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The China syndrome: A cross-country evidence

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1 | INTRODUCTION

For many advanced countries, import competition from low-wage countries is always one of the major concerns for policymakers and the general public because it is considered to be one of the most important adjustment processes in globalisation.[1] In particular, the impact on employment of increasing import competition from China, which is also called ‘the China Syndrome’ or ‘the China shock’, has been a major topic of debate in the United States for the last two decades due to the rapid growth of the Chinese economy. Accordingly, several studies have examined the effects of imports from China on the US employment (e.g., Acemoglu et al., 2015, 2016; Autor et al., 2013, 2015; Pierce & Schott, 2016; Wang et al., 2018).

Among these studies on the China shock, one of the most influential studies is Acemoglu et al. (2016). They examined the effects of imports from China on US employment between 1999 and 2011. Using detailed input–output data, they found that job losses from rising Chinese import competition for the above period amount to 2.0–2.4 million. Due to the huge negative impact on US employment, this number was featured in stories by news publications such as the *Washington Post* (12/15/2014) and the *New York Times Magazine* (9/5/2016).

Concern about the China shock is not only limited to the United States but is also shared with other advanced countries. Figure 1 compares the Chinese import penetration and manufacturing employment for six advanced countries: France, Germany, Japan, South Korea, the United Kingdom and the

[1]For the earlier studies on this issue, see Revenga (1992) for the case of the United States and Tachibanaki, Morikawa, and Nishimura (1998) and Tomiura (2003) for the case of Japan.

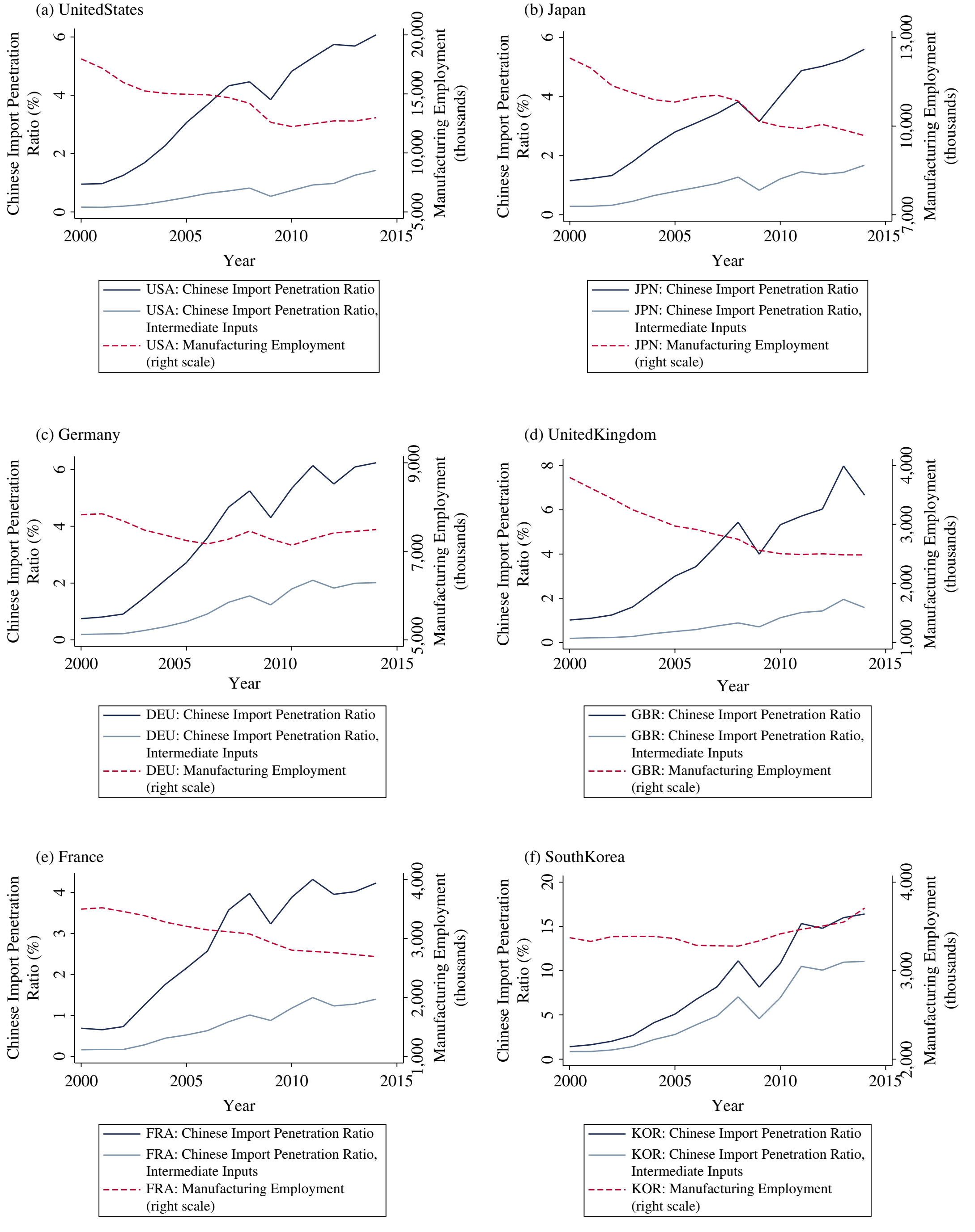

FIGURE 1 Import penetration ratio from China (*left scale*) and share of manufacturing employment (*right scale*). Notes: The order of the country is based on the size of the GDP. Imports are limited to manufacturing sector. Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018 [Colour figure can be viewed at wileyonlinelibrary.com]

United States for the period between 2000 and 2014.[2] These are top six destination countries to which China exports intermediate inputs. On the one hand, import penetration from China increased throughout the period in all six countries. On the other hand, manufacturing employment declined over the period for all countries except South Korea. Indeed, the studies on the China shock thus have expanded from the United States to various other countries. For example, Dauth et al. (2014) have investigated the effects of imports from China and Eastern Europe on German employment. Taniguchi (2019) and Choi and Xu (2020) have studied the effects of imports from China on Japanese and Korean employment, respectively.

However, to our knowledge, the previous studies have paid little attention to the cross-country differences about the China shock. It is possible that the China shock could be different across countries, depending upon the volume and the composition of the products. Although the studies on the China shock have expanded from the United States to other countries such as Germany (Dauth et al., 2014) and Japan (Taniguchi, 2019), these studies are conducted independently. Thus, their results are difficult to compare with each other due to differences in the period and industry coverage as well as differences in industry classification. More comprehensive analysis is needed for cross-country comparisons.

In this paper, we examine the effects of imports from China on employment in six advanced countries: France, Germany, Japan, South Korea, the United Kingdom and the United States. Our empirical approach is similar to Acemoglu et al. (2016), but we extend their analysis in the following three aspects. First, we extend their analysis to cross-country comparisons during the same period under the same industry classification that enables us to compare the results across countries.[3] To do so, this paper utilises the data from the World Input-Output Database (WIOD) between 2000 and 2014. This extension enables us to identify similarities and differences in the China shock across countries, based on the same analytical framework during the same period under the same industry classification.

Second, unlike Acemoglu et al. (2016), this paper distinguishes between imports of final goods and those of intermediate inputs. The imports of final goods could yield negative effects on domestic producers of final goods from import competition. In contrast, the imports of intermediate inputs can have two opposite effects. On the one hand, it could compete with domestic production of intermediate inputs. On the other hand, it could contribute to domestic production of final goods and thereby could have positive effects on employment of final goods producers. Without considering such positive effects explicitly, the negative effects could be overemphasised. Indeed, Figure 1 also indicates that the imports of intermediate inputs increased in the six advanced countries, where imports of intermediate inputs are defined as imports that are not used for final demands. Nonetheless, there are still only a few studies that distinguish between the imports of final goods and those of intermediate inputs. Taniguchi (2019) examined the effects of increased imports from China on Japanese local labour markets. She found that increases in the imports of intermediate inputs from China had positive effects on employment. Wang et al. (2018) and Caliendo et al. (2019) also found similar positive effects of imported intermediate inputs from China on US employment, where both studies utilise the WIOD to capture the imports of intermediate inputs. Building upon these studies and using the WIOD, this paper distinguishes the difference in the effects of the imports of final goods and those of intermediate inputs.

Finally, we take into account the effects of exports as well as imports. As Dauth et al. (2014) pointed out, while the growth of China increased import competition, it simultaneously leads to a substantial rise in market opportunities for companies in advanced countries. Without considering the effects of exports explicitly, one could overestimate the negative effects of foreign exposure on employment.

[2]The data come from the World Input-Output Database. Next section explains about the data used in this paper in more detail.

[3]Our main focus is on the cross-country comparisons of the China shock on overall employment. Due to the limited availability of the local labour market data across countries, local labour market issue is not pursued here.

TABLE 1 Summary of the trade data of the related studies

	Source	Country	Period	Industry (# of industries)	Imports: Separation of Final demands and Intermediate inputs	Exports
Autor et al. (2013)	UN Comtrade	US	1990–2007	Manufacturing (397)	No	No
Acemoglu et al. (2016)	UN Comtrade	US	1991–2007	Manufacturing (392)	No	No
Dauth et al. (2014)	UN Comtrade	Germany	1988–2008	Manufacturing (97)	No	Yes (to China)
Choi and Xu (2020)	UN Comtrade	South Korea	1993–2013	Manufacturing (180)	No	Yes (to China)
Acemoglu et al. (2015)	UN Comtrade	US	1991–2009	Manufacturing (392)	No	No
Wang et al. (2018)	Inter-country input–output tables (OECD)	US	2000–2014	All (34) Manufacturing (16)	Yes (only in downstream channel)	Yes (to China)
Feenstra et al. (2019)	UN Comtrade	US	1991–2011	Manufacturing (392)	No	Yes (to the world)
Fabinger et al. (2017)	JIP Database	Japan	1996–2009	Manufacturing (50)	No	No
Taniguchi (2019)	JIP Database; Japan–China input–output table	Japan	1995–2007	Manufacturing (52)	Yes	No
Feenstra et al. (2019)	World Input-Output Database	US	1995–2011	All (35) Manufacturing (13)	Yes (expressed in inverse matrix)	Yes (to the world)
Caliendo et al. (2019)	World Input-Output Database	US	2000–2007	All (22) Manufacturing (12)	Yes	Yes
Our study	World Input-Output Database	US, Japan, UK, Germany, France, South Korea	2000–2014	Manufacturing (19)	Yes	Yes (to China)

Notes: 'Yes (to China)' in the last column indicates that only exports to China are included, whereas 'Yes (to the world)' indicates that exports to the world are included.

Indeed, Dauth et al. (2014) found significantly positive effects of trade exposure on employment in Germany. In spite of the importance of exports, however, only a few studies such as Choi and Xu (2020), Dauth et al. (2014), Feenstra and Sasahara (2018), and Feenstra et al. (2019) explicitly took into account the effects of exports as well as imports in recent studies on the China shock.[4] Based on this background, this paper explicitly focuses on the effects of exports as well as those of imports.

