage and Pace (2009) and Elhorst (2010) in the next sections to select the spatially appropriate model.

For the estimation of efficient and unbiased coefficients in the estimation of export convergence, previously determined spatial effects should be included in the analysis (Anselin, 1988). We apply the Stata command “xsmle” which fits fixed and random-effects spatial models for our balanced panel data (Belotti et al., 2017). In this regard, we select the appropriate model after estimating statically and dynamically spatial models of SAR, SEM, SAC and SDM. The spatial models contain unit and time fixed effects, including the control variables (total imports as well as imports of intermediate, capital, and consumer goods) that change over time. Direct and indirect effects are calculated for all models and presented separately for comparison.

Tab. 5: Spatial Model Selection

	Imports		**Sub-Groups of Imports**	
	χ^2	p-**value**	χ^2	p-value
SEM-SDM	7.28	0.0263	6.08	0.1930
SAR-SDM	3.51	0.1731	2.64	0.6192
SAR-DSAR	3.31	0.0690	4.46	0.0346
SDM-DSDM	4.12	0.0423	4.94	0.0262
DSAR-DSDM	4.93	0.0849	3.79	0.4354
SEM-DSDM	6.23	0.1011	6.46	0.2639

Tab. 4 provides results for the model which includes the total imports as a control variable. The parameters ρ, λ, and ω in the table indicate the spatial interaction depending on our models. Among the models, all coefficients of SEM and SAR static models are statistically significant, like the DSAR model. The comparison of all spatial models using the χ^2 test is presented in Tab. 5. It provides the chi-square results and their associated p-values separately for total imports and sub-categories of imports. As the model selection criteria based on the chi-square values favor the DSAR model in Tab. 5, we focus on the interpretations of the DSAR model. Compared with the non-spatial model, the convergence coefficient in the DSAR and SAR models does not change (i.e., 41%), while the convergence coefficient in the SEM model decreases to 40%. Since the ρ-coefficient in the DSAR model is negative and statistically significant, the per capita export growth of the province in question decreases by about 1.6% when the per capita export growth of neighboring provinces changes by 10%. This shows that the provinces decrease their exports at the expense of neighboring provinces. The previous period's export growth in the province in question has a positive effect on the current period. If the export growth of the previous period increased by 10%, the export growth of the current period increases by 0.5%.

The direct, indirect and total effects calculated from the DSAR model are statistically significant for all variables (Tab. 6). The differences between the direct effects and the estimation results obtained from the model are very small. Therefore, the feedback effect is not very important. Focusing on the direct effect in the short run, the export growth of the same province would increase by about 0.63% if the import of that province increases by 10%. In contrast, the short-run indirect effect is negative, but negligible (−0.01%). For the long-run effects, the above rates are almost similar to the short-run ones, 0.7% and −0.01%, respectively. Thus, if the imports of the province in question increase by 10%, the total effects in the short and long run increase by 0.57%, pointing at the same rate.

All coefficients in the static model SEM, which is closest to the DSAR option, are significant at the 1% level. According to the results of the model SEM, the estimated coefficients are quite close to the DSAR model and the convergence coefficient is 40%. Since the coefficient λ in the model is negative and significant, a 1% shock in neighboring provinces could reduce the export growth of that province by 0.13%. In the SEM model, the long-run direct effect of imports on exports is very similar to that in the DSAR model (i.e. 0.58%).

Tab. 7 shows the effects of imports of intermediate, capital, and consumer goods on export growth and convergence. Among these models, all coefficients of the static SEM and SAR models and the DSAR model are statistically significant, except for imports of consumer goods. However, the model selection criteria favor the DSAR model (Tab. 5). Compared to the non-spatial model, the convergence coefficient increased to 47% in the DSAR model and 41% in the SEM model. Since the coefficient ρ in the SAR model is negative and statistically significant, when the growth of per capita exports of neighboring provinces changes by 10%, the growth of per capita exports of the province in question decreases by about 1.6%. This leads to the same result from the model with total imports, whereas the export growth of neighboring provinces is negatively related to the export growth of neighboring provinces. However, the export growth of the previous period in the province in question has a positive effect on the current period. If the export growth of the previous period increased by 10%, the export growth of the current period increases by 0.6%.

