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RESEARCH ARTICLE

Export Competition in China: Evidence from Data at Provincial Level

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Abstract Through an analysis of the effects of Guangdong on exports from other provinces, this paper examines China's interregional relationships regarding exports. We utilize provincial level data from 1998 to 2008 and apply the system GMM to estimate an empirical model derived from the gravity equation. The results indicate that Guangdong significantly crowds out exports from other provinces. Coastal provinces are less affected than their non-coastal counterparts. In coastal areas, the displacement effect on the Yangtze River Delta is less than that on the Pan Bohai Rim. Further research reveals that the improvements in service industries, labor productivity, capital-labor ratio, and agglomeration of manufacturing industries have significantly reduced export competition. Additionally, a province with a larger market potential or a lower degree of market disintegration is less affected by Guangdong's export competition.

Keywords Export competition · Industry agglomeration · Market potential · Market disintegration

1 Introduction

In China, industrial development displays several worrying trends. First, firms congregate at the low-end of the value chain, putting the whole country in a

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disadvantageous position. Second, there is a high degree of similarity in industrial structure between regions, leading to redundant production capacity. Third, resources of real sectors are shifting toward speculative activities, resulting in industrial hollowing-out. These facts are puzzling. In a large country, regions should specialize in different areas given that their resource endowments are not identical. However, this is not the case in China. With regard to this situation, we attempt to conduct a quantitative analysis from the perspective of exports. We particularly want to know what type of relationship exists between regions regarding exports—substitute or complementary.

We will examine interregional competition in exports by analyzing Guangdong's impact on exports of the other provinces. The reason for choosing Guangdong is obvious. Guangdong is the largest exporter in China. In 2009, it had three quarters more exports than the second largest exporter, Jiangsu. Guangdong also had an export dependence ratio of 82 % from 1996 to 2009, much higher than the national average of 39 and 59 % for Shanghai, which had the second highest ratio.

We hope our work will make sense in three aspects. First, it offers a new perspective on the analysis of the interregional relationship in economic development. The literature on fiscal decentralization believes that China's 1994 tax-sharing reform gives the local governments incentives to "compete for growth." Following this logic, we further investigate whether interregional competition exists not only in the *domestic* market but also in the *global* market. Second, the study of interregional relationships with respect to exports provides a way to discern the evolution of industrial structures of different regions. A substitute relationship may suggest that regions have similar industrial structures, while a complementary relationship may imply that each region enjoys a different comparative advantage. Third, this work adds new elements to earlier research on the cause of China's export growth. China's export expansion results from competition at two levels: competition between China and other countries, and competition between regions within China. A large body of literature emphasizes the former type of competition but we will focus on the latter.

The rest of this paper is organized as follows: Sect. 2 reviews the literature, Sect. 3 presents the data and summary statistics, Sect. 4 discusses the estimation strategy and results, Sect. 5 and 6 offer an extended analysis and robustness check, and the last section is the conclusion.

2 Literature Review

Three strands of literature are of particular relevance to our research topic. The first strand of literature is on fiscal decentralization in China. We want to know whether interregional competition induced by fiscal decentralization also extends to the global market via export. The second one is on market segmentation in China. We will explore if the heavy reliance on foreign demand induced by market disintegration has intensified export competition between regions. The third one is on industry agglomeration in China. We are going to inquire, along with industry agglomeration, whether "domestic trade" substitutes for "international trade" to some extent so that the inland provinces have a lower degree of dependence on exports than coastal areas.

2.1 Fiscal Decentralization and Export

The literature on fiscal federalism has frequently been cited to explain China's growth miracle (Qian et al. 1999, pp. 1085–94; Jin et al. 2005, pp. 1719–42). According to this literature, the interregional competition induced by fiscal decentralization is the key to explaining China's rapid economic growth. However, while this institutional arrangement provides impetus for economic growth, it also produces side effects of different types, such as ever-increasing income disparity, shortage of public goods, redundant production capacity, similarity in industrial structure, etc. (Zhang 2006, pp. 713–26). Along this strand of literature, we go on to ask if interregional competition induced by fiscal decentralization exists not only in the domestic market but also in the global market.

2.2 Market Disintegration and Export

Young first pointed out that China's incremental reform would lead to fragmentation of the domestic market (Young 2000, pp. 1091–35). Since then, a large body of literature has emerged on this issue. Some scholars believe that domestic market disintegration has been worsening since the reform and opening-up of China (Poncet 2003, pp. 1–21). The opposite view argues that market disintegration has been alleviated (Xu 2002, pp. 116–33; Bai et al. 2004, pp. 29–40). Utilizing industrial level data, Zhang et al. study the effect of market disintegration on China's exports. Their research shows that firms in a segmented market are more inclined to export (Zhang et al. 2010, pp. 29–41). In a theoretical research, Zhu et al. drew the same conclusion. They claim that because a disintegrated domestic market renders economies of scale impossible, firms have to resort to the external market. As a consequence, China's total exports grow very quickly (Zhu et al. 2005, pp. 68–76). The idea that domestic market disintegration compels firms to export has direct relevance to our research. However, we want to go further: if market disintegration is an underlying cause of China's export growth, do the provinces compete with each other in exports?

