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Journal of Policy Modeling 45 (2023) 202–227



www.elsevier.com/locate/jpm

Trade options for a small open economy: The different impact of Taiwan exports to China and to other countries

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Received 29 May 2022; Received in revised form 7 August 2022; Accepted 24 November 2022

Available online 2 December 2022

Abstract

This study aims to explore advantageous trade arrangements for a small open economy. To discover the arrangement, the fundamental question to ask is how trade affects a small economy. Due to the differential factor mobility, the two main streams of trade theory—new economic geography and comparative advantage—make divergent predictions of trade effects. This study identifies the differences in factor mobility and distinguishes the differential impacts of exports to China and other countries on Taiwan's manufacturing clusters. Using Taiwan's 2006 and 2011 census data and trade statistics, this study applies the two-stage least squares method to test the differential impacts. The findings reveal that the growth in Taiwan's exports to other countries significantly increased the employment level of manufacturing clusters in Taiwan. However, such effects have not been found for exports to China. The lack of response in Taiwan's local employment to exports to China can be inferred as a short-term exhibition of the long-run core-periphery effect. The policy implication of this study is that trade involving low factor mobility is more beneficial than that involving high factor mobility for a small open economy. Thus, for a small economy, trade liberalization that will 'not' attract large factor outflows from the small economy is more desirable.

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JEL classifications: F16; R12; J23

Keywords: Exports; New economic geography; Employment; Factor mobility

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¹ The author thanks Sabah Cavallo and four anonymous referees for their valuable comments.

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<https://doi.org/10.1016/j.jpmod.2022.11.008>

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1. Introduction

For a small open economy such as Taiwan, exports are the main source of economic growth. However, does trade with different trading partners have similar impacts on the economy? Trade statistics show that the proportion of Taiwan's export went to mainland China and Hong Kong has risen from 24% in 2000 to 40% in 2006, and it has remained so until now. In contrast, Taiwan's exports to the United States and Europe dropped from 38% in 2000 to approximately 20% in 2010 (Fig. 1). However, associated with the increasing size and frequency of interaction between Taiwan and China, Taiwan's economic performance was weakening. The annual economic growth rate slowed from 6.23% during 1991–2000 to 3.61% during 2001–2015. Based on the calculation of this study, the mean growth rate of employment in a manufacturing cluster is found to be -1.57% per year over the period 2006–2011, when Taiwanese investment in China grew the fastest. Due to this phenomenon, one would wonder whether the significant changes in the structure of its export regions—the shift of major trade partners—would affect the economic performance of a small open economy. Through this study, we can infer the beneficial trade arrangements and policy directions for small economies.

On trade effect, the existing literature proposes two theoretical strands: economic geography and comparative advantage. From the new economic geography (NEG) perspective, trade between two economies will cause a home market effect, that is, industries with increasing returns tend to settle in the larger market and export to the other market, as first demonstrated by Krugman (1980) and then by Helpman and Krugman (1985). Such patterns of trade expansion can even lead to a core-periphery structure characterized by deindustrialization in the smaller economy resulting from labor movements following firm relocation (Krugman, 1991) or the mutual purchase of intermediate inputs among firms (Krugman & Venables, 1995). These arguments suggest that although trade benefits large economies, small economies may suffer. Conversely, the traditional comparative advantage (CA) view assumes a fixed amount of factor endowment in the form of immobile factors and claims that trade benefits both large and small countries.

So why do these differences in trade benefits exist? Fujita et al. (1999) argued that based on low to high factor mobility, trade practices can be categorized into three levels: international, interregional, and urban-rural. Different degrees of factor mobility correspond to different trade



Fig. 1. Taiwan's exports to major trade partners as a percentage of Taiwan's total exports. Source: Database of the Customs Administration, Ministry of Finance, Taiwan.

models. [Davis and Weinstein \(1999\)](#) used data from regions within Japan to obtain evidence supporting the existence of the economic geography effect. However, based on international data, [Davis and Weinstein \(1996\)](#) asserted that the economic geography effect is scant. [Davis and Weinstein \(1999\)](#) stated that the cause of this divergence is the greater mobility of factors across regions than across countries. The existing literature suggests that factor mobility is an important element when examining the impact of trade on a small economy.

To investigate our issue, this study, theoretically and empirically, compares the impact of trade with different trading partners. The theoretical model used in this study combines three mutually-trading economies: a small economy, a large economy, and the global market, wherein firms can move between the two economies (large and small). By contrast, no factor movement between the global market and either of the economies is assumed. Such simulations enable us to distinguish the differential effect of two trade scenarios—the small economy's trade with the large economy versus its trade with the global market, namely, the trade involving high versus low factor mobility.

In the empirical analysis, Taiwan's trading partners are divided into China and other countries, corresponding to the large economy and global market in the theoretical model, respectively. The similarity of language and geographical proximity of Taiwan to China have facilitated high mobility of firms and entrepreneurs between the two economies, and trade is likely to result in circular causality, as suggested by the core-periphery patterns of the NEG theory. However, the languages spoken in Taiwan and other regions outside China differ, leading to relatively low factor mobility, which could result in immovable comparative advantages in trade.

Although this policy-oriented study can supplement the existing body of empirical research on NEG, its strategy differs from previous literature as discussed in Section II. This study extends the empirical method of [Acemoglu et al. \(2016\)](#), who examined the impact of imports from China on employment in the United States. The method proposed by [Acemoglu et al. \(2016\)](#) is applied to investigate the differences in the economic impact of Taiwan's exports to different trading partners and to verify the implications of the theoretical model—industrial growth driven by trade with the large economy is no more than that driven by trade with the global market for a small economy in the short run. This application, which considers exports as an independent variable and a small economy as the observation target, has the advantage of revealing the dynamic process of the NEG effect rather than the equilibrium consequences shown in previous literature. Thus, the current empirical setting can provide further insight into small-state trade policies. Moreover, the proposal and verification of short-run core-periphery effect are also the contributions of this study to NEG empirical literature. According to [Redding \(2010\)](#), many studies have exploited the changes in exogenous expenditure when testing the NEG effect. Therefore, to address possible endogeneity, this study introduces the two-stage least squares (2SLS) approach using the changes in industrial imports of various trading partners as instruments of Taiwan's industrial exports.

This study focuses on the manufacturing clusters in Taiwan. By matching the trade data reported under Harmonized System Codes with the data coded with Taiwan's Standard Industrial Classification, the study demonstrates that the impact of trade with different trading partners differs. Increasing exports to trading partners deemed to involve low factor mobility can drive employment growth, whereas exports involving high factor mobility do not.

The remainder of this paper is organized as follows. Section II introduces Taiwan's major trade relationships and reviews relevant literature on NEG. Section III presents a conceptual framework for understanding the mechanisms of the distinguishable trade effects of the two

trade categories. Section IV describes the empirical approach and establishes testable hypotheses regarding the short-run effect. Section V addresses the data sources and the construction of the observations. Section VI presents the results of the study, and Section VII concludes the paper.

2. Background and related literature

2.1. Background

Taiwan joined the World Trade Organization (WTO) in 2002, immediately after China joined in 2001. Further, in 2010, Taiwan and China signed the Cross-Straits Economic Cooperation Framework Agreement, a free trade agreement under the WTO to reduce mutual trade barriers. In terms of personnel exchange between Taiwan and China, apart from the national security field, there are no specific restrictions.³

Taiwan's investment in China is prohibited only by a negative list of projects that hinder national security and industrial development. The investment caps for general projects and corporate investments are loose, and since 2008, they have hardly constituted any restrictions.⁴

2.2. Related literature

The present analysis addresses the relative explanatory powers of the NEG and CA theories. Related studies (Martínez-Galarraga, 2012; Midelfart-Knarvik et al., 2000; Wolf, 2007; Naude and Gries, 2009; Klein & Crafts, 2012) have introduced proxy variables for market size or market potential based on NEG, along with factor endowments, in accordance with the CA argument. Instead, Davis and Weinstein (1999, 2003), Lundbäck and Torstensson (1998), Head and Ries (2001), Crozet and Trionfetti (2008), and Claver et al. (2011) examine the responses to idiosyncratic or home-biased demands to evaluate whether the home market effect exists and embed the endowment variables related to CA. The approach of the present analysis differs in that it leverages the implications of the endogenous locations of firms and demands emphasized by NEG (Head & Mayer, 2004). Accordingly, response versus non-response to exports is used to distinguish between the different impacts of the CA and NEG aspects of trade. Furthermore, existing literature on NEG has obtained results indicating an over-proportionate increase in production in large countries and a decrease in production in small countries following the establishment of trade equilibrium. However, the short-term effect of increased market access after reducing trade barriers between small and large countries remains to be investigated. The current study uses exports—a natural consequence of lowering trade barriers—as a driving factor to reveal the immediate impact of exports rather than the effect of long-run equilibrium on small economies.

