A Gravity Model Analysis of Chinese Apparel Export Flows

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1. Introduction

Over the past two decades, China has played a significant role as a leading apparel supplier in the global clothing trade markets. China's apparel export values have increased almost continuously in the last decade (Figure 1), going from $32.3 billion in 2000 to an average of $146.6 billion in the 2010s, with an average annual growth rate of 9 percent (COMTRADE, 2021). In terms of market share, China accounted for approximately 18 percent of global clothing exports in 2000. Since its admission into the World Trade Organization (WTO) in 2001, particularly after the abolition of the Agreement on Textiles and Clothing (ATC)[2] in 2005, China has gained a substantial market share of the world's total apparel exports. By 2014, China's market share had peaked, accounting for 40 percent of world clothing exports. However, in recent years, China's apparel export values and market share have already either declined or stagnated under the influence of new market conditions and shifting business environment, dropping by $48.9 billion in export values and around 7 percent in market share during 2015 – 2020. Given the shifting economy in China and globally and uncertainties in the world marketplace, the growth prospects for China's apparel industry is more uncertain for the foreseeable future.

[2] A 10-year transitional trade arrangement allowing for selective application of tariffs and quotas, which had replaced the more restrictive Multi-fiber Arrangement (MFA) in 1995.

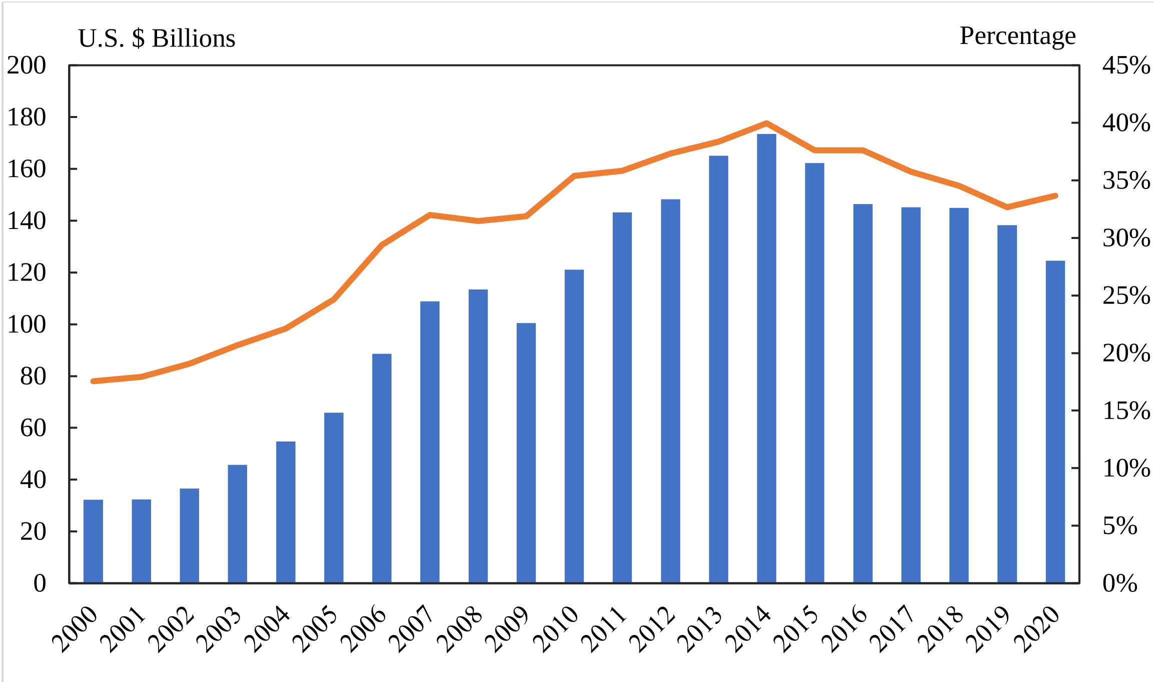

Figure 1. China's Apparel Export Values (U.S. $ Billions) and Market Shares (by value), 2000 – 2020

According to the China National Textile and Apparel Council (CNTAC), the 14th five-year plan released for its textile and apparel sector remarks development guidelines and growth strategies set out by policymakers from 2021 – 2025. Specifically, the plan encourages China's textile and apparel companies to allocate a minimum of 1.3% (compared to 1.0% in the past five years) of their sales revenue to research and development (R&D), reflecting China's efforts to move towards a more value-added and technology-intensive textile and apparel industry over the next five years. Meanwhile, the 14th five-year plan sets a reasonable growth rate[3] for China's textile and apparel production and exports through 2025, in comparison to the 13th five-year plan in which China specified an annual 6-7% growth in textile and apparel output.