To clarify the similarity in and the difference between the previous studies and our study, we summarise the related studies in Table 1. This table indicates that the use of the WIOD allows one to distinguish the imports of intermediate inputs and final goods while restricting the number of industries.

The major findings of our paper are twofold. First, the import penetration of final goods from China has a negative effect on manufacturing employment in most of the six countries, whereas the import penetration of intermediate inputs from and the exports to China show positive coefficients while they are statistically insignificant in most countries. Second, in the counterfactual analysis, we show that such positive effects could offset or even outweigh the negative effects in some countries. For the United Kingdom and the United States, the negative effects of the imports of final goods outweigh the positive effects of the imports of intermediate inputs and exports. In contrast, for France and Japan, the negative effects of the imports of final goods offset the positive effects of the imports of intermediate inputs and exports. For South Korea and Germany, the positive effects outweigh the negative effects. These results together suggest that a careful interpretation is needed when evaluating the external validity of the China shock that is obtained in one country.

These results have an important caveat. Our analysis is based on small sample. This could cause the small sample problem, which results in the less precise estimates. Noting that the small sample is caused by the aggregation of industries, this could also magnify the problem of within-industry heterogeneity. Therefore, our estimation results should be interpreted with caution.

The rest of this paper is organised as follows. The next section explains the methodology and data used in this paper. Section 3 presents the estimation results. Section 4 addresses issues to be discussed further on our approach and the estimation results. A summary of our findings and their implications are presented in the final section.

2 | METHODOLOGY AND DATA

2.1 | Methodology

2.1.1 | Preliminary analysis

We first examine the effect of total imports on employment as a preliminary analysis. Following Acemoglu et al. (2016), the specification in our preliminary analysis has the following form[5]:

$$\Delta L_{j,\tau} = \alpha_\tau + \beta \Delta IP_{j,\tau} + \varepsilon_{j,\tau}, \tag{1}$$

[4]In this connection, several studies have found the positive relationship between exports and employment. See, for example, Kiyota (2012) for the case of Japan. Kiyota (2016) extended the analysis of Kiyota (2012) to China, Indonesia and South Korea as well as Japan.

[5]One may argue that we employ alternative estimation strategy such as difference-in-differences (DID) design. However, the DID is based on a common trends assumption, which should be tested before the China shock (the early 2000s). As we will explain below, the data we use cover from 2000. The period of our data thus is not long enough to test this assumption, which makes it difficult to employ the DID design.

where $\Delta L_{j,\tau}$ is 100 times the log change in employment in industry j in country c over the period τ; α_τ is a country- and period-specific constant; $\Delta IP_{j,\tau}$ is 100 times the change in import penetration from China in industry j in country c over the time period τ; and $\varepsilon_{j,\tau}$ is an error term. For ease of presentation, we omit country notation c, unless otherwise noted.

The change in import penetration from China is defined as follows:

$$\Delta IP_{j,\tau} = \frac{\Delta M_{j,\tau}^{CHN}}{Y_{j,0} - E_{j,0} + M_{j,0}}, \tag{2}$$

where $\Delta M_{j,\tau}^{CHN}$ is the change in imports during the period τ; $Y_{j,0} - E_{j,0} + M_{j,0}$ is the initial absorption (measured as industry outputs, $Y_{j,0}$, plus industry imports, $M_{j,0}$, minus industry exports, $E_{j,0}$). Equation (1) is estimated using two-stage least squares (2SLS) as well as ordinary least squares (OLS) specifications.

An instrumental variable (IV) for 2SLS is:

$$\Delta IPO_{j,\tau} = \frac{\Delta M_{j,\tau}^{CHN,O}}{Y_{j,0}^{O} - E_{j,0}^{O} + M_{j,0}^{O}}, \tag{3}$$

where $\Delta M_{j,\tau}^{CHN,O}$ is the change in imports from China during the period τ in other high-income countries; $Y_{j,0}^{O} - E_{j,0}^{O} + M_{j,0}^{O}$ is the initial absorption of other high-income countries. For the initial absorption, we choose the absorption value in 2000. We would note that using the absorption value in 2000 might lead to bias if the included economic variables are affected by an anticipated increase in imports and/or exports with China. If we use the earlier version of the WIOD, we may be able to choose the previous (or earlier) year for the absorption. However, because the industry classification in the earlier version of the WIOD is more aggregated, the sample size becomes further small. As a compromise, we choose the initial year of our sample for the absorption. Noting that the major export and import destination countries vary between final goods and intermediate inputs and across countries, we choose other high-income countries in which the correlation between IV and $\Delta M_{j,\tau}^{CHN}$ is relatively high and the first-stage F-value is also high.[6]

2.1.2 | Benchmark specification

We extend the specification in the preliminary analysis in two ways. First, similar to Taniguchi (2019) and Wang et al. (2018), we distinguish between imports of intermediate inputs and those of final goods. As mentioned above, without considering the positive effects of the imported intermediate inputs explicitly, the negative effects of imports could be overemphasised.

Second, we control for the effects of exports as well as imports. As was pointed out by Dauth et al. (2014) and Choi and Xu (2020), employment could be affected not only by imports but also by exports. We thus include exports to the regression equation in an analogous measure.[7]

Our main regression is specified as follows:

$$\Delta L_{j,\tau} = \alpha_\tau + \beta_1 \Delta IP_{j,\tau}^{IM} + \beta_2 \Delta IP_{j,\tau}^{FN} + \gamma \Delta EP_{j,\tau} + \varepsilon_{j,\tau}, \tag{4}$$

[6]The choice of other high-income countries thus varies between imports and exports and between final goods and intermediate inputs.

[7]Choi and Xu (2020) employed similar indexes to export–output ratio that indicates the changes in Korean exports as well as those in Japanese exports as an instrument.

where

$$\Delta IP_{j,\tau}^{IM} = \frac{\Delta x_{j,\tau}^{CHN}}{Y_{j,0} - E_{j,0} + M_{j,0}}, \tag{5}$$

where superscript *IM* denotes intermediate inputs and $\Delta x_{j,\tau}^{CHN}$ denotes the changes in the imports of intermediate inputs from China to industry j in the importing country over the period τ;

$$\Delta IP_{j,\tau}^{FN} = \frac{\Delta f_{j,\tau}^{CHN}}{Y_{j,0} - E_{j,0} + M_{j,0}}, \tag{6}$$

where superscript *FN* denotes final goods and $\Delta f_{j,\tau}^{CHN}$ denotes the changes in the imports of final goods from China to industry j in the importing country over the period τ. Their instruments are:

$$\Delta IPO_{j,\tau}^{IM} = \frac{\Delta x_{j,\tau}^{CHN,O}}{Y_{j,0}^{O} - E_{j,0}^{O} + M_{j,0}^{O}} \text{and} \Delta IPO_{j,\tau}^{FN} = \frac{\Delta f_{j,\tau}^{CHN,O}}{Y_{j,0}^{O} - E_{j,0}^{O} + M_{j,0}^{O}}, \tag{7}$$

where $\Delta IPO_{j,\tau}^{IM}$ and $\Delta IPO_{j,\tau}^{FN}$ are the change in the imports of intermediate inputs and final goods, respectively, from China to industry j in other high-income countries during the period τ.

Similarly, $\Delta EP_{j,\tau}$ is 100 times the change in exports to China relative to output in industry j in country c over the time period τ:

$$\Delta EP_{j,\tau} = \frac{\Delta E_{j,\tau}^{CHN}}{Y_{j,0}}, \tag{8}$$

where $\Delta E_{j,\tau}^{CHN}$ is the change in exports from country c to China. Its instrument is:

$$\Delta EPO_{j,\tau} = \frac{\Delta E_{j,\tau}^{CHN,O}}{Y_{j,0}^{O}}, \tag{9}$$

where $\Delta E_{j,\tau}^{CHN,O}$ is the change in exports from other high-income countries to China during the period τ. Equation (4) is estimated using 2SLS as well as OLS specifications with IVs of $\Delta IPO_{j,\tau}^{IM}$, $\Delta IPO_{j,\tau}^{FN}$, and $\Delta EPO_{j,\tau}$.

Note that Acemoglu et al. (2016) featured the general equilibrium effect of an increase in imports from China including indirect effects through sectoral linkages. However, since the WIOD has limited number of industries, the inclusion of indirect effects causes severe multicollinearity and loss of a degree of freedom. Thus, while we follow the empirical specification with focusing on direct effect in Acemoglu et al. (2016), we extend the analysis on the direct effect, which explicitly distinguishes the imports of final goods, those of intermediate inputs, and exports.

2.1.3 | Instrumental variables

Our instrumental strategy is similar to that of the previous studies such as Autor et al. (2013) and Acemoglu et al. (2016). That is, to instrument the imports from China by a target country c, we use the imports from China by other OECD countries which experienced a similar surge in the imports from China during the sample period. As in the previous literature, we choose a set of countries as the IV candidate that have characteristics similar to a target country regarding trade with China. We then take the mean of these countries' Chinese import penetration ratios and export–output ratios to form the instruments.

We choose countries to construct IV for each explanatory variable as follows. First, following the literature, we select nine high-income OECD countries that are available in the WIOD and experienced a large increase in trade with China. We consider these nine countries as a baseline set of countries, which consists of Australia, Canada, France, Germany, Japan, South Korea, Taiwan, the United Kingdom and the United States. Then, in the case where the baseline set of countries does not satisfy the conditions that are required to be valid instruments, we modify a set of countries by adding or excluding some of these countries to satisfy these conditions.[8] We select the countries that have high correlations with a target country in terms of the imports of intermediate inputs or of final goods from China. We also adjust the set of countries in order to include at least three countries and not to choose the target countries and other IV countries from only one region. This would avoid the IV correlating to unobserved labour demand shocks that would also affect the employment change in the target country. The countries we use to construct the IV for each explanatory variable in six target countries are listed in Table A2.

We form the IVs for the export–output ratios in a similar way with those for the import penetration ratios of final good and intermediate inputs. To reduce the correlations between the IVs for each explanatory variable, we further adjust the sets of IV countries such that we do not have too low Shea's adjusted partial R^2, which is an indicator for a valid IV in a multivariate model (see Shea, 1997).

2.2 | Data

2.2.1 | Source

This paper uses data from the WIOD for the period from 2000 to 2014.[9] The WIOD is built on national accounts data and was developed within the 7th Framework Programme of the European Commission. The WIOD provides time series of global IO tables for 28 EU countries, 15 other major countries and the rest of the world (ROW). The 15 countries include non-EU OECD member countries such as Japan and the United States as well as emerging economies such as China and Mexico. These tables are constructed on the basis of officially published IO tables in conjunction with national accounts and international trade statistics.

One advantage of using the WIOD is that it provides Socio Economic Accounts which include annual data such as employment at the industry level. This enables us to examine the effects of trade on employment more precisely. Moreover, throughout the data collection effort, harmonisation

[8]We consider a set of IV valid if the IV satisfies the following conditions at the first stage: 1) the IV is well correlated with the explanatory variable, 2) F-value in the first-stage regression is high enough, and 3) the IV is not strongly correlated with the other IVs (e.g., the IV for import penetration ratio of final goods does not have a high correlation with the IV for import penetration ratio of intermediate inputs and the IV for export–output ratio), which means Shea's adjusted partial R^2 is high (see Shea, 1997). These first-stage statistics are provided in Tables A4-A6.