In addition, existing literature includes studies providing empirical evidence of trade effects. For instance, the effects of import competition from China on the labor markets of the United States (Acemoglu et al., 2016; Autor et al., 2017) and Europe (Bloom et al., 2016) have been investigated. However, for an export-oriented country such as Taiwan, the current study focuses on the impact of exports rather than imports competition and differentiates the effect between

³ Refer to Act Governing Relations between the People of the Taiwan Area and the Mainland Area.

⁴ Refer to Principles for Reviewing Investment or Technical Cooperation in Mainland.

exports from Taiwan to China and to other countries. [Baliamoune-Lutz \(2019\)](#) suggested that the destination of a country's exports is an important factor, as in this study. [Baliamoune-Lutz \(2019\)](#) findings indicate that through the channel of skill upgradation, exports to developed economies enhance the export sophistication in developing countries. However, this study addresses the differences in country size and factor mobility between trading partners as the key elements affecting the distribution of gains from trade.

3. Conceptual framework

[Tsai \(2017\)](#) model, which is an extension of the model proposed by [Krugman and Venables \(1995\)](#), is used in this study to simulate the economic effects of trade between a small economy and two categories of trading partners. The model's framework is a trading system with three regions: a small economy, a large economy, and the global market. The labor supply of the small economy is a fixed value L , whereas the large economy has a horizontal labor supply curve, the height of which is established using the agricultural sector wage.

Suppose that both the small and large economies contain two sectors: agriculture and manufacturing. Although unskilled workers are mobile between the two sectors within an economy, they cannot move across geographical regions. However, firms and entrepreneurs can move between the two economies because the number of firms in large and small economies can vary under different trade scenarios. For instance, the small economy can become deindustrialized, necessitating the import of manufactured goods from the large economy. The global market, which imports manufactured goods from both the small and large economic regions, is treated as a consumer market for industrial goods without a manufacturing sector; thus, factors of production cannot be moved between the global market and either economy. The assumption that the global market does not comprise manufacturing activity is closer to the actual situation in the United States and Europe. Considering Taiwan's four major export regions in [Fig. 1](#), the total proportion of Taiwan's exports to the United States and Europe in 2011 was 22% higher than that of exports to Southeast Asia, which was 17%. Furthermore, this assumption aims to distinguish the small economy's trade with third countries from its trade with the large economy, since the relative importance of the comparative-advantage and the core-periphery effect varies under these two scenarios ([Tsai, 2017, p396](#)).

Firms sell manufactured goods to consumers as consumption goods and to other firms as intermediate inputs. Manufactured goods sold outside the producing regions incur iceberg trade costs, and trade costs between different pairs of regions differ. Let τ represent the rate of trade costs between the large and small economies, ρ represent that between the large economy and the global market, and ρ_c represent the rate between the small economy and the global market.

Focusing on the effects of separate trade between small and large economies, the rate of trade costs (τ) between the small and large economies is set to be sufficiently low to facilitate trade between the two countries, and the cost of trade (ρ_c) between the small economy and the global market is extremely high, making trade difficult. The simulation results are shown in [Figure 2a](#). In contrast, the simulation with high τ and low ρ_c indicates the effect of separate trade between the small economy and the global market, as shown in [Figure 2b](#).

As trade and investment liberalization between small and large economies continue, firms have access to both markets and can locate factories in either economy. To take advantage of economies of scale, firms will only set up factories in one place, and to save on trade costs (e.g., transportation costs), firms in the small economy will relocate to the large economy. If downstream firms take the lead, the linkage effect will attract the migration of upstream firms to

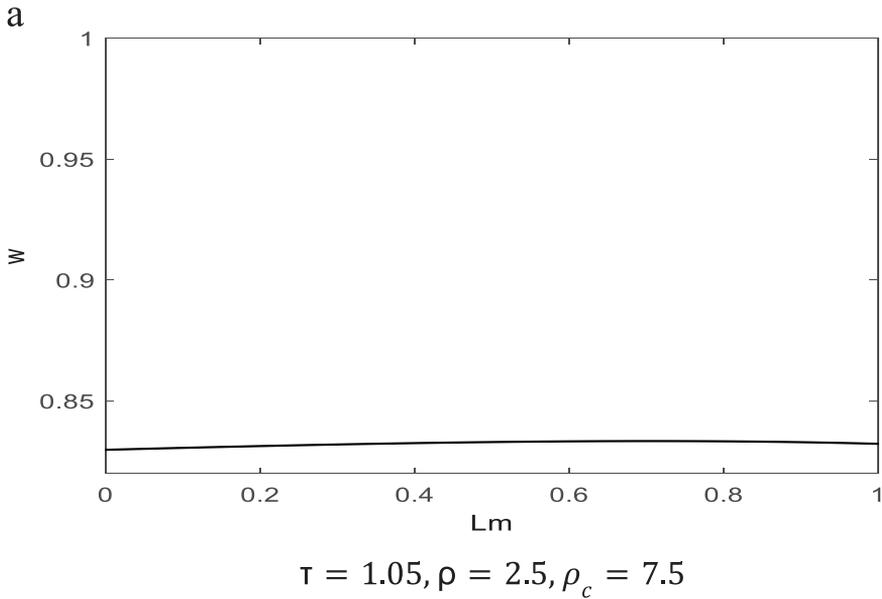


Fig. 2a. Labor demands in the small economy.

a. Low trade costs between the small and large economy and high trade barriers between the small economy and the global market.

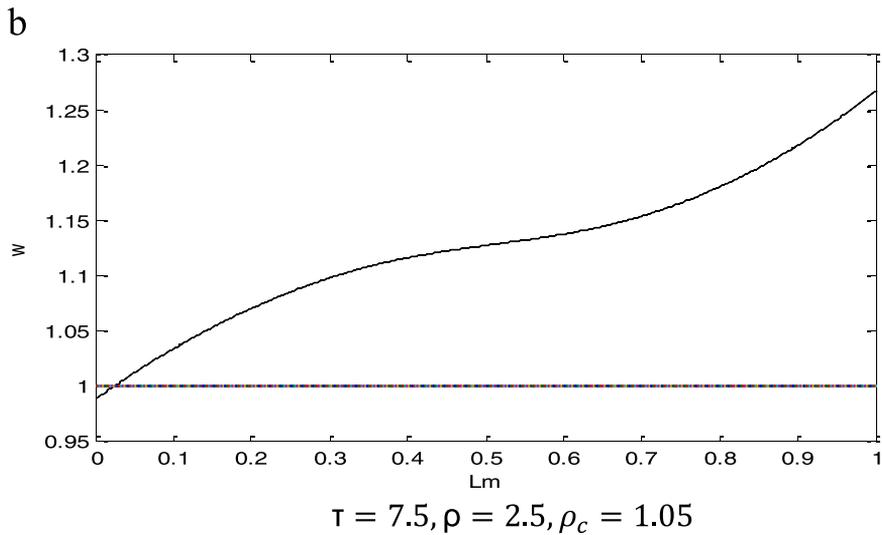


Fig. 2b. Low trade costs between the small economy and the global market and high trade barriers between the small and large economy.

Note: The labor force (L) of the small economy equals one. The length of the horizontal axis is Lm , the share of industrial employment in the small economy; the vertical axis is the wage rate, w ; and the horizontal line at height unity represents the agricultural wage rate. τ represents the rate of trade costs between the large and the small economy, ρ represents that between the large economy and the global market, and ρ_c represents that between the small economy and the global market.

the large economy to access their manufacturing customers. As manufacturing continuously shifts from small to large economies, the small economy gradually becomes the periphery. As Fig. 2a illustrates, the labor demand curve is always below the agricultural wage, which is equal to 1; hence, the manufacturing employment level shrinks in the small economy.

Fig. 2b shows the dynamic process resulting from trade liberalization between the small economy and the global market. For a small economy, the market expansion effect following trade liberalization will not cause factor outflows. In turn, unskilled workers in the small economy will continue to shift from the agricultural sector to the industrial sector if the mass of the industrial sector in the small economy exceeds the critical value in the unstable steady state and if its wage (w) is higher than the agricultural wage. Since the small economy is relatively smaller than the global market, after reducing the trade costs between them, the employment level in the industry in the small economy will almost certainly expand because of a substantial job creation effect, and the critical value of L_m (the proportion of manufacturing employment in the labor force in the small economy) in the figure will be easily surpassed.

The circumstances described in the aforementioned model and the standard NEG model depict a long-term result. However, the decline in trade costs between two countries initially promotes an increase in exports; thus, it would be instructive to determine the short-term effects of this increase in exports. Will these effects be conducive to employment growth as assumed by the general public? What is the message implied in Fig. 2a regarding exports? Most of Taiwan's exports to China, a large economy, comes from Taiwanese downstream firms that previously moved to China and purchased intermediate goods from upstream firms in Taiwan. Therefore, the job creation effect of these exports may be insignificant because linkage effects and agglomeration economies continue to attract upstream firms' movement to China. This effect is explained in more detail in Section IV.

By contrast, Taiwan's trade with the global market (countries other than China) operates differently. Owing to linguistic differences, the relative immobility of technology and factors of production make it difficult to trigger the agglomeration effect induced by backward and forward linkages. Thus, when products from firms located in Taiwan enter the global market, employment decisions are made based on the condition of long-run profit maximization as the trade relationship is established. The employment level in Taiwan then increases, as shown in Fig. 2b.

