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Trading with China: Productivity Gains, Job Losses

By JaeBin Ahn and Romain Duval

**I N T E R N A T I O N A L M O N E T A R Y F U N D**

**IMF Working Paper**

Research Department

**Trading with China: Productivity Gains, Job Losses<sup>1</sup>**

**Prepared by JaeBin Ahn and Romain Duval**

Authorized for distribution by Luis Cubeddu and Romain Duval

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**Abstract**

We analyze the impact on productivity in advanced economies of fast-growing trade with China between the mid-1990s and late-2000s, separately identifying the export and import channels. We use country-sector-level data for 18 advanced economies and, similar to Autor, Dorn, and Hanson (2013), exploit exogenous variation in trade with China in a given country-sector by instrumenting imports from (exports to) China in a given country-sector with the average imports from (exports to) China in the same sector in other advanced economies. Our estimates point to large productivity gains from trading with China—the (exogenous) rise of China in global trade may have increased the level of total factor productivity by about 1.9 percent, or 12.3 percent of the overall increase over the sample period, in the median country-sector. By contrast, using a similar empirical strategy, we find adverse employment effects of Chinese imports in exposed country-industries, consistent with previous studies. Taken together, these findings point to large gains from free trade, while underscoring the scope for a more active policy role in redistributing them, particularly by easing workers’ transition between jobs and industries.

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## I. INTRODUCTION

Protectionist sentiment is on the rise amid prolonged economic stagnation in advanced economies, and represents a major shift in political focus away from the benefits toward the costs of globalization. In particular, rising trade with China has been increasingly blamed for job losses in exposed industries, and influential work by Autor, Dorn, and Hanson (2013) has indeed confirmed adverse effects of Chinese import penetration on local labor markets in the U.S. At the same time, any such effects should be weighed against the gains from trading with China. A major source of gains, which this paper seeks to quantify, is the effect of rising trade with China on productivity in advanced economies.<sup>2</sup>

There are good reasons to believe that trade can improve the productivity of an economy. For one thing, imports can promote productivity by increasing competitive pressure on domestic firms through the entry of foreign producers in domestic markets (e.g., Helpman and Krugman, 1985). In addition, imported inputs can improve firm-level productivity by expanding the variety and enhancing the quality of the intermediate goods to which firms have access (e.g., Grossman and Helpman, 1991).<sup>3</sup> Such “pro-competition” and “imported input” channels constitute the “import” channel. At the same time, exporting can increase firm-level productivity via learning from foreign markets both directly, through buyer-seller relationships, and indirectly, through increased competition from foreign producers or externalities. Together these form the “export” channel (e.g., Balassa, 1978). Alongside the realization of those firm-level productivity gains, reallocation of resources toward more productive firms yields a further increase in productivity at the aggregate level (e.g., Melitz, 2003; Pavcnik, 2002).

The modern empirical literature on trade and growth traces back to, among others, Sachs and Warner (1995) and Frankel and Romer (1999), who explored cross-country variation without distinguishing export and import channels.<sup>4</sup> More recently, firm-level studies in emerging market economies successfully identified productivity gains from exporting (e.g., Bustos, 2011; Lileeva and Trefler, 2010; Verhoogen, 2008; De Loecker, 2013) and importing (e.g., Amiti and Konings, 2007; Kasahara and Rodrigue, 2008; Gopinath and Neiman, 2014; Fernandes, 2007; Halpern, Koren, and Szeidl, 2015; Topalova and Khandelwal, 2011) separately. However, it is difficult to derive from these firm-level estimates aggregate productivity effects, especially insofar as the latter stem in part from reallocation of resources *across* firms. This paper attempts to fill this gap in the empirical literature by transposing the econometric methodology used in micro-level studies to a sector-level framework, so as to estimate sector-level—rather than firm-level—productivity gains from import and export channels separately. Another objective of this paper is to use these estimates to quantify the productivity gains from rising trade with China

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<sup>2</sup> For the other main channel operating through the demand side (i.e., the cost of living), see e.g., Fajgelbaum and Khandelwal (2016).