[9]The WIOD and all satellite accounts are available at http://www.wiod.org. The satellite accounts include National IO Tables, Socio Economic Accounts (i.e., data on employment, capital stocks, etc.) and Environmental Accounts. In this paper, we utilise World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018. For a detailed description of the database construction, see Timmer, Dietzenbacher, Los, Stehrer, and de Vries (2015).

procedures are applied to ensure the international comparability of the data. This enables us to conduct comparative analysis across countries for the same period under the same industry classification. If the period or the industry classification is different, one cannot figure out whether the difference of the effects of the China shock can be attributable to the differences in country, period or industry classification.

Another advantage of using the WIOD is that it includes information on the use of imported goods, whether for intermediate inputs or for final demand. It provides data for domestic and imported intermediate inputs as well as domestic and imported final demands separately and by country. In our analysis, imports in the intermediate demand sector are regarded as imports of intermediate inputs, whereas imports in the final demand sector are regarded as imports of final goods. In addition, information on both source and destination industries is also available. Note that the use of and the destination industry of imported goods are not reported in standard trade data. Similarly, the national input–output table reports the imports as a total and does not distinguish between intermediate inputs and final goods. These features in turn mean that the WIOD enables us to capture the imports of manufacturing goods for intermediate inputs as well as for final demand. Thus, the WIOD is useful for cross-country comparisons of international trade flows between a particular pair of countries with a separation of intermediate and final goods.

In contrast, a disadvantage of the WIOD is that the industry classification is less disaggregated than the classification in the previous studies. This makes it difficult to analyse the inter-industry linkages precisely, even though the recent studies such as Acemoglu et al. (2016) emphasised the importance of the general equilibrium effects. Therefore, this study does not pursue the issue of inter-industry linkages. In addition, many Eastern European and South East Asian countries are not included in the WIOD. This paper focuses on the imports from China rather than those from low-wage countries.

Note that the China shock became evident from the early 2000s. For example, Autor et al. (2013) confirmed that the share of imports from China in the United States increased from 2001 when China joined the World Trade Organization (WTO).[10] Similarly, Taniguchi (2019) pointed out that, in Japan, imports from China in 2002 exceeded imports from the United States that was the largest importing partner for a long time. Because the WIOD covers the period from 2000, it is desirable to examine the effects of the China shock.[11]

2.2.2 | Definition of key variables

There are two key variables in our analysis: employment and trade (imports and exports). In Socio Economic Accounts in the WIOD, employment is defined as the number of persons engaged (EMP in the WIOD).[12] Note that there is neither distinction between temporary and permanent workers nor distinction between part-time and full-time workers in the WIOD. Therefore, employment in our analysis includes temporary as well as permanent workers.

[10]In contrast, Pierce and Schott (2016) argued that the increased imports from China are attributable to the changes in US trade policy rather than the China's entry to the WTO.

[11]The Release 2013 version of the WIOD covers the period between 1995 and 2011. However, the number of sectors is much smaller (34 sectors) than the current version (the Release 2016). This makes a small sample problem much severe in our analysis. This paper thus uses the Release 2016 rather than the Release 2013.

[12]Although the WIOD provides us with the number of persons engaged (EMP) and that of employees (EMPE), we use the former because the latter excludes self-employed workers.

Trade is measured as the transactions between countries. Imports of final goods are defined as the imports that are used for final demand. The rest of the imports are defined as the imports used for intermediate inputs. To ensure the comparability of our findings with previous studies, we focus on the effects of manufacturing trade; therefore, industries are limited to industries with the WIOD industrial codes from 5 to 23.[13] In this study, we define manufacturing by the supply side sector.[14] This, in turn, means that the imports of intermediate inputs in manufacturing do not include the imports from non-manufacturing industries such as natural resources because they do not directly cause competition in manufacturing industries.[15] When we measure procurement from China to industry j in a target country, the imports of intermediate inputs are based on the user side sector. x_j^{CHN} in Equation (5) indicates the imports of intermediate inputs from industries 5 to 23 in China to industry j in a target country. Note that an exporting industry can be different from an importing industry in the WIOD. E_j^{CHN} in Equation (8) indicates the exports from industry j in the target country to industries 5 to 23 in China.

To compute the growth rate with enough observations, we split the sample into two sub-periods: 2000–2007 and 2007–2014. The growth rate is computed for 2000–2007 and for 2007–2014. The initial year for the first sub-period (2000–2007) is the year 2000. The year 2007 is the initial year for the second sub-period (2007–2014). One may propose the use of overlapping data (e.g., 2000–2007 and 2001–2008) rather than non-overlapping data (i.e., 2000–2007 and 2007–2014). As Clark and Coggin (2011) point out, the use of overlapping data sometimes allows us to obtain greater statistical efficiency. However, overlapping data create a moving average error term and thus OLS parameter estimates would be inefficient.[16] Besides, the previous studies on the China shock (e.g., Autor et al., 2013) used non-overlapping data. In conformity with the existing literature, we use non-overlapping data.

2.2.3 | Descriptive statistics

Table 2 presents the descriptive statistics for the main variables in the regression analysis (i.e., Equations (1) and (4)). We highlight three main findings. First, manufacturing employment declined for all countries except for South Korea. Second, the growth of the imports of final goods from China is greater than that of intermediate inputs except for South Korea. Finally, total imports from China grew faster than total exports to China from the United States, Japan, the United Kingdom and France, while total exports grew faster than total imports for Germany and South Korea. These results suggest that the effects of imports from and exports to China could be different across these six countries.

[13]For the list of industries, see Table A1 in Appendix A2.

[14]Appendix A1 explains the structure of the WIOD in more detail.

[15]For example, according to Japan Foreign Trade Council, the 1st and the 2nd major products of the Japanese imports in 2018 are oil (10.8 per cent) and liquefied natural gas (5.7 per cent), respectively. It is difficult to imagine that these products bring competition in manufacturing industries.

[16]For more detail about the overlapping data problems, see Harri and Wade Brorsen (2009).

TABLE 2 Descriptive statistics

	United States		Japan		Germany	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
ΔEmployment (ΔL)	−16.492	15.149	−10.282	17.367	−4.342	11.482
ΔImports (ΔIP)	2.333	2.907	1.962	2.541	2.730	4.492
ΔImports of final goods (ΔIP^{FN})	1.693	2.908	1.337	2.356	1.874	3.972
ΔImports of intermediate inputs (ΔIP^{IM})	0.640	0.542	0.625	0.563	0.856	0.796
ΔExports (ΔEP)	0.646	0.828	1.36	1.687	2.953	3.173
	United Kingdom		**France**		**South Korea**	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
ΔEmployment (ΔL)	−20.812	16.759	−16.672	14.968	5.171	22.672
ΔImports (ΔIP)	2.938	3.831	2.143	3.558	6.415	5.130
Δ Imports of final goods (ΔIP^{FN})	2.227	3.753	1.37	3.313	2.012	3.318
ΔImports of intermediate inputs (ΔIP^{IM})	0.711	0.545	0.774	0.880	4.403	3.668
ΔExports (ΔEP)	1.27	2.818	1.373	2.346	7.861	8.664

Note: For the definition of variables, see main text.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

3 | ESTIMATION RESULTS

3.1 | Preliminary analysis

Table 3 presents the OLS and 2SLS regression results of Equation (1). We use small option in Stata software to make degrees-of-freedom adjustments and report small sample statistics to take into account the small sample problem. To avoid the potential endogeneity problem, the focus is on 2SLS results, while the OLS results are presented as references. We highlight two results. First, the first-stage partial R^2 is relatively high in all countries.[17] This result supports the validity of our instruments.

Second, the imports from China have significantly negative effects on employment in most countries. Table 3 indicates that the significantly negative coefficients of Chinese import penetration (ΔIP) are confirmed in the United States, Japan, the United Kingdom and France. This result implies that import competition from China negatively affected for employment in these countries.

[17]Table A3 indicates the first-stage results. For each country, the coefficients in the first-stage estimations, F-value and partial R^2 are listed for each explanatory variable. The results indicate that the correlations between explanatory variable and its instrument, F-values, and partial R^2 are high enough in each target country, which suggests that our instrumental variables are not weak and thus valid.

TABLE 3 Estimation results: Preliminary analysis

	United States		Japan		Germany	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Import penetration	−2.636***	−3.139***	−1.788	−2.353*	−0.378	−0.519
(ΔIP)	(0.863)	(0.826)	(1.285)	(1.357)	(0.503)	(0.608)
N	38	38	36	36	38	38
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2		0.9070		0.7928		0.8601
	United Kingdom		**France**		**South Korea**	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Import penetration	−2.650***	−2.553***	−1.811*	−2.483**	−0.695	−0.063
(ΔIP)	(0.551)	(0.573)	(0.918)	(1.015)	(0.596)	(1.049)
N	38	38	38	38	36	36
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2		0.8826		0.8885		0.7387

Notes: This table presents the estimation results of regression Equation (1) with instruments (i.e., Equations (2) and (3)) for 2SLS. ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set. The sample period consists of two sub-periods: 2000--2007 and 2007--2014. The number of industries thus is *N*/2.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

As discussed in Section 2, however, the effects of import penetration may be different if the difference between intermediate inputs and final goods or the effects of exports are taken into account. Section 3.2 addresses these issues in more detail.

3.2 | Benchmark results

Table 4 indicates the OLS and 2SLS regression results of Equation (4). As in the preliminary analysis, we focus on 2SLS results to avoid the potential endogeneity problem.[18] We highlight three results. First, the effects of imports of final goods from China on employment are generally negative and significant. Significantly negative coefficients of the imports of final goods are confirmed in all target countries except South Korea. The results imply that the increasing imports of final goods from China could pose a threat to employment in many advanced countries.

[18]Table A6 indicates the first-stage results. Like the preliminary analysis, results indicate that the correlations between explanatory variable and its instrument, *F*-values, and partial R^2 are high enough in each target country, which suggests that our instrumental variables are not weak and thus valid.