[3] The goal growth rate is not specified in the 14th five-year plan.

From a global perspective, the world apparel trade sector could shift dramatically in the coming years affected by the COVID-19 pandemic, the global economic slowdown and weaker consumer spending as a result of tighter budgets. It was estimated that the value of world merchandise trade declined by 8 percent in 2020 as the COVID-19 pandemic severely jolted the global economy. Consequently, the world apparel export value suffered a 9 percent drop from the previous year. On the other hand, due to the increased demand for protective personal equipment, world exports of textiles experienced a strong increase in 2020, growing by 16 percent (WTO, 2021). The contrast between textile and clothing exports underlines deep structural change in the future years of post-COVID-19 era. In recent years, due to rapid increases in domestic income and production costs (especially labor cost), China is gradually losing comparative advantage in the apparel sector which resulted in shifts in the location of clothing production to other lower cost countries. Furthermore, as China's economy is shifting away from labor-intensive industries, such as textiles and clothing, to more capital and technology-intensive commodities, the market shares of Chinese apparel imports among major importing countries have been declining (Figure 2). While China steadily accounted for declining shares in the world's apparel trade market since 2010, most of its lost market shares have been captured by several emerging economies, such as Vietnam, Bangladesh, and Indonesia. With the rapid growth especially in the past decade, Vietnam and Bangladesh ranked the world's third- and fourth-largest apparel exporters, respectively, in 2020. The cumulative effects of these factors could lead to significant impacts on the global apparel trade flows.

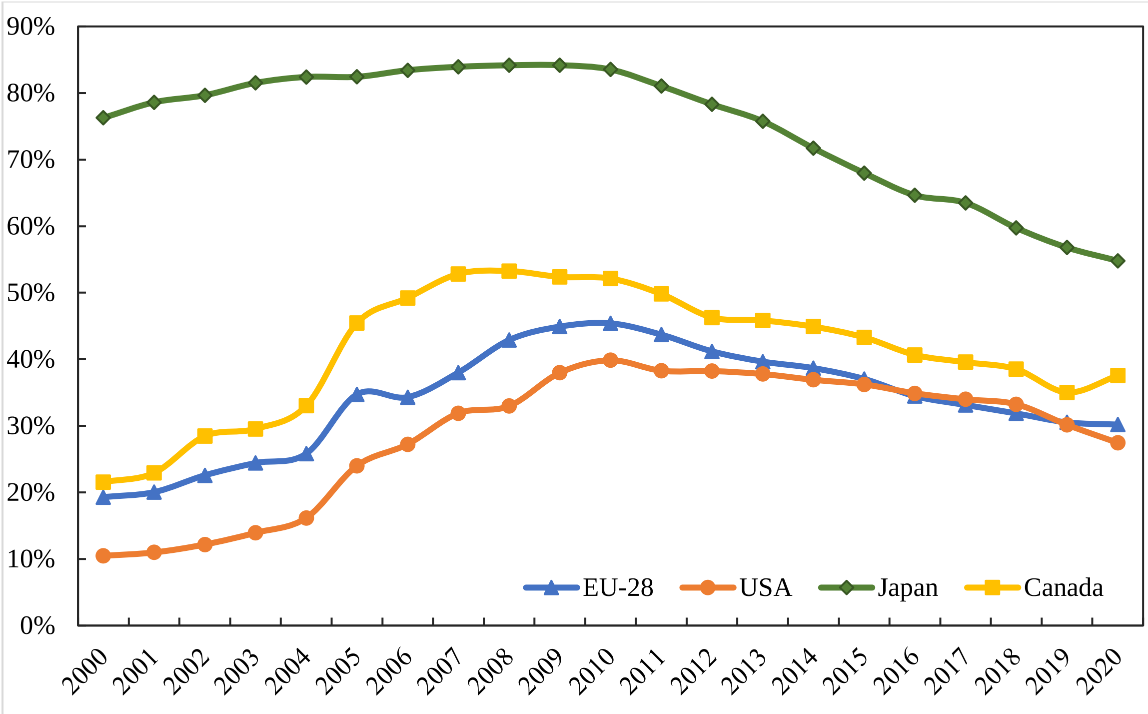

Figure 2. China’s Apparel Market Shares in the World’s Major Apparel Importing Countries (by value), 2000 – 2020