<sup>3</sup> Apart from its effects on productivity, an increase in opportunities to import intermediate inputs could benefit firms directly by reducing their material costs (e.g., Antràs, Fort, and Tintelnot, forthcoming).

<sup>4</sup> For a recent study that looks at the growth impact of the recent global trade slowdown, see Constantinescu, Mattoo, and Ruta (2016).

between the mid-1990s and late 2000s, and to assess their contribution to overall productivity growth in advanced economies over this period.

## II. DATA AND EMPIRICAL STRATEGY

In order to identify the respective effects of exports to and imports from China on productivity at the country-sector level, we combine the country-sector-year-level TFP data from the EU KLEMS and World KLEMS databases with the corresponding trade data from the World Input Output Database (WIOD). The resulting dataset provides annual information on sectoral input, output, employment, TFP as well as exports (by destination country) and imports (by source country) over the period 1995–2011, covering 18 manufacturing and non-manufacturing sectors across 18 advanced countries.<sup>5,6</sup>

At the sector level, both exports to, and imports from China grew steadily between the mid-1990s and mid-2000s, before falling during the global financial crisis and recovering only slowly since then, particularly on the import side (Figure 1). At the same time, there has been wide dispersion in these trends across countries and industries, providing a source of variation that can be used to identify the impact of each trade channel on productivity.

We consider the following baseline empirical specification<sup>7</sup>:

$$\ln TFP_{ist} = \beta_1 IMP_{is,t-1}^{CHN} + \beta_2 EXP_{is,t-1}^{CHN} + FE_{is} + FE_{it} + \varepsilon_{ist}, \quad (1)$$

where subscripts  $i$ ,  $s$ ,  $t$  denote country, sector, and year, respectively. The dependent variable  $\ln TFP_{ist}$  denotes log total factor productivity (TFP) in country  $i$  and sector  $s$  in year  $t$ , while  $IMP_{is,t-1}^{CHN}$  and  $EXP_{is,t-1}^{CHN}$  are the corresponding country-sector-level imports from and exports to China (both as a ratio to total domestic output) lagged 1 year. The specification also includes country-sector ( $FE_{is}$ ) and country-year ( $FE_{it}$ ) fixed effects. The country-year fixed effects control for any variation that is common to all sectors of a country's economy, including for instance exchange rate shocks, aggregate output growth or economy-wide reforms in other areas. The country-industry fixed effects control for country-industry-specific factors including, for example, cross-country differences in the growth of certain sectors that could arise from differences in comparative advantage. This specification with fixed effects is tantamount to

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<sup>5</sup> The list of 18 countries in the sample is: Australia, Austria, Canada, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Slovenia, Spain, Sweden, United Kingdom, United States of America.

<sup>6</sup> For more details on TFP data employed in this study, see Ahn et al. (2016) and Dabla-Norris et al. (2015).

<sup>7</sup> A set of panel unit root tests, not reported here but available upon request, rejects the hypothesis that these variables contain a unit root.

asking how changes in trade with China in a given sector in a given country are associated with changes in productivity levels in that country-sector.

Identifying the causal effect of trade on growth is challenging due to potentially severe reverse causality and measurement issues. Several studies have addressed these issues through the use of instrumental variables for overall trade (Frankel and Romer 1999; Nogueur and Siscart 2005). Since the analysis in this paper attempts to identify the causal effect of the two distinct channels through which trade may shape productivity, it requires a separate instrumental variable for each of them.

Our strategy is to follow Autor, Dorn, and Hanson (2013), and run 2SLS regressions by instrumenting imports from China in a given country-sector with the average imports of other sample countries from China in that same sector. Likewise, we propose average exports to China by other sample countries as an instrumental variable for exports to China in any given country-sector. These instruments exploit the exogenous time-series variation in other countries' imports from China (driven by China-specific supply-side factors) and exports to China (driven by China-specific demand-side factors).