TABLE 4 Estimation results: Benchmark specification

	United States		**Japan**		**Germany**	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Import penetration						
Final goods	−2.722***	−3.263***	−2.283*	−2.925**	−1.579***	−2.000***
(ΔIP^{FN})	(0.833)	(0.765)	(1.249)	(1.095)	(0.507)	(0.613)
Intermediate inputs	2.128	−3.084	4.977	6.408	7.134**	8.972**
(ΔIP^{IM})	(6.150)	(8.905)	(6.948)	(7.406)	(2.888)	(4.187)
Export–output ratio	1.530	5.285	0.350	1.149	−0.107	−0.393
(ΔEP)	(3.486)	(6.525)	(1.906)	(2.012)	(0.440)	(0.575)
N	38	38	36	36	38	38
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP^{FN}		0.7363		0.7528		0.5401
ΔIP^{IM}		0.2153		0.5864		0.5435
ΔEP		0.1396		0.6143		0.5593
	United Kingdom		**France**		**South Korea**	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Import penetration						
Final goods	−2.719***	−2.680***	−1.888**	−2.950**	−1.705 **	−1.056
(ΔIP^{FN})	(0.549)	(0.561)	(0.912)	(1.249)	(0.747)	(0.987)
Intermediate inputs	0.420	0.294	−3.513	1.045	0.716	1.457
(ΔIP^{IM})	(2.747)	(3.377)	(5.081)	(4.372)	(1.640)	(2.272)
Export–output ratio	0.009	0.451	1.599	0.783	0.002	0.217
(ΔEP)	(0.364)	(0.678)	(1.373)	(1.419)	(0.836)	(0.989)
N	38	38	38	38	36	36
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP^{FN}		0.9130		0.7993		0.8662
ΔIP^{IM}		0.7126		0.6970		0.5965
ΔEP		0.7343		0.7754		0.6114

Notes: This table presents the estimation results of regression Equation (4) with instruments (i.e., Equations (7) and (9)) for 2SLS. ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set. The sample period consists of two sub-periods: 2000--2007 and 2007--2014. The number of industries thus is $N/2$.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

Second, however, the imports of intermediate inputs have different effects from those of final goods. The positive coefficients are confirmed in all target countries except the United States. Moreover, the coefficient is statistically significant at the 5 per cent level for Germany. The results indicate that the increasing imports of intermediate inputs are not threats in all countries but it could affect employment positively in many of these countries.

Finally, the effects of exports are generally positive although insignificant. Insignificantly positive coefficients of export–output ratio are confirmed in all countries but Germany. The results weakly suggest that the increasing exports to China also affect employment positively in these countries.

These results together imply that the import penetration of final goods from China could have significantly negative effects on manufacturing employment in six target countries. In contrast, the import penetration of intermediate inputs from and the exports to China could have weak but positive effects in most of these countries. These results seem to suggest that these six advanced countries face similar reactions to the China shock. However, the magnitude may be different across countries. In Section 3.3, the issue of magnitude is discussed further.

3.3 | Counterfactual manufacturing employment

In Section 3.2, we found that the import penetration of final goods from China has significantly negative effects on employment, while the import penetration of intermediate inputs from and exports to China commonly have weak positive effects across most of these countries. However, even if the results are similar across countries in terms of statistical significance, their economic significance may be different. To address this issue, we estimate changes in counterfactual employment when there is no increase in trade with China.[19]

The difference between actual and counterfactual manufacturing employment of country c, ΔL_{τ}^{cf}, is:

$$\Delta L_{\tau}^{cf} = -\sum_{j} L_{j,\tau} \left(1 - \exp\left(-\hat{\beta}_1 \Delta \tilde{IP}_{j,\tau}^{IM} - \hat{\beta}_2 \Delta \tilde{IP}_{j,\tau}^{FN} - \hat{\gamma} \Delta \tilde{EP}_{j,\tau}\right)\right), \quad (10)$$

where $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\gamma}$ are the 2SLS coefficient estimates.[20] $\Delta \tilde{IP}_{j,\tau}^{IM}$ and $\Delta \tilde{IP}_{j,\tau}^{FN}$ indicate the increases in import penetration ratio from China for intermediate inputs and for final goods, respectively; $\Delta \tilde{EP}_{j,\tau}$ indicates the increases in export–output ratio to China. Following Acemoglu et al. (2016), $\Delta \tilde{IP}_{j,\tau}^{IM}$ is obtained by multiplying the observed increase in import penetration $\Delta IP_{j,\tau}^{IM}$ with the partial R-squared from the first-stage regression on the instrument. $\Delta \tilde{IP}_{j,\tau}^{FN}$ and $\Delta \tilde{EP}_{j,\tau}$ are estimated in a similar manner. As for time period τ, the estimation covers two periods. Changes in employment and ratios from 2000 to 2007 as well as changes from 2007 to 2014 are examined.

Table 5 presents the results. Each figure indicates the difference between actual and counterfactual employment. For example, the figure in the top-left corner in this table indicates − 1,237.6, which means that the US employment would have decreased by 1.2 million workers in comparison to the case where there was no increase in the imports of intermediate inputs and final goods from, as well as the exports to, China between 2000 and 2007.

[19]This means that the counterfactual employment is estimated under the assumption that there is no change in imports of intermediate inputs, final goods and exports.

[20]Unlike Acemoglu et al. (2016), we multiply the difference by –1 such that the sign of the difference becomes consistent with the sign of the effects of trade.

TABLE 5 Counterfactual manufacturing employment

	United States			Japan			Germany		
	2000–07	**2007–14**	**2000–14**	**2000–07**	**2007–14**	**2000–14**	**2000–07**	**2007–14**	**2000–14**
Imports: final goods	−1237.6	−316.7	−1554.4	−529.6	−398.3	−927.9	−215.0	−75.5	−290.5
Imports: intermediate inputs	−67.5	−72.5	−139.9	376.7	276.5	653.2	458.8	276.5	735.3
Exports	88.8	75.2	164.1	207.7	67.3	275.0	−61.4	−65.1	−126.4
Total	−1216.3	−314.0	−1530.2	54.8	−54.5	0.3	182.4	135.9	318.3
	United Kingdom			**France**			**South Korea**		
	2000–07	**2007–14**	**2000–14**	**2000–07**	**2007–14**	**2000–14**	**2000–07**	**2007–14**	**2000–14**
Imports: final goods	−284.6	−99.9	−384.5	−180.0	−8.6	−188.5	−133.6	−84.9	−218.5
Imports: intermediate inputs	4.6	4.8	9.4	18.6	13.3	31.9	127.6	204.6	332.2
Exports	9.9	12.8	22.7	28.7	16.8	45.6	34.6	57.3	91.9
Total	−270.1	−82.3	−352.4	−132.6	21.6	−111.0	28.6	177.0	205.6

Notes: The counterfactual employment is estimated from Equation (10). The unit is thousand workers. ‘Imports’ means import penetration ratio, while ‘exports’ means export–output ratio.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

TABLE 6 Counterfactual manufacturing employment: Alternative specification

	United States			Japan			Germany		
	2000–07	2007–14	2000–14	2000–07	2007–14	2000–14	2000–07	2007–14	2000–14
Total imports	−1708.0	−671.7	−2379.7	−627.3	−468.0	−1095.3	−130.9	−55.9	−186.8
	United Kingdom			**France**			**South Korea**		
	2000–07	**2007–14**	**2000–14**	**2000–07**	**2007–14**	**2000–14**	**2000–07**	**2007–14**	**2000–14**
Total imports	−310.6	−140.8	−451.4	−221.1	−47.2	−268.3	−13.7	−14.9	−28.7

Notes: The counterfactual employment is estimated from Equation (10). The unit is thousand workers. ‘Imports’ means import penetration ratio, while ‘exports’ means export–output ratio.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

The effect of the imports of final goods is generally negative on manufacturing employment, while the effects of the imports of intermediate inputs and exports are generally positive. However, the magnitude is different across six countries. For the United Kingdom and the United States, the negative effects of the imports of final goods outweigh the positive effects of the imports of intermediate inputs and exports. These results suggest the significant negative effects of the China shock on manufacturing employment in these two countries, which may be consistent with the recent surge of anti-globalisation activities in these two countries.

For France and Japan, in contrast, the negative effects of the imports of final goods offset the positive effects of the imports of intermediate inputs and exports. For example, negative effects are reduced to one-tenth for Japan if the effects of imports of intermediate inputs and exports are taken into account. Therefore, the effect of the China shock in France and Japan may be much smaller than in the United Kingdom and the United States.

For South Korea and Germany, positive effects outweigh negative effects. For example, for Germany, the employment would have *decreased* by 318 thousand workers if there were no imports from and exports to China. A similar finding is confirmed in South Korea. The China shock thus might have positive effects on manufacturing employment in these two countries. These results together imply that the effects of import competition from China vary across countries. Therefore, a careful interpretation is needed for the external validity of the results that are obtained in one country.

It is important to note that the negative effects of the China shock could be overestimated if the analysis does not take into account exports as well as the imports of intermediate inputs. Table 6 presents the results of counterfactual employment, based on Equation (1).[21] The results indicate negative employment effects in these six countries, which is consistent with the results of final good imports in Table 5. The results suggest that the negative effects of the China shock could be overemphasised without accounting for the effects of imports of intermediate inputs and those of exports.

It is also important to note that the negative effects of the imports of final goods from China declined from 2000–2007 period to 2007–2014 period in these six countries. These results suggest that the significantly negative effects of the China shock were mainly observed in the 2000s right after China's entry into the WTO. The negative shock seems to have declined in the 2010s. The recent decline in manufacturing employment may be attributable to other factors such as the substitution between capital and labour caused by the growing use of robots, although more detailed analysis is needed to determine the exact factors behind these changes.

4 | DISCUSSION

4.1 | Alternative specifications

One may concern the consistency between the results of our study and those of the previous studies. Because none of the previous studies take into account the effects of exports and the difference between intermediate inputs and final goods simultaneously, we re-estimate our benchmark equation, dropping exports or using total (intermediate inputs + final goods) imports. Table 7 indicates the results without exports, while Table 8 indicates the regression results of Equation (4) without distinction

[21]Counterfactual employment is computed from the 2SLS results and $\Delta L^{cf}_{\tau} = -\sum_j L_{j,\tau}\,(1 - \exp(-\hat{\beta}\,\Delta \widetilde{IP}_{j,\tau}))$.

between intermediate inputs and final goods, both of which are similar to the specifications employed by the previous studies.[22]

For the United States, if we drop exports from our benchmark equation, we can find a positive but insignificant coefficient for the imports of intermediate inputs (Table 7). Wang et al. (2018) also employed a similar specification and found the positive effects of imported intermediate inputs from China. Strictly speaking, however, our results are not directly comparable to their results because their positive effects are confirmed through downstream linkages, which we are unable to address due to the small sample size.

For Japan, even if we drop exports, we continue to find a positive but insignificant coefficient for the imports of intermediate inputs (Table 7). Taniguchi (2019) also found that the increases in the imports of intermediate inputs from China had positive effects on employment. Note, however, that her study is based on the regional variation (i.e., cross-region analysis), while our study is based on the industry variation (i.e., cross-industry analysis). It is therefore not surprising that our results are slightly different from her results.

For Germany, if we use total imports, we can confirm a significantly positive coefficient for exports (Table 8), which is consistent with the findings of Dauth et al. (2014) where they found significantly positive effects of trade exposure on employment in Germany. However, when they focus on trade with China, they find significantly negative effects of imports while insignificant effects on exports. Note that, like Taniguchi (2019), however, their study is based on the regional variation. Their sample period is also different from ours (Table 1). This may be one of the reasons why our results are slightly different from their results.