2.3 Industry Agglomeration and Export

Chen and Xu present evidence that agglomeration of the manufacturing industry in China is underway. They also indicate that *agglomeration* mainly occurs between coastal and non-coastal regions, while *diffusion* mostly takes place within the coastal regions (Chen and Xu 2008, pp. 104–16). Pan and Li show that coastal development has very small spillover effects on non-coastal development. The primary reason is that these two areas have few industrial linkages. Compared with the inland provinces, there is a strong industrial linkage between the coastal areas. From this literature, we know industry agglomeration of the eastern regions is a major trend. Yet due to a lack of industrial linkages, the coastal regions fail to drive non-coastal development (Pan and Li 2007, pp. 68–77). Based on these studies, this paper intends to address the following questions: do the spatial characteristics of industry agglomeration affect the geographic distribution of exports? Moreover, does the fact that coastal regions enjoy much closer industrial linkages while having weaker linkages with inland areas imply a difference between intra-coastal relationships and coastal-inland relationships?

To investigate interregional relationships concerning export, we will use export data at the provincial level to carry out empirical studies. Our work contributes to existing literature in three aspects. First, we take the lead in utilizing the gravity model to explore the interregional relationships regarding export, which provides a new perspective for understanding regional economic relations. Second, it explores the effects of industrial structure, labor productivity, factor endowment, and industry agglomeration on interregional relationships with respect to exports. Third, the impact of market potential and market disintegration on this relationship is also discussed.

3 Empirical Model, Variables and Data

In physics, the gravity between two objects is positively correlated to the product of their mass and is inversely correlated to their distance (Bergstrand 1985, pp. 474–81; Feenstra et al. 2001, pp. 430–47; Redding and Venables 2004, pp. 53–82). Inspired by this law, we have the gravity model in international trade empirical studies, from which we build our export equation:

$$\begin{aligned} \ln\_EXP_{ijt} &= \ln\_EXPGD_{jt} + \ln\_GDPPAIR_{ijt} + \ln\_PERGDPPAIR_{ijt} \\ &+ \ln\_AREAPAIR_{ijt} + \ln\_DIS_{ij} + \varepsilon_{ijt} \end{aligned}, \quad (1)$$

In Eq. (1), i represents an exporting province, j is an importing country, and t the year. EXP_{ij} stands for the export of province i to country j; $EXPGD_j$ for the export of Guangdong to country j; $GDPPAIR_{ij}$ represents the product of the real GDPs of the trading partners; $PERGDPPAIR_{ij}$ represents the product of their real GDPs per capita; $AREAPAIR_{ij}$ stands for the product of their land areas, and DIS_{ij} for the distance between them; ε represents the random error.

We utilize provincial export data sorted by destinations to carry out empirical studies. Due to data limitation, our sample is confined to the exports of 26 provinces in China to nine countries during the period from 1998 to 2008: Australia, Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, and Russia.[1] In addition to Tibet, the export sources exclude Jilin, Hubei, and Guizhou. Due to lack of data, the export destinations preclude Southeast Asian countries, though this region is an important market for China's export products. Considering the complication of *entrepôt* trade, we also do not take into account exports to Hong Kong. Finally, we get a sample with balanced panel data, which should have 234

[1] These nine countries are big economies and leading importers in the world. More importantly, these countries are China's major trading partners. In addition, during the whole sample period, China's position in the imports of these nine countries has been enhanced all the way.

cross-sections ($ij = 26 * 9$). However, the actual cross-sections come to 231, as export data for Inner Mongolia to Australia and Fujian and Ningxia to Russia are unavailable. Our specification for the variables in Eq. (1) is as follows:

ln_EXP = ln(export/cpi). *export* is the export volume (in USD10,000) of a province to a foreign country, taken from provincial statistical yearbooks; *cpi* is the consumer price index (1998–2008, 2000 as the base year) which comes from *BLS Data Series*.

ln_EXPGD = ln(exportGD/cpi). *exportGD* is the export volume (in USD10,000) of Guangdong to a foreign country, quoted from Guangdong's statistical yearbooks.

*ln_GDPPAIR = ln(expGDP*impGDP)*. *expGDP* is the real GDP of a province (USD 100 million, with 2000 as the base year), quoted from provincial statistical yearbooks; *impGDP* is the real GDP for a country (USD 100 million, 2000 as the base year), quoted from the WDI.

*ln_PERGDPPAIR = ln(expPERGDP*impPERGDP)*. *expPERGDP* is the real GDP per capita of a province (USD, 2000 as the base year), quoted from provincial statistical yearbooks; *impPERGDP* is the real GDP per capita of a country (USD, 2000 as the base year), quoted from WDI.

*ln_AREAPAIR = ln(expAREA*impAREA)*. *expAREA* is the land area of a province (square kilometers), quoted from Ministry of Commerce; *impAREA* is the land area of a country (square kilometers), quoted from the WDI.

ln_DIS = ln(DIS). *DIS* is the distance between the importing country and the exporting province (kilometers). We divide the distance between a province and a country into two parts: domestic and international. The former is the distance between a province's capital city and its nearest port, which is determined by the shortest railway mileage and transportation time.[2] The latter is defined as the maritime voyage (kilometers) between China's port and the importing country's representative port. This is calculated by a maritime voyage measuring software (PortWorld Distance Calculator).

Descriptive statistics for the variables above are given in Table 1.

4 Estimation Results

We employ the generalized method of moments (GMM) to estimate the empirical model. There are two reasons for choosing this method: first, the sample has many cross-sections but only covers a short time period, and the GMM is suitable for handling this kind of data; second, among the explanatory variables, a country's imports from Guangdong, the product of the real GDPs and the product of real GDPs per capita are all endogenous. When it is hard to find instrumental variables from outside the model, GMM becomes a feasible method to address endogeneity (Arellano and Bond 1991, pp. 277–97). DIF-GMM means estimating the following

[2] The nearest port to Hebei is Tianjin rather than Qinhuangdao, and the nearest port to Jiangsu is Shanghai rather than Lianyungang. Using Qinhuangdao and Lianyungang as the respective ports of Hebei and Jiangsu makes no difference.