As discussed in detail in Autor et al. (2013), recent growth in imports from and exports to China has stemmed mostly from exogenous supply shocks—e.g., across-the-board productivity surge—and demand shocks—e.g. improved market access following China's entry into WTO—originating from China, rather than from common demand and/or technology shocks in our sample countries. Nevertheless, they, and we acknowledge that resulting IV estimates might still be contaminated by any remaining correlated demand and supply shocks across sample countries, and thus caution is warranted in interpreting the magnitude of the estimated coefficients.<sup>8</sup>

### III. ESTIMATION RESULTS

#### A. Regression results

Table 1 presents the baseline regression results from both simple OLS (columns (1)-(3)) and 2SLS (columns (4)-(6)), which confirm the positive and sizable impact of imports from China and exports to China on TFP. In particular, 2SLS coefficient estimates in column (6) suggest that a 1 percentage point increase in China's import penetration in a given sector leads to a 0.9 percent increase in the TFP level of that sector, while a 1 percentage point increase in the ratio of exports to domestic output—an illustrative change that, however, considerably exceeds the total increase seen in the median country-industry over the sample period—is associated with about a 11 percent increase in productivity in a given sector.

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<sup>8</sup> In particular, if it was correlated productivity shocks across sample countries that drove growth in their imports from (exports to) China, our estimated effect for imports (exports) would likely provide a lower-(upper-)bound for the true effect.

We also note that compared with OLS estimates, the magnitude of the estimated effects is typically stronger when using instrumental variables. This suggests that measurement bias—which leads OLS to underestimate the impact of trade on productivity—is in practice a more serious concern than simultaneity bias—which is likely instead to inflate OLS estimates particularly for the exports channel—as already flagged by Frankel and Romer (1999).

As noted earlier, to the extent that common technology shocks across sample countries might have driven part of the growth in exports to China, our 2SLS estimates might reflect such forces, leading to an overestimation of the true export channel. As a robustness exercise, we restrict the sample to the period following China's accession to WTO in 2001, over which demand shocks from improved access to China's market are likely to have been a primary driver of the growth in China's imports. The estimated impact of the export channel is indeed smaller over this period than over the full sample, suggesting some upward bias in the baseline estimate of the productivity effect of exporting (columns (1)-(3) in Table 2).

Moreover, to the extent that import demand is likely to be positively correlated across EU member country-sectors, not least because of the common customs tariffs and quotas, comparing previous results with those obtained when excluding EU member countries can help gauge potential biases in the estimated coefficient of the import channel. However, the estimated coefficient of the import channel does not change significantly when restricting the sample to non-EU member countries, suggesting that any bias from common demand shocks is unlikely to be a serious concern (columns (4)-(6) in Table 2).

Finally, we explore whether the positive TFP effects from trading with China are also concomitant with net employment gains or losses in those same industries in advanced economies. Previous studies, such as Autor, Dorn, and Hanson (2013), have found an adverse employment impact of the import channel. By contrast, the export channel should stimulate employment *a priori*. Simply replacing TFP with total employment as the dependent variable in equation (1), we find significant adverse impacts of rising import penetration from China but positive effects from growing exports to China (Table 3). The size of coefficient estimates from 2SLS is such that a 1 percentage point increase in China's import penetration in a given sector leads to about a 2 percent decline in the level of total employment in that sector, while a 1 percentage point increase in the ratio of exports to China to domestic output is associated with about a 5 percent increase in employment.

Overall, these findings point to sizeable TFP gains from both exports to and imports from China, but conflicting net employment effects that vary across industries depending on their exposure to growing exports to, versus increased competition from, China.