Studies (e.g. Redding & Venables, 2004) have confirmed the relationship between a reduction in trade costs and exports. Therefore, the increase in exports is regarded as a derivative of the decline in trade costs, and the present investigation focuses on the impact of changes in exports on employment. Exports to the global market, in particular, induce employment growth as a result of lower trade costs; however, exports to the large economy may not.

4. Empirical test

The present analysis compares the trade-induced effects of Taiwan's exports to China and other countries by measuring the responses of employment growth, total real wage bill growth, growth in number of establishments, and total factor productivity. An empirical model is constructed to determine export-induced effects. Specifically, export sales are categorized as goods produced in Taiwan and the overseas production of Taiwan's export orders. To maintain consistency with national accounts, export sales produced in Taiwan are simply referred to as exports. The export destinations of Taiwan can be classified into two categories. The first category consists of exports to China, including exports to mainland China and Hong Kong, and

exports to other countries. The second category retains the exports to China, while the exports to other countries are subdivided into exports to the U.S., Southeast Asia, and the rest of the world (ROW). The empirical framework of the first category is presented in a general form and the regression results of the second category are shown in the estimation results. Growth in exports to different regions constitutes the primary independent variable of the regression equation.

Notably, the overseas production of Taiwan’s export orders represents products that are purchased, manufactured, or processed abroad (offshore) and do not go through Taiwan customs, that is, triangle trade; hence, the export statistics collected by Taiwan customs can be completely separated from the values of the triangle trade. Moreover, the revenues from triangle trade are generated through the services of establishments in Taiwan that work as go-betweens, and therefore, they should be distinguished from exports (revenue from firms’ production in Taiwan). In the present analysis, the growth of triangle trade captures the current effect of overseas production, while the ratio of overseas production in mainland China to the industry’s exports in the initial period takes the accumulated effect.

In this study, the regression equation is not embedded with variables related to imports, as conducted by [Acemoglu et al. \(2016\)](#) and [Bloom et al. \(2016\)](#), because Taiwan participates in international supply chains and there is a close link between Taiwan’s imports and exports. As demonstrated by [Lee and Chang \(2012\)](#), owing to the prevalence of the international division of labor, Taiwan’s intra-industry trade, especially the vertical intra-industry trade, increased sharply between 1997 and 2006. Since there is a significant increase in the proportion of trade within the same industry, the changes in imports and exports in the same industry are closely related to each other. The study conducted by [Tsai \(2018\)](#) demonstrated a high correlation between exports and imports. Taiwan’s imports, regardless of the country of origin, were found to have no significant effect on employment, average wages, and the number of establishments. Since exports are key drivers of economic growth, import-related variables were not included in the present analysis.

To develop a verifiable hypothesis, based on the previous discussion, a general equation for a cluster in industry k and economic region r at time t is established as follows:

$$\begin{aligned}
 dY_{k,r,t} = & \text{constant} + \beta_1 dXchina_{k,t} + \beta_2 dXother_{k,t} \\
 & + \beta_3 dtriangle_{k,t} + \beta_4 tri_china_ra_{k,t-1} \\
 & + H1'_{k,r,t-1} \cdot \eta_1 + H2'_{r,t-1} \cdot \eta_2 + Z'_{k,t-1} \cdot \gamma + \varepsilon_{k,r,t}
 \end{aligned} \tag{1}$$

In the above equation, the dependent variable $dY_{k,r,t}$, which is used to measure the trade effect, represents the annual growth rate of the following variables: employment ($dL_{k,r,t}$), total real wage bill ($dwL_{k,r,t}$), number of establishments ($dnum_{k,r,t}$), non-production employment (number of officers) ($dmana_{k,r,t}$), and production employment (number of workers) ($dworker_{k,r,t}$) in the cluster over the period starting from 2006 to 2011, or total factor productivity ($tfpdot_rl_{k,r,t}$) in same cluster over the same period. Appendix A and [Table 1](#) provide a detailed description of the variables in [Eq. \(1\)](#).

The relevant independent variables used in the current analysis include the annual real growth rate of exports to China, $dXchina_{k,t}$, the annual real growth rate of exports to countries other than China, $dXother_{k,t}$, the annual real growth rate of overseas production of Taiwan’s

Table 1
Summary statistics.

variable	description	Unit	Mean	Median	Std. Dev.	Min	Max
dL	100 times the annual log change in one plus employment in a cluster over the period 2006–2011	%	-1.574	-0.402	11.138	-150.685	88.342
dwL	100 times the annual log change in one plus total wage payments in a cluster over the period 2006–2011	%	-1.713	-0.339	16.616	-276.777	102.625
dnum	100 times the annual log change in one plus the number of establishments in a cluster over the period 2006–2011	%	-0.360	0.000	8.354	-41.589	41.589
dmana	100 times the annual log change in one plus the number of non-production employment in a cluster over the period 2006–2011	%	0.725	1.717	11.465	-143.964	94.841
dworker	100 times the annual log change in one plus the number of production employment in a cluster over the period 2006–2011	%	-2.547	-1.358	11.447	-135.981	91.078
tfpdot_r1	Total factor productivity of single-establishment firms in a cluster over the period 2006–2011=the difference between the rate of change of output and the sum of the rate of change of each input times its expenditure share	–	-0.048	-0.022	1.181	-34.985	34.014
dXchina	100 times the annual log change in one plus real exports to China of an industry over the period 2006–2011	%	1.530	1.054	12.530	-60.801	49.202
dim_china	100 times the annual log change in one plus real imports of China from the world of an industry over the period 2006–2011.	%	10.779	8.783	8.567	-25.500	50.997
dXus	100 times the annual log change in one plus real exports to the U.S.A of an industry over the period 2006–2011	%	-2.649	-3.231	13.333	-210.525	78.180
dXseasia	100 times the annual log change in one plus real exports to Southeast Asia of an industry over the period 2006–2011	%	4.872	5.973	10.184	-50.891	51.062
dim_seasia	100 times the annual log change in one plus real imports of Southeast Asia (except for Laos and Myanmar for which imports in 2006 are unavailable) from the world of an industry over the period 2006–2011.	%	19.626	19.987	8.214	3.716	68.630
dXother_chinausasia	100 times the annual log change in one plus real exports to the rest of the world (ROW) of an industry over the period 2006–2011	%	1.316	1.955	8.795	-28.933	52.567
dXother	100 times the annual log change in one plus real exports to regions other than China of an industry over the period 2006–2011	%	1.211	1.956	8.418	-27.638	41.302
dim_other	100 times the annual log change in one plus the sum of real imports of the U.S.A and the Association of Southeast Asian Nations (except for Laos and Myanmar for which imports in 2006 are unavailable) from the world of an industry over the period 2006–2011	%	6.237	5.793	6.541	-21.708	42.509
dtriangle	100 times the annual log change in one plus real overseas production of Taiwan's exports orders of an industry over the period 2006–2011	%	10.719	6.440	45.683	-275.570	304.579

(continued on next page)

Table 1 (continued)

variable	description	Unit	Mean	Median	Std. Dev.	Min	Max
tri_china_ra	Ratio of Taiwan's overseas production in China to the industry's exports in 2006, $(triangle95_{k,t-1} \times trichina95_{k,t-1} \times 0.01) / ex95r_1_{k,t-1}$	100 %	1.284	0.031	6.130	0.000	40.146
tri_china100_ra	Ratio of Taiwan's overseas production in China to the industry's exports in 2011, $(triangle100_{k,t-1} \times trichina100_{k,t-1} \times 0.01) / ex100_1_{k,t-1}$	100 %	2.336	0.070	12.296	0.000	89.802
exportratio100	Export share of industry product sales in 2011	100 %	0.468	0.397	0.237	0.057	0.950
cluster_L	log(employment in a cluster in 2006)	log value	8.434	8.504	1.506	0.000	11.483
region_L	log(employment in a region in 2006)	log value	13.567	13.524	0.921	10.403	14.850
diverse	Inversed Herfindahl concentration index: $\left[\frac{\sum_{r=k} \left(\frac{L_{i,r,2006}}{L_{r,2006} - L_{k,r,2006}} \right)^2 \right]^{-1}$	–	97.826	102.701	25.091	14.540	122.793
localcompetition	$\frac{(\text{number of establishments in cluster})_{k,r,2006}}{(\text{number of establishments in Taiwan industry})_{k,2006}}$	–	1.000	0.947	0.694	0.046	96.091
HI	Herfindahl index: $\sum_{p \in k} \left(\frac{L_{p,k,2006}}{L_{k,2006}} \right)^2$	–	0.035	0.019	0.060	0.001	0.940
worker_ra	Share of production employment in employment of an industry in 2006= production employment/employment	100 %	0.616	0.638	0.099	0.219	0.812
average_wage	average wage in an industry in 2006=(total wage bill)/(employment)	1,000NTD	484.178	458.010	121.791	288.879	1011.100
KL_ra	Capital-labor ratio in an industry in 2006=(net value of fixed assets in operation)/(employment)	1,000NTD	3,130.730	1,652.250	3,753.856	295.654	35,239.370
rd_ra	Ratio of R&D expenditures to sales in an industry in 2006 =(R&D expenditures)/(sales)	100 %	0.014	0.009	0.014	0.000	0.121
rprofit_pro	Profit ratio in an industry in 2006=(profit)/(total value of production)	100 %	0.116	0.097	0.083	-0.167	0.460