Table 1 Descriptive statistics

Variables	Observations	Average	S.D.	Min.	Max.
ln_EXP	2463	9.16	2.08	0.65	15.19
ln_EXPGD	2574	12.69	1.30	8.89	15.64
ln_GDPPAIR	2574	15.54	1.45	10.98	19.78
ln_PERGDAPAIR	2574	17.00	1.06	13.30	19.64
ln_AREAPAIR	2574	26.17	2.14	21.14	30.93
ln_DIS	2574	9.26	0.73	7.47	10.07

difference equation using instrumental variables, when the moment condition $E[X_{i,t-k}\triangle e_{i,t}] = 0 \quad (k \geq 2)$ is satisfied:

$$\Delta y_{i,t} = \alpha' \Delta X_{i,t} + \Delta e_{i,t}, \tag{2}$$

When the moment condition is satisfied, the lagged terms of the endogenous variables for two periods or more $(X_{i,t-k}, \quad k \geq 2)$ are qualified instrument variables of the differenced Eq. (2).

SYS-GMM is an even more effective method of estimation than DIF-GMM (Arellano and Bover 1995, pp. 29–51; Blundell and Bond 1998, pp. 115–43; Roodman 2009, pp. 86–136). The SYS-GMM introduces a level equation in addition to the differenced equation:

$$y_{i,t} = \alpha' X_{i,t} + u_i + e_{i,t}. \tag{3}$$

As long as the moment condition $E[\Delta X_{i,t-k}(u_i + e_{i,t})] = 0 \ (k = 1)$ is satisfied, the differenced terms of the lagged endogenous explanatory variables$(\Delta X_{i,t-k}, \quad k = 1)$ are proper instrumental variables of the level Eq. (3).

We employ SYS-GMM in the empirical research, given its merits of estimation. In model specification, we treat Guangdong's export to a country, the product of the real GDPs and the product of real GDPs per capita as endogenous variables, while the product of the land areas and distance are treated as exogenous variables.

4.1 Baseline Results

The estimation results of Eq. (1) using SYS-GMM are presented in Table 2. In the first column, we find that two variables, the product of the real GDPs and the product of real GDPs per capita of the importer and the exporter, are positive and significant, while the other two variables, the product of the land areas of trading partners and the distance between them, are negative and significant. These results coincide with the theoretical prediction. Guangdong's export (*ln_EXPGD*), our prior concern, has a significant and negative coefficient, implying that Guangdong's exports produce "crowding-out" effects on the other provinces. Keeping other variables constant, exports of the other provinces will decrease 0.6 % for every 1 % increase in Guangdong's exports to the nine countries involved in our research.

In order to ascertain the influence of Guangdong on exports of different areas (source of export, *SE*), we add interaction terms of a regional dummy and Guangdong's export in the next four columns. In the second column, we include interaction of Guangdong's exports and the coastal dummy (*coastal* = 1 if it is coastal, otherwise 0) and then find a positive coefficient; however, the significance level is only 10 %.[3] This indicates that the impacts of Guangdong on coastal and inland provinces are different. On the other hand, the effects of Guangdong on different coastal provinces should also be different, as the significance level is only 10 %. To verify this assertion, we interact Guangdong's export with the dummy variables of the Yangtze River Delta (for Jiangsu, Zhejiang, and Shanghai, *yzr* = 1, otherwise 0), and the Pan Bohai Rim (for Beijing, Tianjin, Hebei, Liaoning, and Shandong, *pbr* = 1, otherwise 0), respectively. Both interaction terms are positive, but only the former is significant. According to the estimated coefficients, we find that compared with the other provinces, the Yangtze River Delta suffers 30 % less crowding-out effects than the other provinces. The Pan Bohai Rim shows no such difference.

Finally, we discuss whether Guangdong's exports affect the neighboring provinces differently. Thus, we introduce an interaction term of Guangdong's export and the dummy variable of the neighboring provinces (for Fujian, Jiangxi, Hunan, Guangxi, and Hainan, *gdng* = 1, otherwise 0). This interaction term is positive but insignificant.

4.2 The Difference of the Effects of Guangdong

Here, we further discuss the effects of Guangdong by including interaction terms of Guangdong's export and provincial dummy variables. During 1998–2008, the ranking of export-GDP ratio is as follows: Guangdong (84 %), Shanghai (64 %), Tianjin (48 %), Jiangsu (39 %), Beijing (37 %), Zhejiang (36.5 %), Fujian (34 %), Liaoning (21 %), and Shandong (18 %). Except Guangdong and Fujian, they are all located in the Yangtze River Delta and the Pan Bohai Rim.[4] Now, we study the influence of Guangdong's exports on these provinces or municipalities and present the estimation results in Table 3.