For South Korea, if we use total imports, we continue to find a positive but insignificant coefficient for exports (Table 8), which is consistent with the finding of Choi and Xu (2020) where they also found the positive effects of exports. Their analysis is based on more detailed industry-level data, which may allow them to capture the variations across industries more precisely.

4.2 | Why is the impact so large in the United States?

Our estimation and counterfactual analysis suggest that the United States had the largest negative impact from the China shock in our six target countries. The coefficient of interest in our benchmark specification is the largest; as well, the number of counterfactual employment loss outweighs the numbers in the other five countries.

What causes this stronger ‘China shock’ in the United States? A close look at industries shows that industry 6 (C13-C15 in ISIC)—manufacture of textiles, wearing apparel and leather products, had a distinct behaviour in changes in employment. In 2000, employment in the textile industry in the United States was over 1.2 million, but the number fell to almost one-half in 2007. During 2000–2007, this industry experienced the harshest employment decline as well as the largest increase in imports of final goods from China in the US manufacturing sector for the whole sample period. In the US textile industry, losses for the entire period from 2000 to 2014 were 744.5 thousand jobs.

Our benchmark estimation results show how much this single industry affected employment in the United States. To briefly look at this effect, we estimate our benchmark model excluding the textile industry. Without this industry, in the 2SLS estimation, the effect of a one per cent increase in the import penetration ratio of final goods from China on manufacturing employment is −1.38. This number

[22]For the first-stage results, see Tables A5 and A6.

TABLE 7 Estimation results: Alternative specification 1

	United States		Japan		Germany	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Import penetration						
Final goods	−2.683***	−3.099***	−2.283*	−2.807**	−1.541***	−1.971***
(ΔIP^{FN})	(0.814)	(0.776)	(1.244)	(1.147)	(0.462)	(0.535)
Intermediate inputs	3.991	3.063	5.744	8.665	6.705***	7.958 ***
(ΔIP^{IM})	(2.734)	(3.339)	(4.772)	(5.586)	(1.879)	(2.878)
N	38	38	36	36	38	38
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP^{FN}		0.9008		0.7708		0.5053
ΔIP^{IM}		0.7523		0.6814		0.4896
	United Kingdom		France		South Korea	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Import penetration						
Final goods	−2.719***	−2.699***	−1.911*	−2.975 **	−1.705**	−1.008
(ΔIP^{FN})	(0.541)	(0.552)	(0.992)	(1.307)	(0.717)	(1.075)
Intermediate inputs	0.428	0.295	−0.772	2.437	0.719	2.007
(ΔIP^{IM})	(2.826)	(3.366)	(3.072)	(2.944)	(0.845)	(1.615)
N	38	38	38	38	36	36
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP^{FN}		0.9192		0.8045		0.8184
ΔIP^{IM}		0.6889		0.7363		0.7353

Notes: This table presents the estimation results of regression Equation (4), dropping exports, with instruments (i.e., Equations (7)) for 2SLS. ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set. The sample period consists of two sub-periods: 2000--2007 and 2007--2014. The number of industries thus is $N/2$.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

is nearly one-third of the coefficient in the estimation including the textile industry. In addition, the coefficient of the import penetration ratio of intermediate inputs turns to positive, although it remains insignificant. This exercise suggests that the large employment decline in the US manufacturing in our benchmark results is largely attributable to the textile industry's experience.

The counterfactual employment change using the estimation result without the textile industry is also quite different from our main specification result for the United States. According to a new counterfactual exercise using the estimates without the textile industry, the decrease of employment caused by Chinese trade is 257.1 thousand workers during 2000–2014, which is almost one-sixth of 1,530.2 thousand, the number in the exercise that includes the textile industry. In particular, in 2007–2014,

TABLE 8 Estimation results: Alternative specification 2.

	United States		Japan		Germany	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Import penetration	−2.767***	−3.267***	−2.039	−2.892	−0.600	−0.847
(ΔIP)	(0.811)	(0.703)	(1.204)	(1.058)	(0.557)	(0.648)
Export–output ratio	3.899**	5.379*	1.882	3.063*	0.846**	1.042**
(ΔEP)	(1.472)	(2.991)	(1.453)	(1.556)	(0.397)	(0.451)
N	38	38	36	36	38	38
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP		0.8746		0.7156		0.7913
ΔEP		0.4428		0.7076		0.5577
	United Kingdom		**France**		**South Korea**	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Import penetration	−2.648***	−2.530***	−1.983**	−2.678**	−1.005	−0.702
(ΔIP)	(0.557)	(0.580)	(0.967)	(1.081)	(0.687)	(0.937)
Export–output ratio	0.150	0.587	1.254	1.471	0.496	0.677
(ΔEP)	(0.427)	(0.731)	(0.849)	(1.069)	(0.533)	(0.695)
N	38	38	38	38	36	36
Period fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
ΔIP		0.8742		0.8491		0.7588
ΔEP		0.7539		0.7903		0.7540

Notes: This table presents the estimation results of regression Equation (4), aggregating imports of intermediate inputs and final goods into total imports, with instruments (i.e., Equations (3) and (9)) for 2SLS. ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set. The sample period consists of two sub-periods: 2000–2007 and 2007–2014. The number of industries thus is N/2.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

the counterfactual employment change is 1.44 thousand, which is small but positive in contrast to the number in our benchmark exercise. If we assume that all of the employment decline in the textile industry, 744.5 thousand, was attributable to the China shock, the sum of this decline and the employment loss estimated without the textile industry is approximately 1 million (= 257.1 + 744.5) during the sample period, which is almost two-thirds of the number in our benchmark exercise. Given these large differences, our results suggest that the import exposure in the textile industry would play an important role in the effect of the import penetration from China and the distinctive number of counterfactual employment change in the United States.

4.3 | The small sample problem

We utilised the WIOD in our analysis. On the one hand, because the WIOD covers the same period based on the same industry classification, the use of it enables us to investigate the effects of the China shock in an internationally comparable manner. Besides, because the WIOD is based on the world input–output table, it allows us to distinguish the imports of intermediate inputs and those of final goods in a consistent way. Indeed, a number of studies utilised the WIOD in analysing the effects of trade on employment.[23] For example, Feenstra and Sasahara (2018) utilised the WIOD to examine the effects of exports and imports on the US employment. Caliendo et al. (2019) utilised the WIOD to examine the effects of trade on labour market dynamics, calibrating the model to 22 sectors. The wide use of the WIOD in the literature implies the relatively high reliability of the WIOD.

On the other hand, the use of the WIOD prevents us from using the detailed industry classification, which in turn leads to the small sample size, as is indicated in Table 2. This could cause the following two problems. One is the problem arises from the statistical aspect. The smaller the sample size, the less the precision of the statistical accuracy would be. Indeed, several studies such as Cravino and Sotelo (2019) also faced the problem of small sample, although their study did not discuss this problem explicitly. To address this issue, we use small option in Stata software to make degrees-of-freedom adjustments and report small sample statistics, which would mitigate the problem. Nonetheless, a careful interpretation is needed for the results of our analysis.[24]

The other is the problem arises from the aggregation of industries. The WIOD is available only at the aggregated level. Because of the aggregation, there may be a large within-industry heterogeneity. For example, within manufacture of chemicals and chemical products in the WIOD industry classification, there may be a huge variation of Chinese imports and exports. If one can utilise the data with more detailed industry classification, such problem could be alleviated. However, even when one can utilise firm-level data, international comparative analysis prevents us from the use of detailed industry classification because of, for example, differences in industry classification across countries. For example, Bellone et al. (2014) examined the cross-country productivity gap of exporters using firm-level data in France and Japan. For the comparison between countries, they aggregate the data into 18 manufacturing industries. Dobbelaere et al. (2015) estimated the productivity and markup of firms using the firm-level data in France, Japan and the Netherlands. They aggregate the data into 30 manufacturing industries. For the international comparative studies, it is generally difficult to rely on the detailed industry-level classification at the current moment.

Note also that the problem of within-industry heterogeneity may not be solved even if the internationally comparable detailed product-level data (along with employment data) are available. For example, Schott (2004) found that the unit values of US manufacturing imports varied widely even within 10-digit Harmonized System (HS) product code. Similarly, Kiyota (2010) found such heterogeneity within 9-digit HS product code for the Japanese imports. These studies suggest that, even if we use the internationally comparable detailed product-level data, we may still face the same problem.

[23]For more detail, see the WIOD website (http://www.wiod.org/published).

[24]As a robustness check, we perform a regression with the benchmark specification that also includes non-manufacturing industries, following the previous studies such as Wang et al. (2018) and Caliendo et al. (2019) (see Table 1). It has sample size of over one hundred. Our main messages from the benchmark results are unchanged: the coefficients of the imports of final goods from China are significantly negative in most countries, while the imports of intermediate inputs do not show negative impacts. See Appendix B for the result.

5 | CONCLUDING REMARKS

While in many advanced countries the increasing import competition from China on employment is a major concern for policymakers and the general public, its impact could be different across countries, depending upon the volume and composition of the products. This paper examines the impact of the China shock on employment in six advanced countries: France, Germany, Japan, South Korea, the United Kingdom and the United States. One of the contributions of this paper is that we extend the previous studies to cross-country comparisons, based on the same analytical framework and the same dataset. We used the data from the WIOD between 2000 and 2014.

Our major findings are twofold. First, the import penetration of final goods from China has a negative effect on manufacturing employment in most of the six countries, whereas the import penetration of intermediate inputs from and the exports to China show positive coefficients while they are statistically insignificant in most countries. Second, in the counterfactual analysis, we show that such positive effects could offset or even outweigh the negative effects in some countries. For the United Kingdom and the United States, the negative effects of the imports of final goods outweigh the positive effects of the imports of intermediate inputs and exports. In contrast, for France and Japan, the negative effects of the imports of final goods offset the positive effects of the imports of intermediate inputs and exports. For South Korea and Germany, the positive effects outweigh the negative effects. These results together suggest that a careful interpretation is needed when evaluating the external validity of the China shock that is obtained in one country. It is also important for policymakers to focus on positive as well as negative aspects of trade with China. Furthermore, we should note that consumers generally receive benefits from the imports of low-priced goods, as standard trade theories suggest. Of course, the negative aspects of globalisation should not be ignored, but they should not be overemphasised.

It is important to note that these results have an important caveat. Our analysis is based on small sample. This could cause the small sample problem, which results in the less precise estimates. Noting that the small sample is caused by the aggregation of industries, this could also magnify the problem of within-industry heterogeneity. Therefore, our estimation results should be interpreted with caution.

In conclusion, several future research issues are worth mentioning. First, further investigation of the China shock is an important extension. Recent studies have focused on the effects of Chinese import competition on various outcomes other than employment. For example, Autor et al. (2019) focused on the effects on mortality. Che et al. (2018) focused on the effects on crime. However, to our knowledge, none of these studies distinguish between the imports of final goods and those of intermediate inputs. It is important to extend these studies to take into account such differences. Second, although our instrumental strategy followed Autor et al. (2013), some recent studies such as Goldsmith-Pinkham et al. (2019) and Jaeger et al. (2018) point out potential problems of the use of such shift-share instrument. Exploring alternative instrumental strategy may be an interesting avenue for future research. Finally, it is also essential to extend the analysis to more detailed industry-level data. The use of more detailed industry-level analysis could mitigate the small sample problem. To conduct such analyses, it is imperative that the quality and coverage of the industry-level data must be improved and expanded.