Tab. 6: Short-Run and Long-Run Import Effects

Effects		**SAR**	**DSAR**	**SEM**	**SAC**	**SDM**	**DSDM**
Long-Run Period							
Direct	Exports	−0.3337*	−0.3898*	−0.3301*	−0.3350*	−0.3385*	−0.4013*
	Imports	0.0610*	0.0668*	0.0583*	0.0622*	0.0711*	0.0820*
Indirect	Exports	0.0424*	0.0586*		0.0546*	0.1141*	0.1479*
	Imports	−0.0077**	−0.0099**		−0.0102***	−0.0742***	−0.0932***
Total	Exports	−0.2913*	−0.3312*		−0.2804*	−0.2243*	−0.2533*
	Imports	0.0533*	0.0569*		0.0520*	−0.0030	0.0111
Short-Run Period							
Direct	Exports		−0.3696*				−0.3778*
	Imports		0.0634*				0.0771*
Indirect	Exports		0.0530*				0.1373*
	Imports		−0.0090**				−0.0877***
Total	Exports		−0.3112*				−0.2405*
	Imports		0.0569*				−0.0105

Note: It is statistically significant at the * 1%, ** 5% and *** 10% level.

Tab. 7: Estimation of Spatial Models for Imports of Sub-categories

Models	**SEM**	**SAR**	**SAC**	**SDM**	**DSAR**	**DSDM**
$\ln\left[\frac{\exp_{it}}{\exp_{i(t-1)}}\right]$					0.0600** (0.0284)	0.0633** (0.0284)
$\ln \exp_{i(t-1)}$	−0.3377* (0.0214)	−0.3397* (0.0213)	−0.3394* (0.0213)	−0.3399* (0.0213)	−0.3759* (0.0253)	−0.3773* (0.0253)
$\ln \text{int}_{i(t-1)}$	0.0581* (0.0210)	0.0595* (0.0212)	0.0598* (0.0213)	0.0607* (0.0214)	0.0615* (0.0231)	0.0641* (0.0232)
$\ln \text{cap}_{i(t-1)}$	0.0395** (0.0210)	0.0400** (0.0172)	0.0397** (0.0172)	0.0406** (0.0173)	0.0408** (0.0181)	0.0425** (0.0182)
$\ln \text{con}_{i(t-1)}$	−0.0120 (0.0210)	−0.0135* (0.0210)	−0.0147 (0.0211)	−0.0141 (0.0211)	−0.0085 (0.0224)	−0.0092 (0.0224)
ρ		−0.1448* (0.0411)	−0.1881** (0.0819)	−0.1295* (0.0430)	−0.1604* (0.0425)	0.1395* (0.0446)
λ	−0.1292* (0.0432)		0.0106 (0.0172)			
$\omega \ln \exp_{i(t-1)}$				0.0628 (0.0494)		0.0865*** (0.0525)
$\omega \ln \text{int}_{i(t-1)}$				−0.0365 (0.0458)		−0.0493 (0.0491)
$\omega \ln \text{cap}_{i(t-1)}$				−0.0155 (0.0373)		−0.0213 (0.0393)
$\omega \ln \text{con}_{i(t-1)}$				0.0488 (0.0477)		0.0472 (0.0514)
Convergence Rate	41%	−42%	41%	42%	47%	47%
Half-life Period	1.68	1.67	1.67	1.67	1.47	1.46
Log-likelihood	−778.10	−776.39	−776.22	−775.07	−743.31	−741.66
AIC	1,568.20	1,564.79	1,566.44	1,570.14	1,500.63	1,505.33
BIC	1,599.57	1,596.16	1,603.03	1,622.42	1,536.80	1,562.16

Note: It is statistically significant at the * 1%, ** 5% and *** 10% level. Values in parentheses below coefficient estimates represent robust standard errors.