## **B. Back-of-the-envelope calculation**

In the sample, the median country-sector experienced TFP growth of 15.6 percent over the period between 1995 and 2007. During this period, the median increase in the ratio of imports from China to total domestic output was 1.03 percentage points, whereas that in the ratio of exports to China to total domestic output was 0.38 percentage points. Following the methodology employed in Autor, Dorn, and Hanson (2013), which exploits the difference

between OLS and 2SLS coefficients, we calculate that the exogenous portion of the increase in the ratio of imports from China to domestic output was 67 percent, while that of the ratio of exports to China was 33 percent.<sup>9</sup> Taking as benchmark semi-elasticities for imports and exports the coefficient estimates found in column (6) of Table 1, namely 0.9 and 10.3, respectively, we conclude that exogenous variation in trade with China may have accounted for up to 12.3 percent of the total increase in TFP growth (or a total increase of 1.9 percent in the TFP level) in the median country-sector over the period 1995-2007.<sup>10</sup>

Applying the same methodology using the estimates in Table 3 suggests a more benign effect of rising trade with China on total employment. The estimated net impact of growing imports from and export to China over 1995-2007 is about -0.8 percent in the median country-sector, which is about 2 ( $=0.8/37.5$ ) percent of the total increase in employment, which was about 37.5 percent over that period. This small net job effect on the median country-sector implies, of course, neither that the gross job effect and associated job reallocation were also small, nor that net job losses were small in all country-industries--net job effects vary depending on each country-industry's exposure to growing imports from, relative to growing exports to, China.

#### IV. CONCLUDING REMARKS

This paper identifies sizeable productivity gains from growing trade with China in advanced economies. Taken together with adverse labor market impacts from imports, the findings point to a critical role for policy in redistributing the gains from trade, in particular by easing the costs for workers of transitioning across jobs and industries. At the same time, the analysis implies that stagnating trade intensity on account of China's maturing integration into world trade will be a persistent drag on productivity growth in advanced economies going forward. Outright trade restrictions would mean an outright reversal of some of the large gains reaped over the past two decades.

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<sup>9</sup> For details, please refer to Appendix B.A in Autor, Dorn, and Hanson (2013).