Note: N=2051, except for the variable tfpdot_r1, for which N=1899. NTD denotes New Taiwan Dollar. The rest of the world (ROW) excludes China, the U.S., and Southeast Asia. "triangle95" and "triangle100" are the revenues of the triangle trade of industry k in 2006 and 2011, respectively. "tri_china95 x0.01" and "tri_china100 x0.01" are the proportion of triangle trade products produced in mainland China in 2006 and 2011, respectively, and "ex95r_1" and "ex100_1" represent Taiwan's real exports to the world by industry k in 2006 and 2011, respectively. L represents employment, the subscript t stands for region, k represents industry, and p represents an establishment in an industry. The values used in these computations are deflated to 2011 New Taiwan dollars by applying the Consumer Price Index. Except for the statistics of dnum and tfpdot_r1, all observations are weighted by the 2006 cluster employment.

export orders (triangle trade), $dtriangle_{k,t}$ for industry k over the period 2006–2011, and the ratio of Taiwan’s overseas production in China to the industry’s exports in 2006, $tri_china_ra_{k,t-1}$. According to the model described in Section III, when employment in the small economy increases, both the total real wage bill and the number of firms increase; that is, $dL_{k,r,t}$, $dwL_{k,r,t}$, and $dnum_{k,r,t}$ are simultaneously positive. However, the relative changes in $dmana_{k,r,t}$ and $dworker_{k,r,t}$, and the change in total factor productivity ($tfpdot_r1_{k,r,t}$) are beyond the prediction of the current model.

Based on the model, the hypotheses to be tested are as follows:

$$\beta_2 > 0 \text{ and } \beta_1 \leq \beta_2,$$

where β_1 represents the effect of Taiwan’s exports to China and β_2 represents the effect of Taiwan’s exports to countries other than China. Figure 2b presents the result of the decrease in trade costs when entrepreneurs do not move across regions. The labor demand curve illustrated in Figure 2b indicates that a decrease in trade costs between the small economy and the global market, as long as the initial employment of the small economy is greater than the critical mass, triggers an increase in exports and leads to employment growth, that is, $\beta_2 > 0$.

Figure. 2a illustrates the decrease in employment in the small economy resulting from the decrease in trade costs between the small and the large economies and the relocation of manufacturers. However, the migration of firms from the small economy to the large economy occurs gradually rather than overnight. Hence, the short-term employment creation effect (β_1) of trade between the small and large economies lies between the employment effects exhibited in Fig. 2a and b, which is weaker than the effect of trade between the small economy and the global market (β_2); therefore, $\beta_1 \leq \beta_2$ can be expected. Since some firms may have moved abroad, their employment has decreased, while other firms have not yet moved abroad and in response to the increase in exports, they need to increase their employment. These two forces may be offset and the increase in cluster employment may be insignificant. According to the “Survey⁵ of the Current Condition of the Manufacturing Industry’s Overseas Investment,” the overseas production of export orders in China increased from 38% in 2006 to 47% in 2011. This increase confirms the relocation of Taiwanese manufacturers to China. Moreover, the survey indicated that this migration phenomenon was most evident in the information and communication products industry, and the proportion of Taiwan’s export orders produced in China in this industry reached 83.6% in 2011.

Further, the long-term effect shown in Fig. 2a occurs when most manufacturers move out of the small economy resulting in a decrease in the number of manufacturers in the small economy. This phenomenon is embodied in our empirical model in the form of an increase in the overseas production of Taiwan’s export orders in China. In such a situation, the labor demand declines, and manufacturing wages are less than agricultural wages, which reduces employment opportunities in the manufacturing sector. This effect is reflected by $\beta_4 < 0$, a negative coefficient of the ratio of Taiwan’s overseas production in China to the industry’s exports in 2006.

The model in this study predicts that Taiwan’s exports to countries other than China have a positive effect ($\beta_2 > 0$) on industry performance, such as employment. The effect of Taiwan’s exports to China on promoting employment (β_1) is less than the former effect (β_2), although β_1 is

⁵ The Survey is conducted by the Ministry of Economic Affairs, Taiwan.

not necessarily negative. However, $\beta_1 \leq \beta_2$ is the short-term symptom of the core-periphery effect. The long-run core-periphery effect is reflected by $\beta_4 < 0$.

The control variables are measured in the initial period ($t - 1$) (2006) and comprise three types of variables. The first and second types include variables related to the local environment. The first type, $H1_{k,r,t-1}$, comprises cluster-level controls, including employment within its own industry ($cluster_L_{k,r,t-1}$) following Rosenthal and Strange (2003) and capturing the localization effect,⁶ diversity ($diverse_{k,r,t-1}$) suggested by Jacob (1969) and formulated similar to Cingano and Schivardi (2004), and the local competition ($localcompetition_{k,r,t-1}$) of a cluster following Glaeser et al. (1992). The cluster-level control variables help eliminate the allocation effect among clusters within an industry in response to industry-level changes in export.

The second type, $H2_{r,t-1}$, represents regional-level total local employment ($region_L_{r,t-1}$), which captures the urbanization effect following Rosenthal and Strange (2003). The third type, $Z_{k,t-1}$, includes variables related to industrial circumstances and intensity in the use of non-production labor and capital, including the degree of monopoly measured by the Herfindahl index ($HI_{k,t-1}$), share of non-production employment ($worker_ra_{k,t-1}$), capital-labor ratio ($KL_ra_{k,t-1}$), average real wage ($average_wage_{k,t-1}$), research and development ratio ($rd_ra_{k,t-1}$), and profit rate ($rprofit_pro_{k,t-1}$). $\varepsilon_{k,r,t}$ is error terms.

It is worth noting that trade-related independent variables are defined at the four-digit industry level, while the dependent variables are measured at the cluster level rather than at the regional level⁷ or using commuting zones as observations. Therefore, the trade impact is assumed to be the same across the four-digit industry in all regions. In other words, the coefficients of trade-related independent variables are the average employment responses across clusters in the same industry, while the difference in employment responses of individual clusters is derived from the influence of the above three types of control variables. Since clusters directly bear external shocks and industries can make internal adjustments among the clusters in various regions, the effect of $\beta_1 \leq \beta_2$ should be more pronounced at the cluster level than at the industry level. Therefore, the observations in this analysis are at the cluster level. An investigation at the industry level can be seen in the study conducted by Tsai (2018)⁸

Following Acemoglu et al. (2016), estimates for the regression with the dependent variables related to employment, including $dL_{k,r,t}$, $dwL_{k,r,t}$, $dmana_{k,r,t}$, and $dworker_{k,r,t}$ are weighted by the start-of-period cluster employment.⁹ Observations are manufacturing clusters at the four-digit industry level; standard errors are clustered at the three-digit industry level to permit arbitrary error correlations across clusters within larger industries.

Since exports are induced by reducing trade costs in the model, factors regarding firms' autonomous behaviors (e.g., technology upgrades and marketing) that cause the endogeneity of exports, that is, the simultaneous growth in exports and employment, should be excluded.

⁶ As suggested by Marshall (1920), localization effects refer to a localized industry benefiting from a specialized pooled labor market, a more effective flow of information among firms, and the provision of inputs specific to an industry in a greater variety and at a lower cost.

⁷ Hence, Bartik measures are not fit for this analysis.

⁸ Tsai (2018) conducted the regression at the industry level and also obtained the effect of $\beta_1 \leq \beta_2$, but with $\beta_1 > 0$. In the present analysis, the estimated β_1 s are not significantly different from 0. In addition, compared with this analysis, Tsai (2018) did not introduce instrumental variables and the theoretical model.

⁹ Because growth rates constitute the dependent variables, if the cluster is very small, a slight change in the employment level may cause a very large change in its growth rate. Regression with the employment weight will give the large cluster a greater influence on the coefficient and make it less susceptible to the impact of extreme changes in small clusters.

Hence, the present analysis introduces the two-stage least squares method and instruments for $dX_{china_{k,t}}$ and $dX_{other_{k,t}}$, with the growth in China's imports from the world, $dim_{china_{k,t}}$, the growth in the sum of imports of the United States and Southeast Asia from the world, $dim_{other_{k,t}}$, and the growth in Southeast Asian imports from the world, $dim_{seasia_{k,t}}$.¹⁰ The imports of these countries are supposed to be determined by their own economic situations rather than driven by industries in Taiwan, which has a relatively small economy. Thus, the instruments should be exogenous and have predictive power for Taiwan's exports to these countries.