As the world's largest clothing producer and exporter, China has a key role to play in shaping global clothing trade patterns. If the global apparel sector undergoes these fundamental changes to accommodate changing market and policy conditions, the analysis of China’s apparel export flow is particularly important to assess China' s competitiveness in world apparel trade markets. Based on long-term trade data from 2000 – 2020, this study aims to provide insights into the major factors that have driven China’s apparel export flows, and it also seeks to explore how the trade pattern has been changing over time. A gravity model is used to empirically identify the determinants of China’s apparel exports and their individual effects in terms of significance and direction. Effects of country-specific economic factors including Gross Domestic Product (GDP) of China and trading partners, per capita GDP of trading partners, and exchange rate and time-invariant characteristics between trading nations such as geographical distance, contiguity, and sharing the same language are investigated. In addition, a dummy variable is included to investigate the effects of the accession of China to the WTO on Chinese apparel esports. The investigated factors in this study are not exhaustive but extensive and representative.

2. Literature Review

The gravity model of trade was initially derived as an analogy from physics but developed further since its first introduction (Tinbergen, 1962; Pöyhönen, 1963). Despite the initial criticism for its lack of theoretical foundation, the gravity model has gained wide usage in past decades due to recent methodological developments providing rigorous theoretical foundation to the model (Anderson, 1979; Bergstrand, 1985; Feenstra et al., 2001; Anderson and van Wincoop, 2003; Baldwin and Taglioni, 2006; Anderson, 2011) and became the “workhorse” for econometric analyses of bilateral trade flows of various commodities under different situations.

Despite the extensive application of the gravity model in aggregate and commodity level trade analysis, only few studies investigated bilateral trade in apparel trade sector. Much of the recent studies used the gravity theory in the apparel specific trade literature has focused on analysis of trade flow determinants and regional trade policies/agreements among a few selected countries. Tsang and Au (2008) examined the impacts of North American Free Trade Agreement (NAFTA) on textile and clothing exports from selected South and Southeast Asian developing countries and the NAFTA members to the USA during 1990 to 2005. Chi and Kilduff (2010) analyzed US apparel imports from its 15 major trading partners between 1995 and 2006 using the Ordinary

Least Square (OLS) regression under a gravity model to identify the effects of major determinants. In order to identify the major determinants that have influenced the apparel trading of Asian countries to the EU-15, and American markets, Au et al. (2010) applied the gravity trade model using trade data for fourteen exporting countries and their sixteen importing partners from 2000 to 2007. Lee et al. (2014) examined factors to explain apparel exports in 31 economically developed countries from 2005 to 2007. Rahman et al. (2019) estimated the panel gravity model of Bangladeshi textile and clothing export flows to a total of 40 trade partners from 1990 to 2017 to identify the major determinants and issues influencing exports. Datta and Kouliavtsev (2020) assesses the effects of the expiration of the Multi-Fiber Arrangement (MFA) on the sourcing of US apparel.

Besides these specific studies, to our knowledge, there is no well-established gravity model developed particularly for Chinese apparel exports covering all world trading countries. In the present study, we applied the gravity model using the Poisson Pseudo Maximum Likelihood (PPML) estimator. This approach goes beyond the framework of previous studies, which concentrated on the application of a more traditional approach of gravity using OLS.

3. Method and Data

Borrowing from Newton’s gravitational law, economists explained the gravity equation in the context of bilateral trade flows between two nations as a function of economic mass (typically measured by GDP) and the geographical distance between the two countries. Consequently, countries with larger economies tend to trade more in absolute terms than those with smaller economies, while increasing geographical distance between two nations tends to reduce bilateral trade due to increased transportation costs.

In its general formulation, the gravity model developed in the international trade flow analysis takes on the following form:

$$X_{ijt} = \beta_0 GDP_{it}^{\beta_1} GDP_{jt}^{\beta_2} Dist_{ij}^{\beta_3} \quad (1)$$

where X_{ijt} represents the monetary value of trade flow from country *i* to country *j* in year *t*; GDP_{it} is the importing country's GDP indicating the importers' demand; GDP_{jt} is the exporters' GDP which represents its production potential and the total amount exporters can supply; and $Dist_{ij}$ is the geographical distance between the two countries' capitals. Traditionally, empirical gravity models are log-linearized gravity models and estimated via a linear estimator such as OLS. Taking the natural logarithm of both sides, the linear form of the model is as follows:

$$\ln(X_{ijt}) = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnDist_{ijt} + \varepsilon_{ijt} \quad (2)$$

In this way, β_1, β_2, and β_3 are elasticity parameters to capture the impacts of importers' GDP, exporters' GDP, and distance on bilateral trade flows.