<sup>10</sup>  $(1.03*0.67)*1.1+(0.38*0.33)*7.7=1.9$

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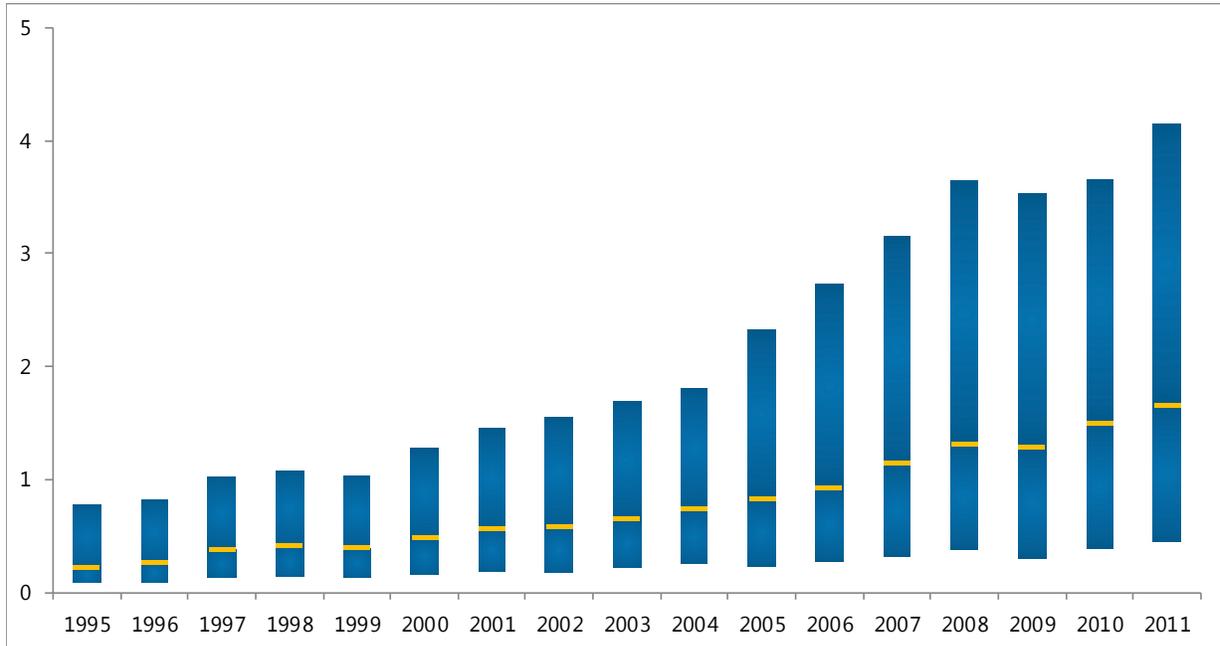
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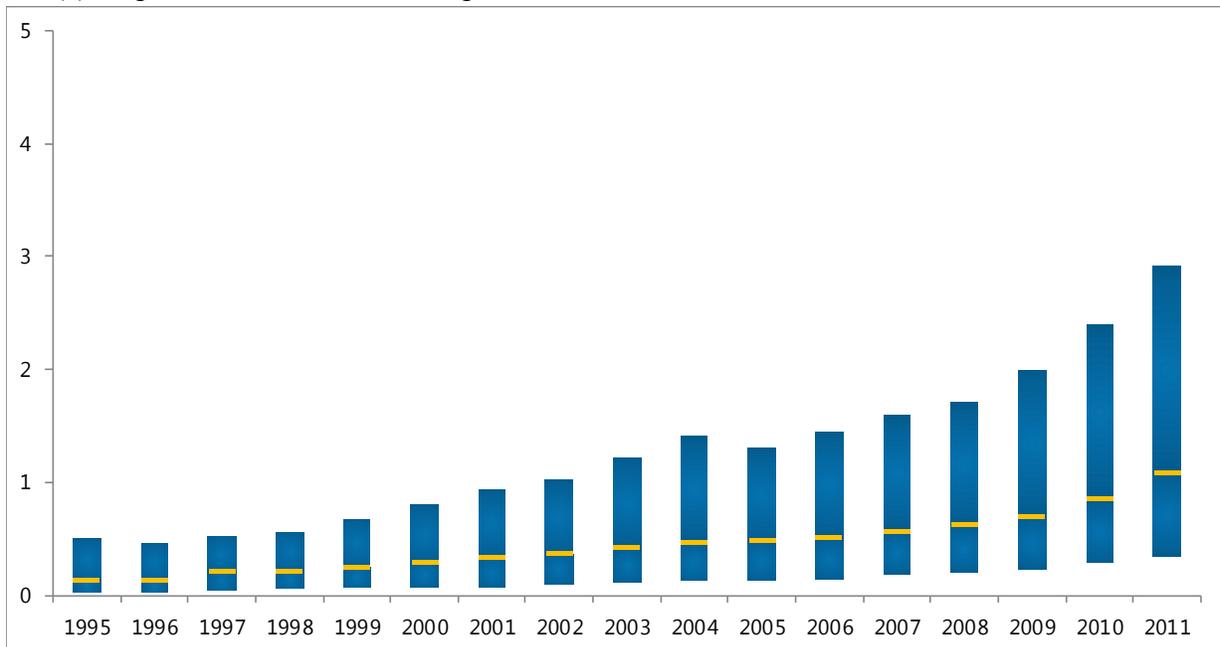
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**Figure 1. The Evolution of Trade with China Across Industries in Advanced Countries**

(a) Imports from China to total output ratio



(a) Exports to China to total output ratio



Note: The horizontal line inside each box represents the median value across all country-industry observations; the upper and lower edges of each box show the top and bottom quartiles. They are all expressed in percent.

Source: World Input Output Database (WIOD); Authors' calculation.