Regarding the independent variable, the ratio of Taiwan's overseas production in China to the industry's exports in 2006, $tri_{china_ra_{k,t-1}}$, has a statistically significant positive correlation with the accumulated actual investment in China by Taiwan's publicly traded companies.¹¹ This finding suggests that the increase in $tri_{china_ra_{k,t-1}}$ resulted from Taiwanese firms' investments in China, and thus, the ratio of overseas production in mainland China to the industry's exports can be an indicator of Taiwan's investment in China. More specifically, the numerator of $tri_{china_ra_{k,t-1}}$ indicates Taiwan's export orders produced in mainland China in 2006 and the denominator reflects those produced in Taiwan (see variable descriptions in Appendix A). Therefore, this variable represents the extent of industrial agglomeration in China by Taiwanese firms in 2006, and controlling this variable can eliminate the influence of agglomeration economies originating in China from the export-induced effect.

5. Data sources and observation descriptions

5.1. Data sources

The data sources for this study include Taiwan's Industry, Commerce, and Service Census (ICSC), customs trade statistics, and the UN Comtrade Database. Variables such as employment, wages, number of establishments, the value of overseas production, and the control variables referred to in Section IV are drawn from the ICSC's establishment data. The ICSC is conducted once every five years by the Directorate General of Budget, Accounting, and Statistics (DGBAS) in Taiwan. Each census covered approximately 16,000 establishments in Taiwan. This study uses the 2006 and 2011 censuses mainly because economic integration between Taiwan and China reached a peak during these periods (Figure 3). According to the Investment Commission of the Ministry of Economic Affairs, Taiwan, the country's investment in China (as a percentage of the total foreign outward investment) reached 14.4 billion (79.5%) in 2011 and has gradually declined since then. The investment was 9.7 billion (44.4%) in 2016 and 4.2 billion (37.9%) in 2019.

Furthermore, the Taiwanese government initiated the New Southbound Policy in 2016 to vigorously strengthen economic and trade collaborations with South and Southeast Asia and Australia through various measures. This policy helped expand Taiwan's trade with countries other than China, reducing its dependence on the Chinese market. If successful, Taiwan will serve as a trading hub and firms in Taiwan can realize economies of scale without migrating to a

¹⁰ To instrumentalize the two regressors, a third instrument— $dim_{seasia_{k,t}}$ —is added to qualify the conditions for the test of overidentifying restrictions.

¹¹ The log value of the accumulated investment in China in 2006 is regressed on the ratio of overseas production in China to the industry's exports in the same year, with a slope coefficient of 0.211 and a standard error of 0.036 (the slope coefficient is significant at the 1% level).

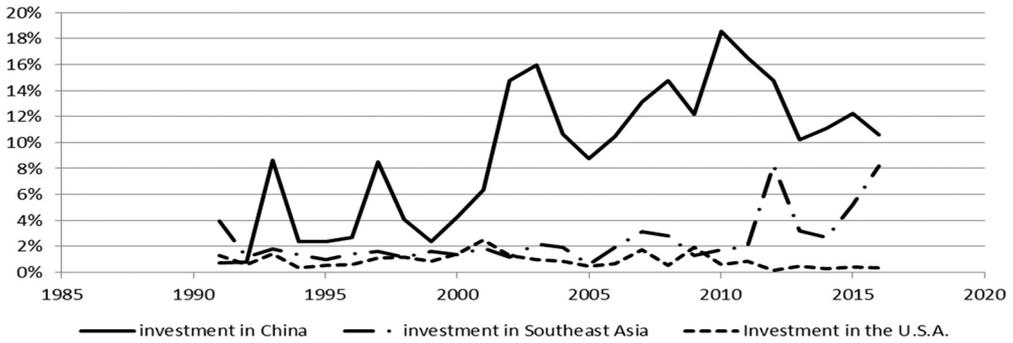


Fig. 3. Taiwan's outward foreign direct investment as a percentage of Taiwan's domestic private investment by major destinations.

Note: The calculation uses foreign direct investment taken from the Investment Commission, Ministry of Economic Affairs, Taiwan, and domestic private investment drawn from the Directorate General of Budget, Accounting, and Statistics, Taiwan.

large economy. Thus, the core-periphery effect resulting from trade with a large economy could be diminished. This simulation was implemented by Tsai (2017). It is possible that Taiwanese entrepreneurs' behaviors could have changed since 2016, and the 2016 census (the next census after 2011) and subsequent censuses would reflect this change. Hence, the census data after 2011 were excluded from the analysis.

Additionally, there have been considerable changes in the industrial classifications of 2006, particularly those related to the fast-growing information and communication industry. However, the DGBAS does not provide detailed industry categories to match the 2006 census with pre-2006 censuses. Thus, it was deemed necessary to exclude the information and communication industry data when using the pre-2006 census data, which resulted in a significant reduction in the number of observations and potential sample selection bias. Therefore, census data before 2006 and after 2011 were omitted from this study.

The observation units in this analysis are clusters of Taiwan's manufacturing industries. Adjacent cities and counties, for instance, Taipei City and Taipei County, are combined as economic regions and a total of 16 economic regions are included in Taiwan. Information on establishments in the same four-digit manufacturing industry and the same economic region is aggregated as a cluster.

Data on trade for both 2006 and 2011 are drawn from the database of the Customs Administration of the Ministry of Finance, Taiwan, which reports exports and imports recorded using the Harmonized Commodity Description and Coding System (HS). To concord these data to the four-digit Standard Industrial Classification System (IC) of Taiwan, the present analysis first applies the crosswalk provided by the DGBAS, which assigns 10-digit HS products to input-output (IO) sectors, at which level each HS product maps into a single IO sector and then connects IO sectors to four-digit IC industries according to the Report on 2011 Input-Output Tables by the DGBAS. Some of the four-digit IC industries are combined because some IO sectors map to multiple IC industries. For instance, sector IO 07910 (wafer) corresponds to a

collection of industries: IC 2611, IC 2612, and IC 2613 (representing integrated circuits, discrete devices, and packaging and testing of semiconductors, respectively). Before this aggregation, the IC codes for 2006 and 2011 were compared to confirm their accordance in definition.

The growths in imports of the U.S.A., China, and Southeast Asia¹² from the world are used as instruments for Taiwan's exports in the 2SLS estimation. The data were obtained from the UN Comtrade Database (<http://comtrade.un.org/db/default.aspx>), which provides bilateral import data for six-digit HS products. Likewise, data on the imports of these countries are matched to the four-digit IC through the IO sectors. Because there are 652 (approximately 10%) six-digit HS codes mapped into multiple IO sectors, Taiwan's exports to mainland China from 2003 to 2009 are applied at the 10-digit HS level to calculate the shares of multiple IO sectors in each of the 652 six-digit HS codes. The present analysis constructs shares based on Taiwan's exports to China because these exports account for the largest portion of Taiwan's exports, the composition of which is closer to Taiwan's industrial structure. However, if no exports occurred for a 10-digit HS product over the 2003–2009 period, product exports to mainland China from 2011 are used to compute the shares of IO sectors.

As this study focuses on trade effects, observations include all manufacturing sectors, except for those providing product services and those not included in HS codes, such as the installation and repair of industrial machines and equipment and metalworking industries. Furthermore, the manufacturing industries analyzed in this study must be inherently mobile. Hence, those industries predominantly selling to the domestic market are omitted because their immobility eliminates the difference between the trade effects associated with high and low factor mobility. In addition, changes in such industries are driven by domestic trends rather than by international trade. Thus, industries with a low export ratio in 2011 are ignored and the estimation process excludes observations with an export ratio lower than or equal to that of the printing industry (5.3%), which is a typical domestic industry. Although some industries have a higher proportion of domestic sales than exports, they are still included in the observations because they are mobile and can relocate to China, selling products to Taiwan. Accordingly, the observations comprise 2051 clusters covering 156 four-digit industries, accounting for 86% of all manufacturing employment in 2011, after eliminating industries that were not listed in HS codes and had an export ratio not more than 5.3% in 2011 from the original 2418 cluster units.

Additionally, the regression regarding total factor productivity uses 1899 observations, excluding multiple-establishment firms because input data (e.g., material, gas, and capital) used by enterprises rather than establishments are available. It is not possible to determine how the inputs are distributed among the establishments of an enterprise located in different economic regions. According to the official ICSC report of 2011, single-establishment firms, which comprise the 1899 observations in this analysis, account for 98% of all enterprises in Taiwan.

5.2. Summary statistics

Table 1 presents the summary statistics of the variables used in this analysis. Unless otherwise specified in the table, all observations are weighted by the start-of-period (2006) cluster employment, and all growth measures record the changes from 2006 to 2011. Based on

¹² Because of a lack of data for 2006 in the UN Comtrade Database, imports by Laos and Myanmar are ignored while constructing the instruments of growth in Taiwan's exports to countries other than China.

the 2051 cluster observations, the mean growth rate of employment in a cluster is found to be -1.57% per year, with a positive growth rate of 0.72% per year for non-production employment and a negative growth rate of -2.55% per year for production employment. The number of establishments declined by -0.13% and the total real wage bill decreased by -1.71% annually. These numbers indicate that, on average, the manufacturing industries in Taiwan did not perform well and experienced a contraction in employment and wages. Taiwan's exports to mainland China and Hong Kong increased by 1.53% annually, while those to Southeast Asia saw a substantial annual growth rate of 4.87% . In contrast, exports to the United States declined by -2.65% annually. Exports to countries other than China increased by 1.21% per year.