The traditional approach of estimating the log-linearized gravity model of Equation 2 involves using a linear estimator such as OLS. However, it is subject to two econometric issues which are receiving attention in recent methodological developments. First, the original formulation of the gravity model omits what Anderson and van Wincoop (2003) call the multilateral resistance terms which are correlated with trade costs. Hence, estimations are biased, the so-called "gold medal mistake". The authors show that estimates from gravity equations could lead to biased inferences without controlling for multilateral resistance terms. A number of variables are generally used to capture trade costs that either facilitating or restricting trade flows between trading nations. In our study, a set of control variables are used to proxy trade costs that are specific to our research interest include: distance between two trading countries ($Dist_j$), a binary variable that equals one when both countries share a border ($Bord_j$), a binary variable that equals one when both countries share a common language ($Lang_j$), and a binary variable that takes the value of one when both countries are members of the WTO (WTO_j). They are used to reflect the hypotheses that transport costs increase with distance and that they are lower for neighboring countries. Dummy for common language is used to capture information costs. In a similar way, countries engage in bilateral and multilateral trade agreements enhance mutual or regional trade between trading partners by lowering tariff and non-tariff barriers.

The second issue is the treatment of zero trade in a given year between two given countries may lead to another potential source of bias if ignored. The log-linearized model results in a truncated dependent variable because of the nonexistence of the natural log of zero-trade observations. For this reason, we follow Silva and Tenreyro (2006) and use a PPML estimator to address this issue. The PPML estimation has the advantage that it can be estimated in a nonlinear form. In addition, the PPML estimator remains consistent with and without the inclusion of the zero-trade observations. Finally, the empirical model specified for China's apparel exports is as follows:

$$ln(X_{jt}) = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnGDP_{jt} + \beta_3 lnPCGDP_{jt} + \beta_4 lnER_{jt} + \beta_5 lnDist_j + \beta_6 Bord_j + \beta_7 Lang_j + \beta_8 WTO_j + \varepsilon_{jt} \quad (3)$$

where t = 1, …, 21, the estimation time period from 2000 to 2021; X_{jt} represents export value of Chinese apparel in thousands of US dollars to an importing country *j*; GDP_t is

China's GDP in thousands of US dollars; GDP_{jt} is importing countries' GDP in thousands of US dollars; $PCGDP_{jt}$ is per capita GDP of importing countries in thousands of US dollars; ER_{jt} is the exchange rate of national currency of importing countries per US dollars; and ε_{jt} is the error terms capturing unobserved effects on exports.

Three estimation periods were analyzed in this study, 2000 – 2020, 2010 – 2020, and 2015 – 2020, to compare the individual effects of trade determinants in terms of significance and direction. The year 2010 was chosen because it is the mid-point of the selected time span. Moreover, China's exports experienced unprecedented growth, particularly after it joined the WTO in 2001 and the abolition of the ATC in 2005. Therefore, it is desirable to investigate trade flows after the immediate effects of the policy changes are realized. The last period analyzed in this paper, between 2015 and 2020, is characterized by the fact that China's apparel exports are declining in terms of both values and market shares after reaching a peak in 2014.

The annual export values of Chinese apparel exports with its 198 trading partners for the period from 2000 to 2020 were obtained from the United Nations Commodity Trade Statistics Database (COMTRADE). Two product categories that are specific to the apparel industry are considered for this study: Harmonized System (HS) classification 61 referring to "Articles of apparel and accessories, knit or crochet" and HS 62 for "Articles of apparel and accessories, not knit or crochet". Data for GDPs, per capita GDP, exchange rates were obtained from IHS global insight. Data regarding distance[4], shared

[4] Distance is measured in kilometers from the capital of China (Beijing) to capitals of the trading partners.

border, common language, and WTO membership were collected from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

4. Results

In Table 1, estimation results of China's Apparel Exports from the PPML estimated gravity model are reported for three time periods, respectively. The parameters of the model were estimated using the *Stata* software package. The proposed model had a high explanatory power, explained 69% of the variance in Chinese apparel exports. All variables are statistically significant except for the dummy variable of common border during the period from 2015 – 2020.

As expected, the variable of GDP of China's trading partners, which is a commonly used proxy for market size of a country, was found to be positive and highly significant at the1% level across all time periods. This result conforms to economic theory and most prior studies on the gravity model (Tinbergen, 1962; Pöyhönen, 1963) that trading partners with greater GDP create larger demand for imports. Specifically, with a 1% increase in the GDP of China's trading partners, there would be a 1.1% growth in the value of Chinese apparel exports.