Tab. 8: Short-Run and Long-Run Import Effects (Intermediate, Capital, and Consumption Goods)

Effects		**SAR**	**DSAR**	**SEM**	**SAC**	**SDM**	**DSDM**
Long-Run Period							
Direct	Exports	−0.3404*	−0.4038*	−0.3377*	−0.4087*	−0.3417*	−0.3414*
	Intermediate	0.0587*	0.0686*	0.0581*	0.0731*	0.0607*	0.0593*
	Capital	0.0420**	0.0431**	0.0395**	0.0458**	0.0430**	0.0419**
	Consumption	−0.0136	−0.0095	−0.0120	−0.0119	−0.0154	−0.0149
Indirect	Exports	0.0439*	0.0595*		0.1397*	0.0967**	0.0549**
	Intermediate	−0.0075**	−0.0100**		−0.0583	−0.0381	−0.0095***
	Capital	−0.0054**	−0.0063**		−0.0277	−0.0198	−0.0066***
	Consumption	0.0017	0.0013		0.0511	0.0443	0.0025
Total	Exports	−0.2964*	−0.3442*		−0.2989*	−0.2450*	−0.2865*
	Intermediate	0.0511*	0.0586*		0.0148	0.0225	0.0497*
	Capital	0.0366**	0.0367**		0.0180	0.0231	0.0352**
	Consumption	−0.0118	−0.0082		0.0391	−0.3417*	−0.0123
Short-Run Period							
Direct	Exports		−0.3793*				−0.3824*
	Intermediate		0.0645*				0.0684*
	Capital		0.0405**				0.0428**
	Consumption		−0.0090				−0.0111
Indirect	Exports		0.0529*				0.1284*
	Intermediate		−0.0089**				−0.0543
	Capital		−0.0056***				−0.0257
	Consumption		0.0012				0.0481

Note: It is statistically significant at the * 1%, ** 5% and *** 10% level.

Observing the direct, indirect and total effects calculated on the basis of the DSAR model, we notice that they are statistically significant for other variables except for consumer goods. In the short and long run, the indirect effects are negative and significant except for consumption goods. For the long-run total effect, if the imports of intermediate goods and capital goods of a province increase by 10%, the export growth of that province would increase by about 0.59% and 0.37%, respectively. The overall short-term effects are expected to be 0.56% and 0.35%.

The results for beta convergence suggest that export-poor provinces tend to have higher growth rates compared to richer regions, which leads to closing the initial export income gap between them over time. This finding is evidently supported by the estimated sigma convergence in the previous section. Moreover, our results propose that other factors than control variables are more effective in the convergence process of the provinces. In other words, these factors can affect the convergence process, including differences in policies, institutions, natural resources and other structural features. Therefore, it is safe to say that our results are entirely in line with the neoclassical growth theory, which suggests that various factors such as declining returns on capital, diffusion of technology and institutional improvements could lead to faster income growth in less developed regions.

5 CONCLUSIONS

Turkish trade policy has undergone a radical transformation since 1980. The import substitution policy, which was mainly applied to industrial products before 1980, aimed at developing domestic production of intermediate and capital goods and expanding industrial ownership. On the other hand, the export-oriented growth policy after 1980 led to an increase in the volume of trade, especially in exports. This increase was supported by the liberal economic policies pursued after 1989. The country's exports shifted significantly from the agricultural sector to the industrial sector. While the share of capital goods in total imports declined, the share of intermediate goods increased rapidly. On the other hand, the share of consumer goods in imports increased slightly. Intermediate goods now account for more than 70% of total imports, indicating that exports are based on imports of intermediate goods. In the context of these developments, our study spatially analyzed the convergence of exports between provinces and the contribution of imports to this convergence. At the same time, our convergence model shows the effect of imports on the growth of exports. This effect provides an opportunity to measure the dependence of exports on imports in Türkiye using an alternative method.

The estimation results confirm our hypotheses determined within the scope of the study. Consistent with the first hypothesis, this study suggests that there is a tendency for convergence in per capita exports across 81 provinces in Türkiye at an average annual rate of 4% from 2004 to 2021. This rate is similar to the results revealed by Kremer et al. (2022) and Radiměřský and Hajko (2016) who study the convergence of trade between countries. The rate of absolute convergence in export growth estimated for Türkiye is twice as high as the "iron law" of 2%. In a recent study, Yamanoğlu (2022) shows that this absolute convergence rate is also valid for Türkiye in the period 2006–2020. Therefore, the results stated above show that exports per capita grow faster than per capita income. Moreover, provinces with low per capita exports show faster growth in exports during the relevant period. This rate of convergence suggests that provinces can reach the same per capita export level in the next 33 years. The previous studies approve higher rates for conditional than absolute convergence. The average conditional convergence rate of Türkiye's provinces shows that their steady state levels or potential export levels have constantly increased during the relevant period. However, they have been approaching their steady-state level at an average annual rate of 38%, which is supposed to take about 3.7 years. The sigma convergence analysis as well as the beta estimations confirm the convergence at the regional level in Türkiye. The coefficient of variation declined from 0.41 in 2004 to 0.27 in 2021. The result proposes that the dispersion of export values per capita by province is gradually shrinking.