Remarkably, Taiwan's overseas production of export orders (triangle trade) exhibited the most significant growth of 10.72% per year. The mean ratio of overseas production in China to the industry's exports was as high as 128% in 2006 and 234% in 2011 suggesting that a larger number of export orders were produced offshore than in Taiwan. This increase in the ratio indicates the massive migration of Taiwanese manufacturers to China, which also forms the foundation of the $\beta_1 \leq \beta_2$ hypothesis.

6. Results

Table 2 presents the regression results for eq. (1). Columns (1) to (12) show the results of the ordinary least squares (OLS) estimates. Exports to China showed no significant effects on the growth of employment, non-production employment, production employment, total real wage bill, number of establishments, and total factor productivity of clusters in Taiwan. In contrast, exports to countries other than China show statistically significant positive effects on the aforementioned dependent variables, and the statistically significant positive effects hold for exports to the United States and Southeast Asia pertaining to growth in employment, non-production employment, production employment, and the total real wage bill. In addition to the weighted regression results, the results of the unweighted regression are presented in Appendix B for reference. Because β_1 is not significantly different from 0, all these estimates are consistent with hypotheses $\beta_2 > 0$ and $\beta_1 \leq \beta_2$.

Regarding the 2SLS estimates, Table 2 presents the statistics for the test of instrument exogeneity. The first-stage F -statistics of the test of instrument relevance show that the three instruments have predictive power for dX_{china} ($F = 276.7$, p -value = $1.33e-150$) and dX_{other} ($F = 218.7$, p -value = $5.80e-123$); furthermore, based on the J statistics of over-identification restrictions, other than the regression for dwL , the null hypothesis that all instruments are exogenous cannot be rejected.

Almost all the 2SLS estimates in Table 2 show qualitatively similar results to those of the OLS estimates, except that exports to countries other than China do not have a statistically significant effect on total factor productivity.¹³ The estimates suggest that a 1% increase in exports to countries other than China, the U.S., and Southeast Asia raises employment across clusters by 0.43% , 0.09% , and 0.11% , respectively, whereas an increase in exports to China does not produce statistically significant effects.

Regarding the effects of the triangle trade, only the growth in non-production employment and the total real wage bill are found to have a statistically significant positive response.

¹³ However, the model does not explain how exports affect total factor productivity, which is an additional outcome of the analysis.

Table 2
Estimates of exports effects on Taiwan's manufacturing clusters.

<u>Indep. Var.</u>	<u>Dep. Var.</u>	(1)	(2)	2SLS	(3)	(4)	2SLS
		dL(employment)			dwL(total wage bill)		
dXchina		-0.00264	-0.0294	0.0257	-0.00504	-0.0265	0.0434
exports to China		(0.041)	(0.045)	(0.099)	(0.052)	(0.052)	(0.135)
dXother		0.335***		0.434**	0.311**		0.375*
exports to other countries		(0.124)		(0.181)	(0.127)		(0.211)
dXus			0.0881**			0.102**	
exports to the U.S.A.			(0.037)			(0.043)	
dXseasia			0.113**			0.110**	
exports to Southeast Asia			(0.044)			(0.049)	
dXother_chinausasia			0.198*			0.152	
exports to the ROW			(0.112)			(0.120)	
dtriangle		0.0111	0.0126	0.0117	0.0151	0.0158	0.0165*
overseas production		(0.009)	(0.010)	(0.007)	(0.012)	(0.013)	(0.010)
tri_china_ra		-0.179***	-0.173**	-0.178***	-0.211***	-0.228**	-0.201**
overseas production in China		(0.056)	(0.073)	(0.063)	(0.072)	(0.093)	(0.080)
<u>controls</u>							
cluster_L		0.430	0.483	0.610	1.365**	1.427**	1.511**
		(0.411)	(0.422)	(0.436)	(0.561)	(0.567)	(0.616)
region_L		-0.297	-0.321	-0.369	0.836	0.810	0.783
		(0.677)	(0.670)	(0.729)	(1.024)	(1.016)	(1.077)
diverse		0.0302	0.0297	0.0294	0.000340	-0.0004	-0.0008
		(0.029)	(0.030)	(0.031)	(0.033)	(0.033)	(0.034)
localcompetition		1.117*	1.145*	1.206**	1.050	1.083	1.123*
		(0.574)	(0.579)	(0.557)	(0.677)	(0.682)	(0.681)
HI		7.562	11.24	8.824	12.26	16.42	12.25
		(10.395)	(10.636)	(10.608)	(11.899)	(12.335)	(13.234)
worker_ra		11.89**	13.79***	10.32*	10.62	11.80*	9.615
		(4.869)	(5.079)	(5.542)	(6.387)	(6.606)	(7.088)
average_wage		-0.000372	0.000539	-0.00365	-0.00624	-0.00522	-0.00877
		(0.007)	(0.006)	(0.008)	(0.009)	(0.008)	(0.011)
KL_ra		-0.0005**	-0.0005***	-0.0005***	-0.0003	-0.0003	-0.0003*
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
rd_ra		57.36	81.04	55.74	126.7**	142.0*	120.2
		(54.437)	(65.682)	(68.286)	(63.218)	(74.134)	(80.035)
rprofit_pro		25.57***	26.15***	24.22***	32.19***	33.03***	31.81***
		(5.874)	(6.175)	(8.411)	(7.362)	(7.642)	(9.945)
_cons		-15.08	-17.48*	-13.28	-34.37**	-36.24**	-33.21**
		(10.266)	(10.089)	(11.458)	(15.383)	(15.438)	(16.699)
N		2051	2051	2051	2051	2051	2051
overident. restri. J (p-values)				2.457(0.117)			4.71(0.030)

Table 2

Estimates of exports effects on Taiwan's manufacturing clusters (continued).

<u>Indep. Var.</u>	<u>Dep. Var.</u>	(5)	(6)	2SLS	(7)	(8)	2SLS
		dnum(number of establishments)			dmana(non-product. employ.)		
dXchina		0.0213	0.0139	0.0133	-0.0249	-0.0474	-0.0391
exports to China		(0.025)	(0.029)	(0.061)	(0.046)	(0.051)	(0.108)
dXother		0.120**		0.279**	0.327***		0.443**
exports to other countries		(0.059)		(0.115)	(0.111)		(0.190)
dXus			0.0190			0.0883**	
exports to the U.S.A.			(0.015)			(0.044)	
dXseasia			0.0431			0.108**	
exports to Southeast Asia			(0.027)			(0.045)	
dXother_chinausasia			0.0732			0.182*	
exports to the ROW			(0.058)			(0.105)	
dtriangle		-0.0005	0.00204	-0.0002	0.0220**	0.0233**	0.0211**
overseas production		(0.004)	(0.003)	(0.004)	(0.010)	(0.011)	(0.009)
tri_china_ra		-0.189***	-0.174***	-0.210***	-0.0780	-0.0758	-0.0915
overseas production in China		(0.034)	(0.041)	(0.040)	(0.080)	(0.100)	(0.071)
<u>controls</u>							
cluster_L		-0.332**	-0.376**	-0.247	0.323	0.367	0.489
		(0.161)	(0.150)	(0.172)	(0.457)	(0.469)	(0.453)
region_L		1.105***	1.157***	1.041***	-0.177	-0.196	-0.254
		(0.276)	(0.266)	(0.270)	(0.690)	(0.682)	(0.767)
diverse		0.0245***	0.0247***	0.0239***	0.0258	0.0252	0.0258
		(0.007)	(0.007)	(0.007)	(0.027)	(0.027)	(0.028)
localcompetition		-0.0770**	-0.0837**	-0.0605	1.743**	1.767**	1.822**
		(0.038)	(0.038)	(0.040)	(0.752)	(0.756)	(0.732)
HI		-3.060	-2.039	0.966	4.180	7.646	6.996
		(4.090)	(4.519)	(5.242)	(10.568)	(11.231)	(10.683)
worker_ra		-3.316	-2.193	-4.895	28.07***	29.88***	26.19***
		(4.883)	(5.047)	(5.403)	(6.247)	(6.436)	(5.884)
average_wage		-0.00183	-0.00108	-0.00418	-0.0107	-0.00957	-0.0139
		(0.004)	(0.004)	(0.005)	(0.007)	(0.007)	(0.009)
KL_ra		-0.00005	-0.0001	-0.0001	-0.0003	-0.0003	-0.0003
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
rd_ra		7.444	9.434	-0.699	74.03	94.54	80.77
		(27.404)	(29.179)	(33.855)	(58.646)	(68.136)	(72.849)
rprofit_pro		11.15***	10.88***	11.72***	31.55***	32.34***	29.15***
		(2.974)	(2.891)	(3.648)	(7.064)	(7.404)	(9.753)
_cons		-12.55**	-14.12**	-10.54*	-20.34**	-22.69**	-18.22
		(5.253)	(5.417)	(5.506)	(10.159)	(9.856)	(12.046)
N		2051	2051	2051	2051	2051	2051
overident. restri. J (p-values)				0.0907(0.763)			2.231(0.135)

Table 2
Estimates of exports effects on Taiwan's manufacturing clusters (continued).