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REFERENCES

Acemoglu, D., Akcigit, U., & Kerr, W. (2015). Networks and the macroeconomy: An empirical exploration. *NBER Macroeconomics Annual*, *30*, 273–335. https://doi.org/10.1086/685961

Acemoglu, D., Autor, D., Dorn, D., Hanson, G. H., & Price, B. (2016). Import competition and the great us employment sag of the 2000s. *Journal of Labor Economics*, *34*(S1), S141–S198. https://doi.org/10.1086/682384

Autor, D. H., Dorn, D., & Hanson, G. H. (2013). The China syndrome: Local labor market effects of import competition in the United States. *American Economic Review*, *103*(6), 2121–2168. https://doi.org/10.1257/aer.103.6.2121

Autor, D. H., Dorn, D., & Hanson, G. H. (2015). Untangling trade and technology: Evidence from local labour markets. *Economic Journal*, *125*(584), 621–646. https://doi.org/10.1111/ecoj.12245

Autor, D. H., Dorn, D., & Hanson, G. H. (2019). When work disappears: Manufacturing decline and the falling marriage market value of young men. *American Economic Review: Insights*, *1*(2), 161–178.

Bellone, F., Kiyota, K., Matsuura, T., Musso, P., & Nesta, L. (2014). International productivity gaps and the export status of firms: Evidence from France and Japan. *European Economic Review*, *70*, 56–74. https://doi.org/10.1016/j.euroecorev.2014.01.017

Caliendo, L., Dvorkin, M., & Parro, F. (2019). Trade and labor market dynamics: General equilibrium analysis of the china trade shock. *Econometrica*, *87*(3), 741–835. https://doi.org/10.3982/ECTA13758

Che, Y. I., Xun, X. U., & Zhang, Y. (2018). Chinese import competition, crime, and government transfers in US. *Journal of Comparative Economics*, *46*(2), 544–567. https://doi.org/10.1016/j.jce.2017.10.003

Choi, J., & Xu, M. (2020). The labor market effects of the China syndrome: Evidence from South Korea. *The World Economy*, *43*(11), 3039–3087.

Clark, S. P., & Coggin, T. D. (2011). Are U.S. stock price mean reverting? Some new tests using fractional integration models with overlapping data and structural breaks. *Empirical Economics*, *40*(2), 373–391.

Cravino, J., & Sotelo, S. (2019). Trade-Induced Structural Change and the Skill Premium. *American Economic Journal: Macroeconomics*, *11*(3), 289–326. https://doi.org/10.1257/mac.20170434

Dauth, W., Findeisen, S., & Suedekum, J. (2014). The rise of the east and the far east: German labor markets and trade integration. *Journal of the European Economic Association*, *12*(6), 1643–1675. https://doi.org/10.1111/jeea.12092

Dobbelaere, S., Kiyota, K., & Mairesse, J. (2015). Product and labor market imperfections and scale economies: Micro-evidence on France, Japan and the Netherlands. *Journal of Comparative Economics*, *43*(2), 290–322. https://doi.org/10.1016/j.jce.2014.08.006

Fabinger, M., Shibuya, Y., & Taniguchi, M. (2017). International Influences on Japanese Supply Chains. RIETI Discussion Paper Series 17-E-022.

Feenstra, R. C., Ma, H., & Yuan, X. U. (2019). US exports and employment. *Journal of International Economics*, *120*, 46–58. https://doi.org/10.1016/j.jinteco.2019.05.002

Feenstra, R. C., & Sasahara, A. (2018). The 'China shock', exports and U.S. employment: A global input-output analysis. *Review of International Economics*, *26*(5), 1053–1083. https://doi.org/10.1111/roie.12370

Goldsmith-Pinkham, P., Sorkin, I., & Swift, H.. (2019) Bartik Instruments: What, When, Why, and How, NBER Working Paper, 24408.

Harri, A., & Wade Brorsen, B. (2009). The overlapping data problem. *Quantitative and Qualitative Analysis in Social Sciences*, *3*(3), 78–115.

Jaeger, D. A., Ruist, J., & Stuhler, J. (2018). Shift-share instruments and the impact of immigration. NBER Working Paper, 24285.

Kiyota, K. (2010). Are US Exports Different from China's Exports? Evidence from Japan's Imports. *The World Economy*, *33*(10), 1302–1324. https://doi.org/10.1111/j.1467-9701.2010.01295.x

Kiyota, K. (2012). Exports and jobs: The case of Japan, 1975–2006. *Contemporary Economic Policy*, *30*(4), 566–583. https://doi.org/10.1111/j.1465-7287.2011.00274.x

Kiyota, K. (2016). Exports and Employment in China, Indonesia, Japan, and Korea. *Asian Economic Papers*, *15*(1), 57–72. https://doi.org/10.1162/ASEP_a_00402

Pierce, J. R., & Schott, P. K. (2016). The surprisingly swift decline of US manufacturing employment. *American Economic Review*, *106*(7), 1632–1662. https://doi.org/10.1257/aer.20131578

Revenga, A. L. (1992). Exporting jobs? The impact of import competition on employment and wages in US manufacturing. *Quarterly Journal of Economics*, *107*(1), 255–284. https://doi.org/10.2307/2118329

Schott, P. K. (2004). Across-Product Versus Within-Product Specialization in International Trade. *Quarterly Journal of Economics*, *119*(2), 647–678. https://doi.org/10.1162/0033553041382201

Shea, J. (1997). Instrument Relevance in Multivariate Linear Models: A Simple Measure. *Review of Economics and Statistics*, *79*(2), 348–352. https://doi.org/10.1162/rest.1997.79.2.348

Tachibanaki, T., Morikawa, M., & Nishimura, T. (1998). Economic Development in Asian Countries, and the Effect of Trade in Asia on Employment and Wages in Japan. *Asian Economic Journal*, *12*(2), 123–151. https://doi.org/10.1111/1467-8381.00056

Taniguchi, M. (2019). The Effect of an Increase in Imports from China on Local Labor Markets in Japan. *Journal of the Japanese and International Economies*, *51*, 1–18. https://doi.org/10.1016/j.jjie.2018.09.001

Timmer, M. P., Dietzenbacher, E., Los, B., Stehrer, R., & de Vries, G. J. (2015). An Illustrated user guide to the world input-output database: The case of global automotive production. *Review of International Economics*, *23*(3), 575–605. https://doi.org/10.1111/roie.12178

Tomiura, E. (2003). The impact of import competition on Japanese manufacturing employment. *Journal of the Japanese and International Economies*, *17*(2), 118–133. https://doi.org/10.1016/S0889-1583(03)00013-3

Wang, Z., Wei, S.-J., Xinding, Y. U., & Zhu, K. (2018) Re-Examining the Effects of Trading with China on Local Labor Markets: A Supply Chain Perspective, NBER Working Paper, 24886.

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APPENDIX A

A.1 | CALCULATION USING THE WIOD

This paper uses data from the WIOD. The WIOD is useful to our analysis for the following reasons. First, the WIOD provides information on the use of imported goods. In the WIOD, data of imported intermediate input are separated from imported final demands. Second, the WIOD provides information on both source and destination industries. The latter is not obtained in standard trade data. The information of destination industry is used when we focus on manufacturing sector. Third, exports and imports are reported by country. In the national input–output tables, it is impossible to distinguish between imports from China and total imports. These features of the WIOD enable us to calculate the import penetration ratio from China, separating intermediate inputs and final goods. Meanwhile, 'imports' or 'exports' used in the calculation is not indicated explicitly in the WIOD, because there is no notation in the tables; therefore, this appendix aims to indicate components of calculations in the WIOD.

Suppose that there are S industries in N countries.[25] For ease of presentation, we omit time subscript t, unless otherwise noted. Note also that this subsection utilises i and j for industry subscripts, following the standard notation in the IO analysis. Therefore, the subscripts below are not necessarily the same as those used in the main text.

As usual IO tables, transactions are divided into two broad sectors of 'intermediate demand sector' and 'final demand sector'. In the intermediate demand sector, an element of $x_{ji}^{m,n}$ indicates the value of

[25]In the WIOD, S equals to 56 including 23 manufacturing industries, and N equals to 44 including the rest of the world. In this paper, strictly speaking, goods include services. For ease of explanation, however, this paper uses the word 'goods' rather than the word 'goods and services'.

transactions from industry j in country m to industry i in country n. The superscript m denotes the country of a source or a supplier, whereas n denotes a country of a destination or a user. A supplier industry is denoted as j, and a user industry is denoted as i. We regard imports in the intermediate demand sector as imports of intermediate inputs, and this is used in Equation (5). Similarly, in the final demand sector, an element $f_j^{m,n}$ indicates the value of transactions in industry j provided from country m to country n. We regard imports in the final demand sector as imports of final goods which is used in Equation (6). Total output of industry j in country m, Y_j^m, is produced to satisfy domestic and foreign final demands, or to be used as intermediate inputs in domestic and foreign production. Therefore, the sum of each row in a horizontal direction, adding elements in the intermediate demand sector and those in the final demand sector, equals to total output:

$$Y_j^m = \sum_{n=1}^{N} \sum_{i=1}^{S} x_{ji}^{m,n} + \sum_{n=1}^{N} f_j^{m,n}. \tag{11}$$

For sake of simplicity, we construct three-country IO table, which consists of China (CHN), Japan (JPN) and the rest of the world (ROW), see Figure A1. Total output in each industry is produced to satisfy domestic and foreign final demands or to be used as intermediate inputs in domestic and foreign production. Let Y_j^{JPN} denotes the value of output of industry j in Japan. Y_j^{JPN} consists of intermediate inputs used in China, Japan and the ROW as well as final goods provided in China, Japan and the ROW. Using the expressions of $x_{ji}^{m,n}$ for intermediate inputs and $f_j^{m,n}$ for final demands, Y_j^{JPN} is expressed as the sum of x-s and f-s in a horizontal direction in the following equation:

$$Y_j^{JPN} = \sum_{i=1}^{S} x_{ji}^{JPN,CHN} + \sum_{i=1}^{S} x_{ji}^{JPN,JPN} + \sum_{i=1}^{S} x_{ji}^{JPN,ROW} + f_j^{JPN,CHN} + f_j^{JPN,JPN} + f_j^{JPN,ROW}. \tag{12}$$