First, we consider the Yangtze River Delta Provinces (columns one, two, and three). They all suffer weaker crowding-out effects than the other provinces. Compared with the other provinces, Zhejiang is 25 % lower, Jiangsu is 83 % lower, and Shanghai even benefits from Guangdong's export expansion. However, results are different for the Pan Bohai Rim Provinces (columns four, five, six, and seven). Compared with the other provinces, the crowding-out effect on Tianjin and Shandong is lower, the former being 18 % lower and the latter being 7 % lower, but there exists no difference between Beijing or Liaoning and the other provinces. Table 2 has shown that in the coastal provinces, the crowding-out effects of Guangdong's exports are weaker on the Yangtze River Delta, while stronger on the Pan Bohai Rim, which is again proven by the results in Table 3. The interaction term of Fujian and Guangdong's export is significantly positive (column 8). Numerically, Fujian suffers 17 % less crowding-out effects than the other provinces. Except for these coastal provinces, we also pay particular attention to Sichuan, the

[3] Besides Guangdong, coastal regions include the Pan Bohai Rim (Beijing, Tianjin, Hebei, Liaoning, and Shandong), the Yangtze River Delta (Jiangsu, Zhejiang, and Shanghai) and Fujian, Guangxi, and Hainan.

[4] Although Hebei is in the Pan Bohai Rim, its export-GDP ratio is only 8 % during 1998–2008.

largest exporter in the non-coastal areas. In column nine, the estimation result shows that, compared with the other provinces, Sichuan suffers an 8 % higher crowding-out effect, which coincides with the evidence in Table 2 that the inland provinces encounter stronger crowding-out effects than the coastal provinces.

5 Extensions

5.1 Factors Affecting the Effects of Guangdong

In this part, we ponder which factors have led to the difference between the effects of Guangdong. Industrial structure is our first concern in that it directly determines export product composition and inevitably affects the interregional relationships with respect to export. Labor productivity, resource endowment, and manufacturing agglomeration are three other factors we need to take into account, as they are crucial determinants in trade pattern. Correspondingly, we introduce four variables into our model: the ratio of the tertiary industry in regional GDP (*Ter*), regional wage level (*Wg*), regional capital-labor ratio (*K/L*), and the proportion of manufacturing industry in fixed assets investment (*Ms*). They are proxy variables for industrial structure, labor productivity, factor endowment, and manufacturing agglomeration, respectively.[5]

We first calculate the relative value of these four variables of the other provinces to Guangdong, based on which 1, 0, or −1 is assigned. Taking Shanghai as an example, Ter_{sh} is its tertiary industry ratio, Ter_{gd} is Guangdong's tertiary industry ratio, and $Rter_{sh}$ is the ratio of these two ratios. Define

$$Drter_{sh} = \begin{cases} 1, Rter_{sh} > 1.05 \\ 0, 0.95 \leq Rter_{sh} \leq 1.05, \\ -1, Rter_{sh} < 0.95 \end{cases} \quad (4)$$

Other indicators are defined similarly. The results of the estimation including these variables are presented in Table 4. In the first column, the tertiary industry ratio, though positively correlated, is not statistically significant. This may be because the major part of the tertiary industry is untradeable. Labor productivity and regional export have a significant positive correlation, which is consistent with the classical trade theory that labor productivity is an underlying determinant of comparative advantage and trade pattern. The capital-labor ratio has an insignificant positive effect. Manufacturing agglomeration has a significant positive effect on regional export, indicating that a more agglomerated manufacturing industry is more competitive.

We now introduce the interaction terms of these variables and Guangdong's exports in the model. In column two, the tertiary industry ratio has a significant negative coefficient, which implies that the development of the tertiary industry helps decrease the dependence on exports. Its interaction term with Guangdong's

[5] The author is grateful to Haojie Shan at Shenyin & Wanguo Securities for data of provincial capital stock (Shan 2008, pp. 17–32). Labor in capital-labor ratio refers to the employed population at the end of the year.

exports has a significant positive coefficient, suggesting that the development of the tertiary industry may alleviate the negative impact of Guangdong's exports.

In column three, labor productivity has a significant positive coefficient for its interaction term with Guangdong's exports, but its own coefficient is significantly negative. The latter result does not meet with our expectation, which may be caused by the multicollinearity between labor productivity and the interaction term. In column four, we keep the interaction term only and it remains significantly positive. This suggests that improving labor productivity will ease the pressure of export competition from Guangdong.

In column five, possibly due to the multicollinearity, capital-labor ratio and its interaction term with Guangdong's exports are both insignificant. In column six, where we drop the capital-labor ratio, the interaction term is significantly positive, indicating that improving the capital-labor ratio will alleviate the pressure of export competition from Guangdong. The relative increase of capital in the endowment structure will promote production and export of capital-intensive and high-tech products, thus avoiding vicious competition in labor-intensive and low value-added commodities.

Columns seven and eight explore the impact of manufacturing agglomeration on the effects of Guangdong's exports. Manufacturing agglomeration and its interaction term with Guangdong's exports are both insignificant. In column eight, we keep the interaction term only, which has a significant and positive coefficient. This provides evidence that provinces with a higher degree of manufacturing agglomeration will face less pressure from Guangdong's exports. When the manufacturing industry is more agglomerated, enterprises will have a better chance to utilize economies of scale and linkage effects between industries, thus reducing average costs and strengthening their export advantage.

We rank and score the 26 provinces under investigation with each of these four indicators: the tertiary industry ratio, the labor productivity level, the capital-labor ratio, and the degree of manufacturing agglomeration. We then aggregate their scores.[6] Shanghai ranks the highest, followed by Tianjin, Beijing, Jiangsu, Qinghai, Zhejiang, Ningxia, and Fujian. They are just the provinces or municipalities that are less negatively affected by Guangdong's exports, with the exceptions of Beijing, Qinghai, and Ningxia. Qinghai and Ningxia rank high, primarily because their smaller economy and population lead to higher levels of tertiary industry ratio, average wage, and manufacturing agglomeration. Although ranking third, Beijing performs poorly with respect to manufacturing agglomeration (ranking 19th), which partly explains why it encounters a stronger crowding-out effect than its coastal counterparts.