<u>Indep. Var.</u>	<u>Dep. Var.</u>	(9)	(10)	2SLS	(11)	(12)	2SLS
		dworker(production employment)			tfpdot_r1(total factor productivity)		
dXchina		0.0133	-0.0180	0.0565	-0.00199	-0.00153	-0.00335
exports to China		(0.042)	(0.049)	(0.105)	(0.002)	(0.002)	(0.003)
dXother		0.330**		0.442**	0.00490**		0.00767
exports to other countries		(0.139)		(0.201)	(0.002)		(0.006)
dXus			0.0801**			0.000623	
exports to the U.S.A.			(0.035)			(0.001)	
dXseasia			0.117**			-0.000438	
exports to Southeast Asia			(0.050)			(0.002)	
dXother_chinausasia			0.202			0.00377	
exports to the ROW			(0.125)			(0.002)	
dtriangle		0.00793	0.00986	0.00894	0.00008	0.00008	0.00009
overseas production		(0.008)	(0.009)	(0.007)	(0.000)	(0.000)	(0.000)
tri_china_ra		-0.258***	-0.244***	-0.253***	-0.017***	-0.017***	-0.018***
overseas production in China		(0.054)	(0.066)	(0.074)	(0.005)	(0.005)	(0.006)
<u>controls</u>							
cluster_L		0.494	0.548	0.710	0.0161	0.0137	0.0183
		(0.424)	(0.431)	(0.479)	(0.021)	(0.021)	(0.022)
region_L		-0.752	-0.775	-0.837	-0.00779	-0.00531	-0.00996
		(0.667)	(0.660)	(0.701)	(0.012)	(0.012)	(0.014)
diverse		0.0379	0.0374	0.0367	0.00106	0.00108	0.00104
		(0.034)	(0.034)	(0.036)	(0.001)	(0.001)	(0.001)
localcompetition		0.875	0.904	0.982	0.0342	0.0338	0.0347
		(0.650)	(0.656)	(0.639)	(0.028)	(0.028)	(0.029)
HI		13.90	17.20	15.03	0.0970	0.102	0.259
		(11.348)	(11.107)	(12.209)	(0.322)	(0.306)	(0.438)
worker_ra		-1.267	0.741	-3.047	-0.202	-0.175	-0.237
		(5.968)	(6.307)	(7.667)	(0.433)	(0.415)	(0.450)
average_wage		0.00657	0.00733	0.00270	0.00001	0.00004	-0.00002
		(0.007)	(0.006)	(0.008)	(0.000)	(0.000)	(0.000)
KL_ra		-0.0007***	-0.0007***	-0.0007***	-0.000006	-0.000006	-8E-06
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
rd_ra		17.09	43.65	13.25	-1.267	-1.331	-1.323
		(58.235)	(70.487)	(71.785)	(1.811)	(1.726)	(1.789)
rprofit_pro		20.87***	21.15***	19.51**	-0.293	-0.317	-0.314
		(5.787)	(6.089)	(8.729)	(0.290)	(0.299)	(0.320)
_cons		-4.500	-6.993	-2.454	-0.0291	-0.0695	0.0209
		(10.862)	(10.715)	(11.822)	(0.330)	(0.327)	(0.363)
N		2051	2051	2051	1899	1899	1899
overident. restri. J(p -values)				1.366(0.243)			1.069(0.301)

Note: Columns (1)–(12) report the OLS regression results. The 2SLS regressions instrument for dXchina and dXother, with the growth in China's imports from the world, dim_china, the growth in the sum of imports of the United States and Southeast Asia from the world, dim_other, and the growth in Southeast Asian imports from the world, dim_seasia. The first-stage F-statistic (p-value) for dXchina is 276.7(1.33e-150) and that for dXother is 218.7(5.80e-123). Standard errors given in parentheses under the coefficients are clustered on 75 three-digit industries. Estimates for the regression of the dependent variables related to employment, including dL, dwL, dmana, and dworker, are weighted by the start-of-period cluster employment. The rest of the world (ROW) excludes China, the U.S., and Southeast Asia.

* p < 0.10, ** p < 0.05, *** p < 0.01.

However, the current effect of overseas production results in only a slight increase in non-production employment ($\hat{\beta}_3 = 0.02$) and total real wage bill ($\hat{\beta}_3 = 0.0165$). Regarding the accumulated effect, along with the increase in the ratio of overseas production in China to the industry's exports, except for non-production employment, all outcome variables—growth in employment, production employment, total real wage bill, and number of establishments, as well as total factor productivity—decrease significantly. That is, $\beta_4 < 0$.

A related issue is¹⁴ how offshoring (or outsourcing) affects the wage payment share of skilled workers in an industry. Based on the perspective of NEG, the ongoing peripheral phenomenon in the small economy reflects the migration of profit-driven firms. In other words, whether there is an increase in the ratio of skilled to unskilled labor resulting in a higher wage payment share of skilled labor, is determined by the type of factory that relocates first. If factories that hire more unskilled labor take the lead, the ratio of skilled to unskilled labor in a small economy may increase, and skilled employment may not significantly decline in the first place. The estimates in the present analysis elicit several effects. Although offshoring behaviors can positively affect the increase in non-production employment in the short run, the accumulated effect of overseas production in the long run appears to have no significant contribution to the increase in non-production employment.

Further, the increase in non-production employment, which includes sales and procurement staff members, implies a response to the need to manage the expansion of the triangle trade rather than an upgrade in technology. This inference is justified in Columns (11) and (12) of Table 2, which reveal that the increase in the ratio of overseas production in China to the industry's exports does not significantly contribute to the total factor productivity of a cluster.

The aforementioned evidence can be summarized by arguing that the insignificant job creation effect of exports to China originating in Taiwan is in accordance with the gradual migration of firms induced by the liberalization of trade and investment between Taiwan and China. Meanwhile, firm migration has culminated in a considerable increase in overseas production in China. Owing to the massive overseas production, manufacturing in the small economy has diminished. These phenomena are consistent with the predictions implied by the core-periphery effect in the evolutionary process.

7. Conclusion

This study aims to explore the advantageous trade arrangements for a small open economy. To discover the arrangement, the fundamental question to ask is how trade affects a small economy. The two main streams of trade theory—new economic geography and comparative advantage—make divergent predictions of trade effects in a small economy. The essential reason for this difference lies in the mobility of factors. Since firms or entrepreneurs are highly mobile between Taiwan and China but not between Taiwan and other countries, this study compares the impact of Taiwan's exports to China and other countries on the performance of Taiwan's manufacturing clusters to test the difference between the two trade effects and, thus, determine the advantageous trade arrangements for a small economy.

This study constructs testable hypotheses for short-run trade effect, that is, a small economy's industrial growth driven by trade involving high factor mobility is no more than that driven by

¹⁴ Many studies on the labor market (e.g. Feenstra & Hanson, 1999; Bloom et al., 2016; Hsieh & Woo, 2005) have focused on this issue.

trade involving low factor mobility. The empirical findings of this study are summarized as follows. The effect of the growth of Taiwan's exports to China on the growth of employment, total real wage bill, and the number of establishments in manufacturing clusters in Taiwan is not statistically significant. This finding represents a short-term exhibition of the long-run core-periphery effect. However, the aforementioned variables have been found to be positively and significantly related to growth in exports to countries other than China, and the OLS estimates indicate the productivity improvement induced by this growth. By specific regions, an increase in the growth rate of exports to the U.S. and Southeast Asia leads to statistically significant growth in employment, including production and non-production employment. These results confirm the testable hypotheses. In addition, the ratio of Taiwan's overseas production in China to the industry's exports, which functions as an indicator of the magnitude of Taiwanese firms' migration to China, is found to have a negative impact on growth in employment, growth in the number of establishments, and total factor productivity. Furthermore, Taiwan's trade with China and its massive outsourcing to China, where wages are relatively lower than that of Taiwan, have not resulted in a significant increase in non-production employment in Taiwan's manufacturing clusters, as experienced in some advanced countries.

In terms of policy, the findings of this study suggest that a small economy should lower trade barriers with the large economies that will 'not' attract large factor outflows from the small economy. Depending on a trade relation, involving high factor mobility might not be favorable for a small economy since the short-run effect of the trade liberalization in promoting employment or industrial growth will be offset by the outward migration of factors or entrepreneurs. Furthermore, this kind of migration will inevitably have negative effects on the industry in the end; such trade exchanges do not contribute to the growth in productivity and non-production employment in the long run.

Additionally, the core-periphery effect occurs even when the two trading economies are slightly different in size, according to the standard NEG theory. Therefore, the current analysis can be extended to examine trade effects in other countries or economies where the scenarios are not necessarily limited to circumstances of disparate sizes, such as Taiwan and China.