		Intermediate demand sector			Final demand sector			Total output
		CHN 1 . . i . . 56	JPN 1 . . i . . 56	ROW 1 . . i . . 56	CHN	JPN	ROW	
CHN	1 : j : 56	$x_{ji}^{CHN,CHN}$	$x_{ji}^{CHN,JPN}$ [import of intermediate goods]	$x_{ji}^{CHN,ROW}$	$f_j^{CHN,CHN}$	$f_j^{CHN,JPN}$ [import of final goods]	$f_j^{CHN,ROW}$	Y_j^{CHN}
JPN	1 : j : 56	$x_{ji}^{JPN,CHN}$ [export]	$x_{ji}^{JPN,JPN}$	$x_{ji}^{JPN,ROW}$ [export]	$f_j^{JPN,CHN}$ [export]	$f_j^{JPN,JPN}$	$f_j^{JPN,ROW}$ [export]	Y_j^{JPN}
ROW	1 : j : 56	$x_{ji}^{ROW,CHN}$	$x_{ji}^{ROW,JPN}$ [import of intermediate goods]	$x_{ji}^{ROW,ROW}$	$f_j^{ROW,CHN}$	$f_j^{ROW,JPN}$ [import of final goods]	$f_j^{ROW,ROW}$	Y_j^{ROW}
Value added		v_i^{CHN}	v_i^{JPN}	v_i^{ROW}				
Total output		Y_i^{CHN}	Y_i^{JPN}	Y_i^{ROW}				

FIGURE A1 An example of a three-country input–output table. Notes: Blocks with a notation [export] are included in exports from Japan, whereas blocks with [import] are included in imports to Japan. The final demand sector is divided into five items, although they are omitted in this table for simplicity

Excluding domestic transactions from Y_j^{JPN}, we obtain exports from industry j in Japan to the world, E_j^{JPN}:

$$E_j^{JPN} = \sum_{i=1}^{S} x_{ji}^{JPN,CHN} + \sum_{i=1}^{S} x_{ji}^{JPN,ROW} + f_j^{JPN,CHN} + f_j^{JPN,ROW}. \tag{13}$$

Exports in Equation (13) are used in the denominator of ΔIP and ΔEP in the Equation (2). Similarly, exports from industry j in Japan to China, $E_j^{JPN,CHN}$, are expressed as follows:

$$E_j^{JPN,CHN} = \sum_{i=1}^{S} x_{ji}^{JPN,CHN} + f_j^{JPN,CHN}. \tag{14}$$

Exports in Equation (14) are used in the numerator of ΔEP, expressed in Equation (8). Imports from industry i (a supplier industry) in China to industry j (a user industry) in Japan are expressed as follows:

$$M_j^{CHN,JPN} = \sum_{i=1}^{S} x_{ij}^{CHN,JPN} + f_j^{CHN,JPN}. \tag{15}$$

Note that industry j includes industries 5 to 23 of the WIOD industry code when exports or imports of intermediate inputs are limited to manufacturing. In order to calculate total imports from the world to Japan, add the value of imports from the ROW:

$$M_j^{JPN} = \sum_{i=1}^{S} x_{ij}^{CHN,JPN} + \sum_{i=1}^{S} x_{ij}^{ROW,JPN} + f_j^{CHN,JPN} + f_j^{ROW,JPN}. \tag{16}$$

The import penetration ratio and export–output ratio of industry j in Japan from/to China are, respectively, calculated as follows:

$$IP_j^{JPN} = \frac{M_j^{CHN,JPN}}{Y_j^{JPN} - E_j^{JPN} + M_j^{JPN}} \text{ and } EP_j^{JPN} = \frac{E_j^{JPN,CHN}}{Y_j^{JPN}}. \tag{17}$$

Next, we extend it to many-country IO. In the regression analysis, we use the change of the import penetration ratio and export–output ratio from the initial period, as shown in Section 2.1. The change of the import penetration ratio at the period τ of a target country c such as Japan, $\Delta IP_{j,\tau}$, is derived as follows. The numerator of the ratio is a change in imports from the initial period 0 to the period τ, expressed as $\Delta M_{j,\tau}^{CHN}$. We omit the subscript c, unless otherwise noted. The denominator is the initial value of domestic absorption. Therefore, the change of the import penetration ratio from China to industry j in the target country, $\Delta IP_{j,\tau}$, is expressed as follows:

$$\Delta IP_{j,\tau} = \frac{\Delta M_{j,\tau}^{CHN}}{Y_{j,0} - E_{j,0} + M_{j,0}}, \tag{18}$$

which corresponds to Equation (2). As for an instrument variable, $\Delta IPO_{j,\tau}$ expressed in Equation (3), we use data of other high-income countries as a target. Similarly, the change of the export–output ratio is calculated as follows:

$$\Delta EP_{j,\tau} = \frac{\Delta E_{j,\tau}^{CHN}}{Y_{j,0}}, \tag{19}$$

where $\Delta E_{j,\tau}^{CHN}$ is the change in exports from 0 to τ. This corresponds to Equation (8). As for an instrument variable, $\Delta EPO_{j,\tau}$ expressed in Equation (9), we calculate it using data of other high-income countries as a target.

We further derive separate expressions of the import penetration ratio of intermediate inputs in Equation (5) and final demands in Equation (6). Let x_{ij}^{CHN} denotes the value of imported intermediate inputs from China to the target country. The sum of imports of intermediate inputs from China to industry j in the target country is:

$$\sum_{i=1}^{S} x_{ij}^{CHN} = x_j^{CHN}. \tag{20}$$

In IO tables, final demand sector does not provide the information of user industries. Therefore, we assume that imports from industry j in China satisfy demands in the same industry in the target country. Total imports from China to industry j in the target country are expressed as follows:

$$M_j^{CHN} = x_j^{CHN} + f_j^{CHN}, \tag{21}$$

where M_j^{CHN} is utilised as a numerator of the import penetration ratio as noted below.

Domestic absorption of industry j, which is a denominator of the import penetration ratio, is $Y_j - E_j + M_j$, where Y_j indicates total output of industry j in country c; E_j is total exports to the world; and M_j is total imports from the world in the same industry. Total exports from the target country c to the world, E_j, are expressed as follows:

$$E_j = \sum_{n=1}^{N} \sum_{i=1}^{S} x_{ji}^{c,n} + \sum_{n=1}^{N} f_j^{c,n} \, (n \neq c), \tag{22}$$

where $x_{ji}^{c,n}$ denotes intermediate inputs from industry j in country c to industry i in country n. In a similar manner, M_j is expressed as the sum of imported intermediate inputs and imported final goods from all the N trade partners:

$$M_j = \sum_{n=1}^{N} \sum_{i=1}^{S} x_{ij}^{n,c} + \sum_{n=1}^{N} f_j^{n,c} \, (n \neq c). \tag{23}$$

Using these equations, the import penetration ratio of industry j is calculated as follows:

$$IP_j = \frac{M_j^{CHN}}{Y_j - E_j + M_j}. \tag{24}$$

TABLE A1 Countries and industries in the WIOD

Countries	
Classification	**Countries**
Target of this paper	France, Germany, Japan, South Korea, the United Kingdom, the United States
Other OECD countries	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Mexico, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, Taiwan, Turkey
Non-OECD countries	Bulgaria, Brazil, Cyprus, Croatia, India, Indonesia, Lithuania, Romania, Russia

Industries	
WIOD	**Name**
5	Manufacture of food products, beverages and tobacco products
6	Manufacture of textiles, wearing apparel and leather products
7	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
8	Manufacture of paper and paper products
9	Printing and reproduction of recorded media
10	Manufacture of coke and refined petroleum products
11	Manufacture of chemicals and chemical products
12	Manufacture of basic pharmaceutical products and pharmaceutical preparations
13	Manufacture of rubber and plastic products
14	Manufacture of other non-metallic mineral products
15	Manufacture of basic metals
16	Manufacture of fabricated metal products, except machinery and equipment
17	Manufacture of computer, electronic and optical products
18	Manufacture of electrical equipment
19	Manufacture of machinery and equipment *n*.e.c.
20	Manufacture of motor vehicles, trailers and semi-trailers
21	Manufacture of other transport equipment
22	Manufacture of furniture; other manufacturing
23	Repair and installation of machinery and equipment

When we separate intermediate inputs from final goods, the first term of the right-hand side of Equation (23) is used as a numerator of the import penetration ratio. The second term, on the other hand, is used in the calculation of the import penetration ratio of final goods. The change of the import penetration ratio of intermediate inputs, $\Delta IP^{IM}_{j,\tau}$, is calculated as follows:

$$\Delta IP^{IM}_{j,\tau} = \frac{\Delta x^{CHN}_{j,\tau}}{Y_{j,0} - E_{j,0} + M_{j,0}}, \tag{25}$$

where superscript *IM* denotes intermediate inputs. This corresponds to Equation (5). Similarly, the change of the import penetration ratio of final goods is calculated as follows:

$$\Delta IP^{FN}_{j,\tau} = \frac{\Delta f^{CHN}_{j,\tau}}{Y_{j,0} - E_{j,0} + M_{j,0}}, \tag{26}$$

where superscript *FN* denotes final goods. This corresponds to Equation (6). We derive instrument variables $\Delta IPO^{IM}_{j,\tau}$ and $\Delta IPO^{FN}_{j,\tau}$ in Equation (7) in a similar manner, using data of other high-income countries as a target.

A2 | LIST OF COUNTRIES AND INDUSTRIES IN THE WIOD

A3 | FIRST-STAGE RESULTS

APPENDIX B

TABLE A2 List of IV countries

Country	Variable	IV countries
US	Imports: intermediate inputs	France; Australia, Portugal
	Imports: final goods	France, Germany, Japan, South Korea, UK; Australia, Canada, Taiwan
	Exports	Germany, Japan; Belgium
Japan	Imports: intermediate inputs	UK; Australia, Italy, Portugal, Sweden
	Imports: final goods	South Korea, UK, US; Australia, Canada, Spain
	Exports	US; Belgium, Canada, Taiwan
Germany	Imports: intermediate inputs	Japan; Finland, Ireland, Portugal, Sweden
	Imports: final goods	France, Japan, South Korea, UK, US; Australia, Canada, Taiwan
	Exports	US; Australia, Finland, Italy, Sweden
UK	Imports: intermediate inputs	South Korea; Australia, Canada, Netherlands, Sweden, Taiwan
	Imports: final goods	France, Germany, Japan, South Korea, US; Australia, Canada, Taiwan
	Exports	US; Italy, Portugal
France	Imports: intermediate inputs	US; Portugal, Sweden
	Imports: final goods	Germany, Japan, US; Austria, Italy, Portugal
	Exports	US; Spain, Italy
South Korea	Imports: intermediate inputs	Germany, UK; Australia, Canada, Taiwan
	Imports: final goods	US; Italy, Portugal, Taiwan
	Exports	France, Germany, Japan, UK, US; Australia, Canada, Taiwan

Notes: Countries before a semicolon are chosen from other target countries, while countries after the semicolon are chosen from other OECD countries.