The second step of the study is to examine the impact of imports on growth and the conditional convergence of exports. For this purpose, total imports and their sub-categories (intermediate, capital, and consumer goods) are included in the model as additional control variables. The estimation results show that total imports contribute positively to both export growth and convergence as suggested in our second hypothesis. When imports increase by 10%, provincial export growth rises by 0.63%. The convergence rate of exports grows to 41% and 42% after adding total imports and their sub-categories respectively. However, the results propose that the positive contribution is due to imports of intermediate and capital goods, while consumer goods have no impact on the growth of exports. For example, when imports of intermediate and capital goods grow by 10%, provincial export growth increases by 0.6% and 0.4%, respectively.

Afterward, the static and dynamic models (SEM, SAR, SAC, SDM, DSDM and DSAR) are estimated since the Moran I and LM statistics specify the existence of spatial interaction. The model selection criteria require us to select the DSAR model for estimating both equations with total imports and their sub-categories. Compared to the non-spatial models, the convergence rate (41%) doesn't change in the model with total imports, while increasing to 47% in the model with imports of sub-categories. In all models, the negative spillover effect of total imports and imports of intermediate and capital goods on export growth is negligible (0.1%). In other words, while its own imports make a limited contribution to the growth of a province's exports, the imports of neighboring provinces do not contribute at all. The overall short-term and long-term effects of imports are not significant, either. To put it more clearly, when a province's imports per capita increase by 10%, the per capita export growth of that province rises only by 0.57%. This effect is estimated as 0.56% in the short run and 0.56% in the long run for intermediate goods whereas 0.37% and 0.35% for capital goods, respectively. These findings conclude that overall imports have a very small influence on Turkish growth of exports, both at the country level and at the provincial level.

Finally, the estimated coefficients for spillover effects varying between 0.053–0.060 are positive in the spatial models. In other words, when the initial export level of neighboring provinces increases by 10%, the growth in exports of a province is expected to be between 0.53–0.60%. The literature argues that such an effect is due to technological spillover effects on the convergence of per capita income. The results also show that the dependence of export growth on imports varies with respect to the sub-categories of imports.

The tendency for convergence is similar to the results revealed by Kremer et al. (2022) and Radiměřský and Hajko (2016) who study the convergence of trade between countries. On the other hand, our study differs from previous research in some respects. Considering the trade of SITC6 and STIC7 products in their studies for EU countries, Radiměřský and Hajko (2016) calculate the absolute and conditional convergence rates as 5.3–5.5% and 13.2–14.9%, respectively. In other words, they suggest that the conditional convergence rate is more than twice the absolute convergence rate. On the other hand, Kremer et al. (2022) propose that the absolute convergence rates of equal-weighted tariffs and value-weighted tariffs might not be different (i.e. 3.46% and 3.38%) based on their cross-country research. In our study, however, we find a 10-fold difference between these rates. It indicates that Türkiye is more heterogeneous at the regional level compared to EU countries in terms of export incomes. We believe that the difference between the model and the method used in our study and other studies might be the main reason why they are calculated differently. We employ spatial panel data models that include control variables with data on a regional basis, whereas the two studies apply country-based standard panel models that do not consider control variables.

Our findings provide some policy recommendations for decision makers and additional study topics for researchers. Policies for the development of exports should be given priority in order to ensure a balanced income distribution throughout the country, as the convergence in Turkish exports is faster than the total income. Considering that the western part of Turkey still has a higher export level than the eastern regions, it is important to focus on the eastern provinces in policies aimed at increasing exports. However, imports of intermediate and capital goods, which only contribute positively to the development of exports, should be prioritized in import-related policies. Moreover, the fact that conditional convergence in exports is faster than absolute convergence suggests that initial factors other than imports are effective in the convergence process. Studies that can identify the factors that really affect the convergence of exports will shed light on which factors should be evaluated in policies for export growth.

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