5.2 Market Potential, Market Disintegration, and the Effects of Guangdong

We also pay attention to two more factors that appear frequently in the literature: market potential and market disintegration. Market potential of a province is defined as (Harris 1954, pp. 315–48):

[6] Take average wage for example, Shanghai, Beijing, Zhejiang, Tianjin, and Jiangsu rank the top five, with scores of 1, 2, 3, 4, and 5 respectively.

$$MP_{jt} = \sum_{r \neq j} (Y_{jt}/D_{jj} + Y_{rt}/D_{rj}), \tag{5}$$

In formula (5), j represents a province, r is j's neighboring province, t represents year, Y_{jt} is the real GDP of j, Y_{rt} is the real GDP of r, D_{jj} is the distance within province j,[7] and D_{rj} represents the distance between capital cities of r and j. With regard to measuring the degree of market disintegration, we employ the methodology adopted by Lu and Chen, and update their data to the year of 2008 (Lu and Chen 2009, pp. 42–52).

The results of estimation are shown in Table 5. Column one is identical to that in Table 2. In column two, we introduce the variable *MP* indicating market potential, whose coefficient is positive and significant. This suggests that the larger a province's market potential is, the greater its export will be. This result, to a certain extent, supports the so-called *home market effects* of China's exports, namely the larger the size of the domestic market, the greater the potential for the export expansion. In column three, we introduce the variable *SEG* reflecting market disintegration in the model. Its coefficient is negative but not significant. In column four, we introduce both market potential and market disintegration into the model. The market potential remains positive. However, the coefficient of market disintegration becomes positive (with significance level of 25 %), indicating that market disintegration could boost regional export growth provided that market potential is controlled. This coincides with the findings that market disintegration stimulates regional export expansion (Zhu et al. 2005, pp. 68–76; Zhang et al. 2010, pp. 29–41). In column five, we add the interaction term of Guangdong's export and market potential, whose coefficient is positive and significant, showing that the greater market potential a province has, the less it suffers from Guangdong's export competition. The figures imply that when the market potential is higher than 4.9, the crowding-out effects of Guangdong's export disappear. During the period of 1998–2008, only Shanghai exceeded this threshold (with a value of 5.12), which means that Shanghai actually benefitted from Guangdong's export expansion. This again coincides with the results of Table 3. The other provinces with higher market potential are (in descending order): Jiangsu (4.7), Zhejiang (4.6), Tianjin/Beijing/Shandong (all 4.5), and Fujian (4.1). Except for Beijing, all these provinces are found less negatively affected by Guangdong's exports. In column six, we introduce both market potential and the interaction term with Guangdong's exports into the model. The interaction term is still positive, but the coefficient of market potential is negative, with both of them being insignificant. This may be caused by the multicollinearity between market potential and the interaction term. In column seven, we introduce the interaction term of market disintegration and Guangdong's exports. The coefficient of this term is negative. This suggests that the more disintegrated a province's market is, the greater the negative impact it suffers from Guangdong's exports. In column eight, we introduce market disintegration and the interaction term to the model. The interaction term is still negative and significant, and market disintegration remains positive with a significance level of 10 %.

[7] The distance within a province is 2/3 of its geographic radius: $D_{jj}{=}2/3 \cdot \sqrt{Area_j/\pi}$, and the area is the land area of a province (Reading and Venables 2004, pp. 53–82).

6 Robustness Check

In this section, we conduct a robustness check. As a comparison, Table 6 duplicates the first column of Table 2. In the second column, we adjust the SYS-GMM instruments. Considering the endogeneity of the core explanatory variable, Guangdong's exports (*ln_EXPGD*), we add the product of real GDPs for Guangdong and the importer (*ln_gdimpGDPPAIR*) as well as the product of their real GDPs per capita (*ln_gdimpPERGDPPAIR*) as GMM instruments (gmmstyle). We also include the product of the land areas of Guangdong and the importer (*ln_gdimpAREA*), and their distance (*ln_DISGD*) as general instruments (ivstyle). However, this adjustment does not change the results, with the crowding-out effects of Guangdong's exports still being significant.

All preceding regressions have been done with SYS-GMM, and now we turn to IV analysis. First, in column three, we employ instrumental variables to test the baseline results of the first column. Since most explanatory variables are constant over time, we apply random effects estimation (GLS) and then random effects instrumental variables estimation (G2LS) to the model. The endogenous variable is Guangdong's exports (*ln_EXPGD*), and its instruments are the four instrumental variables in the second column. The Hausman test supports the results of the G2LS estimation. The coefficient of Guangdong's exports remains negative, thus confirming again the crowding-out effects of Guangdong's exports. In columns four and five, we assess whether Guangdong's exports have different effects on the Yangtze River Delta (*yzr*) and the Pan Bohai Rim (*pbr*). Compared with the third column, the new model adds the interaction terms of Guangdong's exports and the dummy variables of the Yangtze River Delta and the Pan Bohai Rim respectively. The endogenous variables also include the new interaction terms, in addition to Guangdong's exports. The instrumental variables include *yzr* and *pbr*, in addition to the aforementioned four variables. The results of the estimation suggest that the Yangtze River Delta does suffer less than the other provinces, while the Pan Bohai Rim is no different from the other provinces. This corresponds with the previous findings.