Table 1. Gravity Trade Model Estimation Results for China's Apparel Exports using PPML Estimator

	2000 - 2020		2010 - 2020		2015 - 2020	
	Coefficient	Elasticity	Coefficient	Elasticity	Coefficient	Elasticity
GDP of importing country	0.07***	1.1%	0.07***	1.1%	0.07***	1.1%
	(0.001)		*(0.001)*		*(0.001)*	
GDP of China	0.09***	1.1%	0.04***	1.0%	-0.06***	-0.9%
	(0.00)		*(0.01)*		*(0.02)*	
Per capita GDP of importing country	-0.01***	-1.0%	-0.03***	-1.0%	-0.03***	-1.0%
	(0.00)		*(0.00)*		*(0.00)*	
Exchange rate of importing country	-0.00**	-1.0%	-0.00***	-1.0%	-0.00***	-1.0%
	(0.00)		*(0.00)*		*(0.00)*	
Distance	-0.03***	-1.0%	-0.03***	-1.0%	-0.03***	-1.0%
	(0.00)		*(0.00)*		*(0.00)*	
Common border	0.04***	4.4%	0.03***	3.0%	0.01	1.1%
	(0.01)		*(0.01)*		*(0.01)*	
Common official language	0.09***	9.2%	0.07***	6.7%	0.08***	8.1%
	(0.01)		*(0.01)*		*(0.01)*	
WTO	0.05***	5.0%	0.05***	5.3%	0.05***	4.9%
	(0.00)		*(0.01)*		*(0.01)*	
Constant	-1.17***		0.42*		3.65***	
	(0.08)		*(0.24)*		*(0.59)*	
No. of obs.	7727		4125		2255	
R^2	0.68		0.69		0.69	

* Standard errors in parentheses

***, **, *: coefficients statistically significant at 1 percent, 5 percent and 10 percent level, respectively.

The coefficients of the GDP of China, an indicator of the production capacity, are significant and positive for periods of 2000 – 2020 and 2010 – 2020, consistent with our prior expectation. However, it is interesting to note that this coefficient became significant and negative during 2015 – 2020[5]. The change in the sign indicates, as its economy becomes more industrialized and advanced (focused on more capital-intensive industries as labor costs rise), China is gradually losing its comparative advantage in making labor-intensive garments. Moreover, through a large-scale global project, namely the Belt and Road Initiative (BRI) announced in 2013, China continues its strategy of "going global" promoting investment in textile and apparel factories overseas. Statistics indicate that China's foreign direct investments (FDI) in the textile and apparel sector exceeded $6.7 billion during 2015 and 2020, nearly $1.8 billion, representing 27% of the total FDI, went to neighboring South Asian countries, including Vietnam, Bangladesh, Cambodia and Thailand (CNTAC, 2021). This trend of relocation of clothing industry has driven higher exports from these countries to the world market and lower exports of finished goods from China.

Surprisingly, the coefficient of per capita GDP of importing countries are significant and negative with unitary elasticities across all three time periods examined in the analysis, suggesting that importers' economic development levels and consumers' purchasing power are still important factors in determining export flows of Chinese apparel.

This result indicates that consumers with increased purchasing power (higher income) are purchasing less clothing imported from China over years. The shifting sourcing strategy of apparel companies and new trends in consumers' purchasing

[5] When we examined the different starting years of 2012, 2013, and 2014, the coefficients of GDP of China are significant and negative in all time periods investigated.

preference are the two primary factors contributing to the decline in Chinese clothing exports. This result is consistent with the significant structural change in the world apparel import market shown in Figure 2, the value of clothing imports from China among developed economies which are also major clothing importers in the world, such as the EU, the United States, Canada, and Japan, are exhibiting a clear downward trend in recent years. Driven by rapid increases in domestic costs (especially labor costs) in China, fashion apparel brands and retailers in developed economies are seeking alternative apparel sourcing destinations, which induced shifts in the geographical distribution of clothing production to other lower cost countries. Furthermore, consumers' demand and preference for clothing continue to diversify associated with increased purchasing power. For example, from 2010 to 2020, China's apparel imports experienced a nearly 15% annual growth, with 30% of China's apparel imports are luxury items made in the EU (Just Style, 2021)

Comparing the estimated coefficients of importer's GDP and GDP per capita reveals that China's apparel exports are mainly directed to lower income import markets. Garments made in China are perceived as cheaper in average unit values of its product and lower quality, while EU apparel exports are characterized by luxury and higher quality which are sensitive to the levels of income in the importing markets.