Notably, the core-periphery spatial structure of the standard NEG theory is a long-run equilibrium. However, policymakers need to formulate robust policies from the perspective of short-term interests and long-term implications. In particular, lowering trade costs seems to have the immediate benefit of increasing exports. This study shows that even in the short run trade involving high factor mobility may not be as favorable as the general public expects. Therefore, the short-term trade effect analyzed in this study can assist policymakers and provide a relevant direction for future research in this area.

Appendix A: Variable descriptions

This section summarizes the definitions of the major variables used in the study. Table 1 provides a description of the control variables. Because some variables have a value of 0,

growth in exports, triangle trade, employment, production employment, non-production employment, total real wage bill, and number of establishments are defined as $100 \cdot (1/5) \cdot (\ln(1 + q_{k,r,2011}) - \ln(1 + q_{k,r,2006}))$, where $q_{k,r,\tau}$ is the value of the variable in a cluster in industry k in region r in period τ . With the exception of the level of employment and the number of establishments, $q_{k,r,2006}$ is deflated to the 2011 New Taiwan dollars using the Consumer Price Index. Furthermore, because data on export values and triangle trade are only available at the industry level, the subscript r of the variables is omitted when applying the above formula. The employment level of a cluster and total employment level of a region in 2006 are transformed by $\log(q_{k,r,t-1})$ and $\log(q_{t,t-1})$, respectively. $tri_china_ra_{k,t-1}$, the ratio of overseas production in mainland China to the industry's exports in 2006 (the initial period), is defined as follows:

$$tri_china_ra_{k,t-1} = (\text{triangle}95_{k,t-1} \times \text{trichina}95_{k,t-1} \times 0.01) / (\text{ex}95r_1_{k,t-1})$$

where $\text{triangle}95_{k,t-1}$ is the revenue of the triangle trade of industry k in 2006; $\text{tri_china}95_{k,t-1} \times 0.01$ is the proportion of products for triangle trade produced in mainland China in 2006; and $\text{ex}95r_1_{k,t-1}$ represents Taiwan's real exports to the world by industry k in 2006.

Total factor productivity ($tfpdot_r1_{k,r,t}$), measured by the Divisia index of productivity, is defined as follows:

$$tfpdot_r1_{k,r,t} = \dot{Q}_{k,r,t} - \sum_n S_{n,k,r,t} \dot{f}_{n,k,r,t}$$

where \dot{Q} indicates the log change in production, S_n represents the average cost share of input n , and \dot{f} indicates the log change in the inputs. All nominal values are deflated using the Consumer Price Index and the log changes are calculated over the period 2006–2011. The inputs include capital, labor, energy, and materials. The amount of capital input is measured by the net value of fixed assets in operation, and the other inputs are measured by the number of employees, energy expenditure, and material expenditure. Expenditures are summed by including labor expenditures measured as total salaries plus non-wage benefits paid by the firm, energy expenditures, total expenditures on raw materials, and firms' capital expenditures calculated as the residual after subtracting labor expenditure from the firms' gross product. Moreover, the cost share of each input in 2006 and 2011 was calculated; the input cost share S_n is the average of the shares in 2006 and 2011.

Appendix B

Table B

The unweighted regression of employment-related dependent variables.

Indep. Var.	Dep. Var.	(1)	2SLS	(2)	2SLS
		dL	dL	dwL	dwL
		100x annual LogΔ in employment	100x annual LogΔ in employment	100x annual LogΔ in total wage bill	100x annual LogΔ in total wage bill
dXchina		0.0280 (0.040)	-0.0289 (0.126)	-0.0156 (0.071)	-0.116 (0.203)
100x annual LogΔ in export to China					
dXother		0.214* (0.109)	0.598** (0.250)	0.400** (0.160)	0.852** (0.372)
100x annual LogΔ in export to other countries					
dtriangle		0.000790 (0.008)	0.00155 (0.008)	-0.00897 (0.015)	-0.00789 (0.014)
100x annual LogΔ in overseas production					
tri_china_ra		-0.506*** (0.086)	-0.565*** (0.100)	-1.062*** (0.132)	-1.137*** (0.148)
Ratio of overseas production in China					
controls					
cluster_L		-0.880** (0.342)	-0.672* (0.367)	2.766*** (0.700)	3.012*** (0.714)
region_L		2.694*** (0.599)	2.526*** (0.607)	4.093*** (1.130)	3.884*** (1.134)
diverse		0.0363** (0.018)	0.0350** (0.018)	0.0450 (0.032)	0.0436 (0.032)
localcompetition		0.420*** (0.111)	0.462*** (0.112)	0.260 (0.232)	0.313 (0.239)
HI		-16.34** (7.969)	-5.080 (12.011)	-21.82 (15.039)	-7.219 (21.431)
worker_ra		1.821 (8.851)	-1.806 (10.060)	-9.689 (14.188)	-13.79 (15.451)
average_wage		-0.00555 (0.008)	-0.0105 (0.010)	-0.00604 (0.015)	-0.0111 (0.017)
KL_ra		-0.00003 (0.000)	-0.0002 (0.000)	-0.0002 (0.000)	-0.0005 (0.001)
rd_ra		-12.51 (40.618)	-28.39 (53.772)	-205.4*** (62.225)	-220.7*** (67.653)
rprofit_pro		29.52*** (7.086)	29.83*** (9.976)	47.10*** (12.266)	46.52*** (15.455)
_cons		-35.83*** (9.612)	-31.10*** (10.809)	-72.44*** (17.665)	-66.97*** (19.032)
N		2051	2051	2051	2051
adj. R-sq		0.058	0.034	0.069	0.061
N_clust		75	75	75	75
F-statistics(Chi-squared)		14.52	(155.20)	22.58	(271.60)
p-values		6.01e-16	6.61e-26	3.47e-21	9.61e-50
overidentification restriction <i>J</i> statistics			0.990		1.598
	p-values		0.320		0.206

Note: Columns (1)–(4) report the OLS regression results. Standard errors given in parentheses under the coefficients are clustered on 75 three-digit industries. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table B

The unweighted regression of employment-related dependent variables (continued).

Indep. Var.	Dep. Var.	(3)	2SLS	(4)	2SLS
		100x annual LogΔ in non-production employment		100x annual LogΔ in production employment	
		dmana	dmana	dworker	dworker
dXchina		0.0239	0.0133	0.0271	0.0164
100x annual LogΔ in export to China		(0.040)	(0.061)	(0.040)	(0.127)
dXother		0.171*	0.279**	0.195*	0.533**
100x annual LogΔ in export to other countries		(0.093)	(0.115)	(0.114)	(0.251)
dtriangle		0.00978	-0.000247	0.00210	0.00256
100x annual LogΔ in overseas production		(0.009)	(0.004)	(0.008)	(0.008)
tri_china_ra		-0.392***	-0.210***	-0.473***	-0.516***
Ratio of overseas production in China		(0.084)	(0.040)	(0.079)	(0.099)
controls					
cluster_L		-1.629***	-0.247	-0.960***	-0.780**
		(0.327)	(0.172)	(0.344)	(0.363)
region_L		2.196***	1.041***	2.702***	2.570***
		(0.576)	(0.270)	(0.587)	(0.587)
diverse		0.0376**	0.0239***	0.0335*	0.0323*
		(0.018)	(0.007)	(0.019)	(0.019)
localcompetition		0.385***	-0.0605	0.437***	0.471***
		(0.124)	(0.040)	(0.118)	(0.117)
HI		-15.88*	0.966	-15.01**	-6.730
		(9.068)	(5.242)	(6.438)	(11.674)
worker_ra		19.55**	-4.895	-3.804	-7.183
		(9.067)	(5.403)	(8.857)	(10.143)
average_wage		-0.00625	-0.00418	-0.00258	-0.00768
		(0.008)	(0.005)	(0.007)	(0.009)
KL_ra		-0.00008	-0.0001	-0.00004	-0.0002
		(0.000)	(0.000)	(0.000)	(0.000)
rd_ra		40.83	-0.699	-20.14	-38.03
		(45.176)	(33.855)	(41.867)	(48.619)
rprofit_pro		26.30***	11.72***	30.01***	31.39***
		(7.489)	(3.648)	(6.820)	(8.902)
_cons		-32.56***	-10.54*	-34.07***	-29.81***
		(9.188)	(5.506)	(9.628)	(10.662)
N		2051	2051	2051	2051
adj. R-sq		0.074	0.029	0.053	0.034
N_clust		75	75	75	75
F-statistics(Chi-squared)		21.72	(165.20)	9.451	(105.90)
p-values		1.06e-20	4.23e-26	1.55e-11	3.50e-16
overidentification restriction			1.511		0.918
<i>J</i> statistics					
	p-values		0.219		0.338

Note: Columns (1)–(4) report the OLS regression results. Standard errors given in parentheses under the coefficients are clustered on 75 three-digit industries. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix C. Supporting information

Supplementary data associated with this article can be found in the online version at [10.1016/j.jpolmod.2022.11.008](https://doi.org/10.1016/j.jpolmod.2022.11.008).

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