7 Conclusions and Policy Implications

This paper conducts an empirical study on China's interregional relationships in terms of exports. With the gravity model as empirical foundation, we utilize data of exports from 26 provinces to nine major industrialized countries between 1998 and 2008, and investigate the effects of Guangdong on exports of the other provinces. Through SYS-GMM estimation and robustness check, we arrive at three conclusions:

Guangdong has crowding-out effects on exports from the other provinces in China. Given that other factors are under control, every 1 % growth of Guangdong's exports to the nine countries will cause a 0.6 % decline in the exports from the other provinces, to the same countries. These figures suggest that Guangdong's export expansion has a marked impact on the other provinces.

The negative effects of Guangdong's exports on the inland provinces are greater than those on the coastal provinces. Within the coastal areas, the Pan Bohai Rim suffers a greater negative impact than the Yangtze River Delta. The differences of the effects reflect some subtle mechanisms at work. The estimation shows that the improvements of the ratio of service to GDP, labor productivity, capital-labor ratio, and manufacturing industry agglomeration are helpful to ease the competitive pressure caused by Guangdong's export expansion.

A large and integrated home market is also found useful to buffer the effects of Guangdong's exports. Provinces with a greater market potential face a lower crowding-out effect; similarly, provinces with a more integrated local market also suffer less from Guangdong's exports.

These findings have three implications for policy design. First, in facing competition from Guangdong, the other provinces should seek sustainable means to establish advantages in export, rather than simply rely on low labor costs and indulge in the "race to the bottom." Labor productivity improvement is still an effective way to "defeat rivals." Moreover, with the capital-labor ratio going up, production, and exports should be geared to more capital-intensive and high-tech commodities to avoid being stuck in competition in labor-intensive products. Enterprises should make use of economies of scale and the linkage effects between industries to protect their market shares in the global market.

Second, environments friendly to the development of service industries should be fostered so as to reduce the country's dependence on foreign demand. This will facilitate the formation of a complementary interregional division of labor. Service industries not only contribute directly to economic growth but also promote industrial expansion by linking upstream and downstream industries. More importantly, service industries can also propel local governments to exploit the domestic market, which can avoid the inefficient consumption of resources for "export-oriented production."

Last, the central government should lift more domestic trade barriers, enlarge the size of the domestic market, and reinforce the foundation of sustainable development of exports. As the domestic market has yet to be fully integrated, expanding export has become a shortcut for local governments to promote economic growth. Market disintegration leads to similarity of regional industrial development, which in turn causes interregional competition rather than a complementary relationship in exports. Moreover, when economies of scale are unavailable, the provinces will resort to distorted factor prices and undesirable policy incentives to expand exportation. An integrated home market can create adequate flexibility between domestic demand and foreign demand. This is of special importance to the stable development of exports and the national economy as a whole.

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Appendix

See Tables 2, 3, 4, 5 and 6.

Table 2 The effects of Guangdong on exports of the other provinces

Explanatory variables	Explained variable: *ln_EXP*				
		SE = *coastal*	*SE* = *yzr*	*SE* = *pbr*	*SE* = *gdng*
ln_EXPGD	−0.563*** (0.077)	−0.194** (0.088)	−0.528*** (0.076)	−0.465*** (0.077)	−0.487*** (0.081)
*ln_EXPGD*SE*		0.208* (0.113)	0.167** (0.068)	0.022 (0.018)	0.144 (0.118)
ln_GDPPAIR	1.140*** (0.072)	0.937*** (0.067)	1.147*** (0.072)	1.132*** (0.073)	1.139*** (0.074)
ln_PERGDPPAIR	0.676*** (0.106)	0.190 (0.123)	0.604*** (0.105)	0.564*** (0.113)	0.553*** (0.116)
ln_AREAPAIR	−0.101*** (0.035)	−0.083*** (0.030)	−0.114*** (0.035)	−0.122*** (0.035)	−0.123*** (0.035)
ln_DIS	−0.954*** (0.096)	−0.717*** (0.082)	−0.934*** (0.095)	−0.933*** (0.098)	−0.932*** (0.098)
SE		−1.327 (1.455)	−0.568 (0.852)		−1.982 (1.508)
Year	Yes	Yes	Yes	Yes	Yes
AR(1)	0.023	0.021	0.022	0.021	0.025
AR(2)	0.421	0.279	0.406	0.406	0.410
Hansen	0.204	0.123	0.348	0.330	0.219
Observations	2,463	2,463	2,463	2,463	2,463
Groups	231	231	231	231	231

***, **, and * denote significance at the 1, 5, and 10 % level, respectively

Robust standard errors are in parentheses

AR(1), AR(2) and Hansen report the corresponding *p* values. AR(1) and AR(2) are tests for first-order and second-order serial correlation respectively. Hansen is a test of the over-identifying restrictions

SE represents the source province of export. *coastal* is a dummy variable of 11 coastal provinces, including Beijing, Tianjin, Hebei, Liaoning, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, Guangxi and Hainan. *yzr* is a dummy variable of the Yangtze River Delta, including Shanghai, Jiangsu and Zhejiang. *pbr* is a dummy variable of the Pan Bohai Rim, including Beijing,Tianjin, Hebei, Liaoning and Shandong. *gdng* is a dummy variable of Guangdong's neighbors, including Fujian, Jiangxi, Hunan, Guangxi and Hainan