The exchange rate variable was found to be significant with negative signs across all time periods. Changes in exchange rates can change the relative price of a product to be more expensive or cheaper. It is straightforward that the devaluation of the Chinese Yuan will boost Chinese clothing exports because importers enjoy cheaper products. This result confirms the expectation that the weakening of Chinese Yuan against currencies of its trading partners will promote China's trade flows, or vice versa.

In the context of gravity trade model, trade barriers depend on geographical distance, sharing borders, common language, and regional trade agreements. The estimated coefficients of distance are negative and statistically significant at 1% in all estimated time periods, suggesting that the distance between China and its trading partners has a negative impact on the trade value of Chinese apparel exports. This finding is consistent with the theory of traditional gravity model, suggesting that increased distance between two countries tends to restrain trade flows (Bergstrand, 1985; Rose, 2004; Chi and Kilduff, 2010). And the elasticity of Chinese apparel trade flows relative to distance is close to unity across all time periods.

The variable of sharing a common border with China was found to influence the magnitude of exports significant positively in early periods of 2000 – 2020 and 2010 – 2015. However, the coefficient of this variable was not statistically significant during the period 2015 – 2020. This result implies that China developed trade relationships beyond its border countries in recent years. The trend observed can partially be attributed to its recent strategy of "going global". The BRI aims to enhance trade relationships of Asia, Europe, and Africa and stimulate economic cooperation, FDI and international trade among all the participating countries. In addition, recent developments in the globalization of the world economy, regional trade integration, and technological progress are also among the major factors contributing to the enhanced trade relationships. In a similar way, sharing the same language among trading countries facilitates trade flows. Because language barrier could also generate culture barrier, this variable is commonly used in gravity trade models as cultural variables to capture information costs. The estimated coefficients for the dummy variable of common language are positive and significant at 1% level in all time periods analyzed, suggesting that common language would increase China's apparel export values, on average, by 6.7 to 9.2%.

Finally, the WTO Membership of both trade partners is significant at the 1% level with positive effects on trade flows. Specifically, apparel export value will increase by an average of 5% when China trades with members of the WTO. The estimation results indicate that WTO enhances trade flows between member countries because it provides special preferences and lowers net trade costs other things equal.

5. Conclusions

This study builds on the literature of China's apparel exports by providing new estimates of trade determinants from a gravity model estimated using PPML estimator instead of the conventional OLS. Estimation was performed with panel data from 2000 to 2020, for annual export values with its 198 trading partners covering commodity groups HS61 (Articles of apparel and accessories, knit or crochet) and HS62 (Articles of apparel and accessories, not knit or crochet). Variables of country-specific economic factors and time-invariant characteristics associated with Chinese apparel export flow were investigated. Three estimation periods were analyzed in this study, 2000 – 2020, 2010 – 2020, and 2015 – 2020, to capture the individual effects of trade determinants in terms of significance and direction. A few important conclusions were drawn from this study.

As China continues on the high economic growth path, accompanied by the rising production costs (especially labor costs), its comparative advantage in labor-intensive apparel industry is diminishing over time. In recent years, China's economy is experiencing structural changes shifting from labor-intensive sectors to more capital and technology-intensive industries. This fact is supported by our estimation results that China's GDP level has a significant positive impact on its apparel export flows for periods of 2000 – 2020 and 2010 – 2020. While during 2015 – 2020, China's GDP is significantly negatively related to its apparel export flow.

Another interesting result is that the magnitude of China's apparel exports is significantly positively dependent on the GDP of the importers but significantly negatively dependent on the importer's per capita GDP. This result reflects the shifting sourcing strategy of apparel companies and new trends in consumers' purchasing preference over years. Affected by the changing business environment, fashion apparel brands and retailers in developed economies continue to diversify their sourcing strategy seeking alternative apparel sourcing destinations beyond China, which induced shifts in the geographical location of clothing production to other countries. Meanwhile, with increased income, consumers favor luxury clothing made in the EU.

Finally, the improved econometric estimates of apparel specific trade are not only crucial for understanding the current market condition but also highly valuable for accurately predicting the future trend. Such estimates can be used to assess the impact of certain policy restrictions (e.g., new or increased import tariffs) on apparel related trade and predict possible trend of Chinese apparel export flows with the variation of individual economic and political factors.

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