TABLE A3 First-stage results: Preliminary analysis

	United States	Japan	Germany
First-stage coefficient	**Δ*IP***	**Δ*IP***	**Δ*IP***
Δ*IP*	0.596***	0.431***	0.814***
	(0.030)	(0.046)	(0.114)
F-value	201.64	50.94	25.61
Partial R^2	0.907	0.793	0.860
	United Kingdom	**France**	**South Korea**
First-stage coefficient	**Δ*IP***	**Δ*IP***	**Δ*IP***
Δ*IP*	0.758***	1.34783***	1.812***
	(0.087	(0.120)	(0.283)
F-value	38.32	72.44	21.42
Partial R^2	0.883	0.889	0.739

Notes: ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

TABLE A4 First-stage results: Benchmark specification

First-stage coefficient	United States			Japan			Germany		
	ΔIP^{FN}	ΔIP^{IM}	ΔEP	ΔIP^{FN}	ΔIP^{IM}	ΔEP	ΔIP^{FN}	ΔIP^{IM}	ΔEP
ΔIP^{FN}	0.6119019***	−0.0258787***	−0.0165156	0.4250268***	−0.0131978*	−0.019011	0.6738447***	0.0394378**	0.1587849*
	(0.0245296)	(0.0087764)	(0.0131529)	(0.0264863)	(0.0071472)	(0.0133424)	(0.0599141)	(0.0154897)	(0.0926939)
ΔIP^{IM}	−0.2266813	0.6502932***	0.5215827	0.4551562	0.8384118***	0.4503164	1.039299**	0.4725534***	−0.3676927
	(0.2098928)	(0.1401926)	(0.3833313)	(0.5241325)	(0.0969397)	(0.4340429)	(0.4056156)	(0.0468961)	(0.3123487)
ΔEP	0.1641568*	0.0708594*	0.2770709***	−0.0668801	0.0344516*	0.46843***	−0.3831901*	0.0665619***	1.767926***
	(0.0905052)	(0.0350536)	(0.0465431)	(0.1308369)	(0.0185437)	(0.0517583)	(0.2049674)	(0.023772)	(0.2322381)
F-value	156.08	15.72	28.57	213.51	34.39	33.92	34.29	127.30	44.16
Shea's adjusted partial R^2	0.7363	0.2153	0.1396	0.7528	0.5864	0.6143	0.5401	0.5435	0.5593

First-stage coefficient	United Kingdom			France			South Korea		
	ΔIP^{FN}	ΔIP^{IM}	ΔEP	ΔIP^{FN}	ΔIP^{IM}	ΔEP	ΔIP^{FN}	ΔIP^{IM}	ΔEP
ΔIP^{FN}	0.8345364***	0.0011864	−0.051063	1.314953***	0.0104343	−0.0317513	1.813841***	−0.1157539	0.0838196
	(0.0569608)	(0.0098073)	(0.047148)	(0.1667892)	(0.04709)	(0.0318972)	(0.1940288)	(0.0927191)	(0.2257898)
ΔIP^{IM}	−0.1748485	0.3110328***	−0.0017534	−0.1180049	1.483325***	0.6186169**	0.0799699	3.493905***	3.830273***
	(0.1140483)	(0.017886)	(0.1622512)	(0.4821025)	(0.3025585)	(0.2649987)	(0.3011399)	(0.3307331)	(1.008857)
ΔEP	0.070955	0.098651***	1.930921***	0.1671689	0.0338932	1.673026***	−0.3500023**	−0.4700323***	1.700226***
	(0.1183698)	(0.0173853)	(0.2777101)	(0.1965682)	(0.0847925)	(0.3373325)	(0.1491001)	(0.0770473)	(0.2527088)
F-value	56.37	98.18	16.50	22.38	12.70	10.25	44.70	29.31	51.17
Shea's adjusted partial R^2	0.9130	0.7126	0.7343	0.7993	0.6970	0.7754	0.8662	0.5965	0.6114

Notes: ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

TABLE A5 First-stage results: Alternative specification 1

	United States		Japan		Germany	
First-stage coefficient	**ΔIP^{FN}**	**ΔIP^{IM}**	**ΔIP^{FN}**	**ΔIP^{IM}**	**ΔIP^{FN}**	**ΔIP^{IM}**
ΔIP	0.5834735***	−0.008068	0.4244015***	−0.0123189	0.8207572***	0.0879294
	(0.0193502)	(0.0098059)	(0.0288674)	(0.0164659)	(0.1224792)	(0.057903)
ΔEP	0.2057244**	0.3741201***	0.0396797	0.5068113***	−0.0656978	1.602494***
	(0.0793334)	(0.0638035)	(0.13305)	(0.0480111)	(0.1725651)	(0.2021277)
F-value	305.01	15.86	206.59	40.23	18.41	52.51
Shea's adjusted partial R^2	0.8746	0.4428	0.7156	0.7076	0.7913	0.5577
	United Kingdom		**France**		**South Korea**	
First-stage coefficient	**ΔIP^{FN}**	**ΔIP^{IM}**	**ΔIP^{FN}**	**ΔIP^{IM}**	**ΔIP^{FN}**	**ΔIP^{IM}**
ΔIP	0.7566889***	−0.045492	1.327572***	0.003825	1.959013***	0.6049585
	(0.0917049)	(0.0424589)	(0.1242704)	(0.0256222)	(0.2228558)	(0.3978939)
ΔEP	0.172922	1.930687***	0.2089495	1.801484***	−0.3507424*	2.637529***
	(0.2159975)	(0.2740746)	(0.163222)	(0.3416473)	(0.1927299)	(0.3548775)
F-value	33.62	17.32	62.16	14.85	37.52	18.49
Shea's adjusted partial R^2	0.8742	0.7539	0.8491	0.7903	0.7588	0.7540

Notes: ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

TABLE A6 First-stage results: Alternative specification 2

First-stage coefficient	United States ΔIP^{FN}	United States ΔIP^{IM}	Japan ΔIP^{FN}	Japan ΔIP^{IM}	Germany ΔIP^{FN}	Germany ΔIP^{IM}
ΔIP^{FN}	0.6165847***	−0.0238573***	0.4190285***	−0.0101079	0.6999169***	0.0349089**
	(0.0312637)	(0.0065231)	(0.0432195)	(0.00657)	(0.0666349)	(0.0162656)
ΔIP^{IM}	−0.0294322	0.7354371***	0.2510543	0.9435498***	0.669994*	0.5367034***
	(0.1866742)	(0.1079305)	(0.5396745)	(0.1100198)	(0.3892101)	(0.0494048)
F-value	131.17	18.22	35.08	26.85	41.72	101.61
Shea's adjusted partial R^2	0.9008	0.7523	0.7708	0.6814	0.5053	0.4896

First-stage coefficient	United Kingdom ΔIP^{FN}	United Kingdom ΔIP^{IM}	France ΔIP^{FN}	France ΔIP^{IM}	South Korea ΔIP^{FN}	South Korea ΔIP^{IM}
ΔIP^{FN}	0.8351301***	0.0020119	1.315774***	0.0106006	1.811568***	−0.1188059
	(0.054727)	(0.010336)	(0.1669592)	(0.0454149)	(0.2047853)	(0.1516586)
ΔIP^{IM}	−0.1744799	0.3115452***	0.0911627	1.525733***	−0.5144073	2.695692***
	(0.1186418)	(0.0197456)	(0.4170342)	(0.2629553)	(0.3220127)	(0.3509463)
F-value	81.41	99.98	27.36	17.11	33.16	19.84
Shea's adjusted partial R^2	0.9192	0.6889	0.8045	0.7363	0.8184	0.7353

Notes: ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

TABLE B1 Estimation results: Benchmark specification with all industries

	United States		Japan		Germany	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Import penetration						
Final goods	−2.603***	−3.066***	−2.182*	−2.999**	−1.188*	−2.170***
(ΔIP^{FN})	(0.803)	(0.926)	(1.276)	(1.348)	(0.666)	(0.819)
Intermediate inputs	8.910**	5.859	−3.823	5.545	3.149	9.774
(ΔIP^{IM})	(4.256)	(18.654)	(7.716)	(13.089)	(3.809)	(6.339)
Export–output ratio	−1.415	−1.116	1.985	1.477	0.574	0.073
(ΔEP)	(1.202)	(4.552)	(1.995)	(4.178)	(0.554)	(0.885)
N	110	110	102	102	110	110
Sector*Period Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP^{FN}		0.8521		0.5486		0.5870
ΔIP^{IM}		0.2826		0.5169		0.5112
ΔEP		0.1098		0.3940		0.6034
	United Kingdom		**France**		**South Korea**	
	OLS	**2SLS**	**OLS**	**2SLS**	**OLS**	**2SLS**
Import penetration						
Final goods	−2.724***	−2.664***	−2.023*	−4.181***	−1.507*	−1.315
(ΔIP^{FN})	(0.522)	(0.589)	(1.056)	(1.356)	(0.884)	(1.308)
Intermediate inputs	1.176	6.362	3.922	7.390	1.714	2.028
(ΔIP^{IM})	(5.243)	(5.840)	(3.645)	(7.629)	(1.247)	(1.760)
Export–output ratio	0.108	−2.646	0.469	1.547	−0.129	−0.228
(ΔEP)	(0.621)	(2.785)	(0.978)	(2.322)	(0.518)	(0.742)
N	110	110	110	110	106	106
Sector*Period Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
First-stage partial R^2						
ΔIP^{FN}		0.8779		0.5415		0.6534
ΔIP^{IM}		0.4131		0.3794		0.6233
ΔEP		0.0764		0.2508		0.5976

Notes: ***, ** and * indicate the significance levels at 1%, 5% and 10%, respectively. Figures in parentheses indicate heteroscedasticity robust standard errors. Observations are weighted by the 2000 employment level in the data set.

Sources: World IO Tables released in November 2016 and Social Economic Accounts data released in February 2018.

TABLE B2 List of IV countries (all industries)

Country	Variable	IV countries
US	Imports: intermediate inputs	France, Germany, Japan, South Korea, UK; Australia, Canada, Taiwan
	Imports: final goods	France, Germany, Japan, South Korea, UK; Australia, Canada, Taiwan
	Exports	France, South Korea, UK; Australia, Italy
Japan	Imports: intermediate inputs	UK; Italy, Portugal
	Imports: final goods	France, Germany, South Korea, UK, US; Australia, Canada, Taiwan
	Exports	Germany, South Korea; Italy, Taiwan
Germany	Imports: intermediate inputs	Finland, Italy, Mexico, Portugal
	Imports: final goods	France, Japan, South Korea, UK, US; Australia, Canada, Taiwan
	Exports	Japan, South Korea, UK
UK	Imports: intermediate inputs	South Korea; Italy, Taiwan
	Imports: final goods	France, Germany, Japan, South Korea, US; Australia, Canada, Taiwan
	Exports	South Korea, US; Italy, Australia
France	Imports: intermediate inputs	Germany, Japan, South Korea, UK, US; Australia, Canada, Taiwan
	Imports: final goods	Germany, Japan, South Korea, UK, US; Australia, Canada, Taiwan
	Exports	Germany, Japan, South Korea, UK, US; Australia, Canada, Taiwan
South Korea	Imports: intermediate inputs	US; Italy, Netherlands, Portugal, Taiwan
	Imports: final goods	France, Germany, Japan, UK, US; Australia, Canada, Taiwan
	Exports	France, Germany, Japan, UK, US; Australia, Canada, Taiwan

Notes: Countries before a semicolon are chosen from other target countries, while countries after the semicolon are chosen from other OECD countries.