Table 3 The effects of Guangdong: the source of export

Explanatory variables	Explained variable: *ln_EXP*								
	SE = *SH*	*SE* = *JS*	*SE* = *ZJ*	*SE* = *TJ*	*SE* = *LN*	*SE* = *BJ*	*SE* = *SD*	*SE* = *FJ*	*SE* = *SC*
ln_EXPGD	−0.487*** (0.076)	−0.451*** (0.078)	−0.423*** (0.073)	−0.496*** (0.075)	−0.498*** (0.078)	−0.490*** (0.077)	−0.471*** (0.078)	−0.475*** (0.075)	−0.519*** (0.075)
*ln_EXPGD*SE*	0.497*** (0.191)	0.376** (0.160)	0.105*** (0.017)	0.089*** (0.022)	0.058 (0.122)	0.180 (0.214)	0.034** (0.016)	0.081*** (0.018)	−0.042** (0.021)
ln_GDPPAIR	1.164*** (0.073)	1.095*** (0.074)	1.089*** (0.072)	1.228*** (0.076)	1.154*** (0.074)	1.146*** (0.074)	1.118*** (0.076)	1.134*** (0.072)	1.197*** (0.073)
ln_PERGDPPAIR	0.489*** (0.114)	0.537*** (0.111)	0.512*** (0.113)	0.490*** (0.118)	0.571*** (0.113)	0.554*** (0.115)	0.570*** (0.112))	0.535*** (0.113)	0.546*** (0.113)
ln_AREAPAIR	−0.104*** (0.035)	−0.126*** (0.034)	−0.130*** (0.034)	−0.095*** (0.035)	−0.117*** (0.035)	−0.117*** (0.035)	−0.122*** (0.035)	−0.123*** (0.034)	−0.110*** (0.035)
ln_DIS	−0.881*** (0.098)	−0.920*** (0.096)	−0.908*** (0.096)	−0.885*** (0.097)	−0.930*** (0.097)	−0.925*** (0.097)	−-0.933*** (0.097)	−0.926*** (0.096)	−0.909*** (0.097)
SE	−5.440** (2.352)	−3.748** (1.905)			−0.478 (1.651)	−2.076 (2.747)			
Year	Yes	Yes	Yes	Yes	Yes	Yes	yes	Yes	Yes
AR(1)	0.019	0.019	0.020	0.022	0.021	0.020	0.021	0.021	0.021
AR(2)	0.390	0.364	0.358	0.399	0.396	0.343	0.386	0.394	0.399
Hansen	0.582	0.555	0.563	0.526	0.553	0.570	0.569	0.554	0.544
Observations	2,463	2,463	2,463	2,463	2,463	2,463	2,463	2,463	2,463
Groups	231	231	231	231	231	231	231	231	231

***, **, and * denote significance at the 1, 5, and 10 % level, respectively

Robust standard errors are in parentheses

AR(1), AR(2) and Hansen report the corresponding *p* values. AR(1) and AR(2) are tests for first-order and second-order serial correlation respectively. Hansen is a test of the over-identifying restrictions

SE denotes the source province of export. SH, JS, ZJ, TJ, LN, BJ, SD, FJ, and SC denote Shanghai, Jiangsu, Zhejiang, Tianjin, Liaoning, Beijing, Shandong, Fujian, and Sichuan, respectively

Table 4 The effects of Guangdong: the affecting factors

Explanatory variables	Explained variable: *ln_EXP*							
		RT = *Drter*	*RT* = *Drwg*		*RT* = *Drkl*		*RT* = *Drms*	
ln_EXPGD	−0.180*** (0.071)	−0.288*** (0.077)	−0.110 (0.095)	−0.281*** (0.074)	−0.389*** (0.082)	−0.364*** (0.077)	−0.430*** (0.077)	−0.393*** (0.071)
*ln_EXPGD*RT*		0.232*** (0.053)	0.282*** (0.076)	0.058*** (0.007)	−0.019 (0.066)	0.024*** (0.007)	−0.0002 (0.070)	0.035*** (0.005)
ln_GDPPAIR	1.006*** (0.062)	1.239*** (0.066)	1.176*** (0.071)	1.195*** (0.070)	1.146*** (0.066)	1.450*** (0.066)	1.121*** (0.067)	1.102*** (0.067)
ln_PERGDPPAIR	0.116 (0.123)	0.358*** (0.115)	0.235* (0.121)	0.205* (0.120)	0.380*** (0.122)	0.381*** (0.123)	0.522*** (0.114)	0.520*** (0.112)
ln_AREAPAIR	−0.085*** (0.030)	−0.077** (0.035)	−0.094*** (0.034)	−0.080** (0.034)	−0.122*** (0.035)	−0.122*** (0.035)	−0.116*** (0.033)	−0.113*** (0.033)
ln_DIS	−0.675*** (0.084)	−0.808*** (0.096)	−0.764*** (0.097)	−0.732*** (0.095)	−0.863*** (0.099)	−0.863*** (0.099)	−0.902*** (0.094)	−0.896*** (0.094)
Drter	0.098 (0.074)	−2.443*** (0.655)						
Drwg	0.569*** (0.080)		−2.999*** (0.973)					
Drkl	0.093 (0.081)				0.541 (0.854)			
Drms	0.250*** (0.048)						0.314 (0.873)	
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(1)	0.045	0.001	0.111	0.088	0.036	0.036	0.005	0.002
AR(2)	0.520	0.219	0.492	0.391	0.315	0.302	0.303	0.143
Hansen	0.095	0.407	0.418	0.472	0.321	0.399	0.274	0.261
Observations	2,463	2,463	2,463	2,463	2,463	2,463	2,463	2,463
Groups	231	231	231	231	231	231	231	231

***, **, and * denote significance at 1, 5, and 10 % level, respectively

Robust standard errors are parentheses

AR(1), AR(2) and Hansen report the corresponding *p* values. AR(1) and AR(2) are tests for first-order and second-order serial correlation respectively. Hansen is a test of the over-identifying restrictions

RT represents regions' characteristics. *Drter*, *Drwg*, *Drkl*, and *Drms* are dummy variables of the tertiary industry ratio, the labor productivity, the capital to labor ratio and manufacturing agglomeration, respectively

Table 5 The effects of Guangdong: market potential and market disintegration

Explanatory variables	Explained variable: *ln_EXP*							
ln_EXPGD	−0.563*** (0.077)	−0.243*** (0.078)	−0.560*** (0.076)	−0.245*** (0.078)	−0.559*** (0.070)	−0.688* (0.384)	−0.406*** (0.070)	−0.399*** (0.080)
*ln_EXPGD*MP*					0.114*** (0.012)	0.149 (0.099)		
*ln_EXPGD*SEG*							−16.343* (8.903)	−12.092* (6.824)
ln_GDPPAIR	1.140*** (0.072)	0.883*** (0.069)	1.134*** (0.070)	0.890*** (0.068)	0.809*** (0.071)	0.799*** (0.074)	1.057*** (0.068)	1.078*** (0.064)
ln_PERGDPPAIR	0.676*** (0.106)	0.469*** (0.093)	0.677*** (0.106)	0.463*** (0.093)	0.372*** (0.100)	0.370*** (0.103)	0.588*** (0.122)	0.614*** (0.103)
ln_AREAPAIR	−0.101*** (0.035)	−0.039*** (0.031)	−0.103*** (0.035)	−0.037 (0.031)	−0.037 (0.032)	−0.052* (0.031)	−0.128*** (0.035)	−0.121*** (0.035)
ln_DIS	−0.954*** (0.096)	−0.757*** (0.091)	−0.954*** (0.096)	−0.754*** (0.091)	−0.706*** (0.095)	−0.726*** (0.093)	−0.949*** (0.097)	−0.950*** (0.097)
MP		1.191*** (0.149)		1.201*** (0.148)		−0.576 (1.277)		
SEG			−70.378 (80.614)	86.721 (76.057)				136.550* (83.298)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(1)	0.023	0.017	0.026	0.017	0..020	0.026	0.013	0.010
AR(2)	0.421	0.321	0.572	0.215	0.351	0.379	0.913	0.747
Hansen	0.204	0.262	0.210	0.229	0.166	0.157	0.288	0.879
Observations	2,463	2,463	2,463	2,463	2,463	2,463	2,463	2,463
Groups	231	231	231	231	231	231	231	231

***, **, and * denote significance at 1, 5, and 10 % level, respectively

Robust standard errors are in parentheses

AR(1), AR(2) and Hansen report the corresponding *p* values. AR(1) and AR(2) are tests for first-order and second-order serial correlation respectively. Hansen is a test of the over-identifying restrictions

MP and *SEG* represent market potential and market disintegration respectively

Table 6 The effects of Guangdong: endogeneity reconsidered

Explanatory variables	Explained variable: *ln_EXP*				
	SYS-GMM	SYS-GMM	G2LS	G2LS *SE* = *yzr*	G2LS *SE* = *pbr*
ln_EXPGD	−0.563*** (0.077)	−0.473*** (0.074)	−0.207*** (0.061)	−0.300*** (0.061)	−0.410*** (0.060)
*ln_EXPGD*SE*				0.129*** (0.044)	0.015 (0.018)
ln_GDPPAIR	1.140*** (0.072)	1.166*** (0.072)	1.088*** (0.068)	1.119*** (0.060)	1.135*** (0.055)
ln_PERGDPPAIR	0.676*** (0.106)	0.592*** (0.108)	0.615*** (0.109)	0.631*** (0.099)	0.722*** (0.088)
ln_AREAPAIR	−0.101*** (0.035)	−0.110*** (0.035)	−0.108*** (0.038)	−0.105*** (0.034)	−0.089*** (0.030)
ln_DIS	−0.954*** (0.096)	−0.937*** (0.099)	−1.006*** (0.102)	−0.996*** (0.088)	−1.014*** (0.079)
Year	Yes	Yes	Yes	Yes	Yes
AR(2)/R^2	0.421	0.369	0.7290	0.7161	0.6983
Hansen/Hausman	0.204	0.429	84.26 (0.000)	106.74 (0.000)	170.75 (0.000)
Observations	2,463	2,463	2,463	2,463	2,463
Groups	231	231	231	231	231

***, **, and * denote significance at 1, 5, and 10 % level, respectively

Robust standard errors are in parentheses

AR(2) and Hansen report the corresponding *p* values. Both are statistics for the estimation using SYS-GMM of columns 2 and 3. AR(2) is a test for second serial correlation and Hansen is a test of the over-identifying restrictions

R^2 and Hausman correspond to the estimation using G2LS of the right three columns. The null hypothesis of the Hausman test is that the difference of estimated coefficients of RE and G2LS is not systematic

SE denotes the source province of export. *yzr* is a dummy variable of the Yangtze River Delta, including Shanghai, Jiangsu and Zhejiang. *pbr* is a dummy variable of the Pan Bohai Rim, including Beijing,Tianjin, Hebei, Liaoning, and Shandong

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