**Table 1. Baseline Estimates of Trade on Total Factor Productivity**

| Dependent variable: $[\ln(TFP)]_{ist}$  | OLS                 |                      |                      | 2SLS                 |                      |                      |
|---|---------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|   | (1)                 | (2)                  | (3)                  | (4)                  | (5)                  | (6)                  |
| (Imports from China/Total output)*100 <sub>ist-1</sub>                                | 0.006 **<br>(0.003) |                      | 0.004 *<br>(0.003)   | 0.016 ***<br>(0.006) |                      | 0.009 ***<br>(0.003) |
| (Exports to China/Total outputs)*100 <sub>ist-1</sub>                                 |                     | 0.050 ***<br>(0.012) | 0.048 ***<br>(0.012) |                      | 0.118 ***<br>(0.041) | 0.103 ***<br>(0.038) |
| Obs   | 3,133               | 3,133                | 3,133                | 3,133                | 3,133                | 3,133                |
| 2SLS first stage estimates  |                     |                      |                      |                      |                      |                      |
| average (Imports from China/Total outputs)*100 <sub>ist-1</sub><br>in other countries |                     |                      |                      | 1.017 ***<br>(0.130) | 1.037***<br>(0.141)  | 0.023<br>(0.025)     |
| average (Exports to China/Total outputs)*100 <sub>ist-1</sub><br>in other countries   |                     |                      |                      |                      | 0.938 ***<br>(0.162) | -0.350<br>(0.654)    |
| First stage F-stats   |                     |                      |                      | 61.4                 | 33.5                 | 32.2                 |
| First stage p-value   |                     |                      |                      | 0.00                 | 0.00                 | 0.00                 |

Note: The dependent variable is log total factor productivity (TFP) in country  $i$  and sector  $s$  in year  $t$ . Independent variables are corresponding country-sector-level imports from China (as a ratio to total domestic output) and total exports to China (as a ratio to total domestic output), both lagged one year. The average value of imports from China relative to domestic output in all other countries and the average value of exports to China relative to domestic output in all other countries, both lagged one year, are used as IVs for corresponding variables in columns (4)-(6). Country-sector as well as country-year fixed effects are included in all columns. Robust standard errors clustered at country-sector level are provided in parentheses. Corresponding first stage estimates are reported in the lower panel.

\*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

**Table 2. Robustness Checks: 2SLS Estimates of Trade on Total Factor Productivity**

| Dependent variable: $[\ln(TFP)]_{ist}$  | <i>post-China's WTO accession</i> |                      |                      | <i>post-China's WTO accession; non-EU countries</i> |                      |                     |
|---|-----------------------------------|----------------------|----------------------|---|----------------------|---------------------|
|   | (1)                               | (2)                  | (3)                  | (4)   | (5)                  | (6)                 |
| (Imports from China/Total output)*100 <sub>ist-1</sub>                                | 0.014 ***<br>(0.004)              |                      | 0.011 ***<br>(0.003) | 0.013 **<br>(0.006)                                 |                      | 0.010 **<br>(0.004) |
| (Exports to China/Total outputs)*100 <sub>ist-1</sub>                                 |                                   | 0.078 **<br>(0.036)  | 0.077 **<br>(0.035)  |   | 0.074 *<br>(0.040)   | 0.064 *<br>(0.038)  |
| Obs   | 1,809                             | 1,809                | 1,809                | 623   | 623                  | 623                 |
| 2SLS first stage estimates  |                                   |                      |                      |   |                      |                     |
| average (Imports from China/Total outputs)*100 <sub>ist-1</sub><br>in other countries | 1.038 ***<br>(0.138)              |                      | 1.047***<br>(0.139)  | 0.022<br>(0.027)                                    | 1.555 ***<br>(0.347) | 1.554***<br>(0.356) |
| average (Exports to China/Total outputs)*100 <sub>ist-1</sub><br>in other countries   |                                   | 0.876 ***<br>(0.166) | -0.640<br>(0.718)    | 0.860***<br>(0.156)                                 | 1.431 ***<br>(0.423) | 0.066<br>(1.670)    |
| First stage F-stats   | 56.4                              | 27.8                 | 30.5                 | 16.0  | 20.1                 | 11.5                |
| First stage p-value   | 0.0                               | 0.0                  | 0.0                  | 0.0   | 0.00                 | 0.00                |

Note: The dependent variable is log total factor productivity (TFP) in country  $i$  and sector  $s$  in year  $t$ . Independent variables are corresponding country-sector-level imports from China (as a ratio to total domestic output) and total exports to China (as a ratio to total domestic output), both lagged one year. The average value of imports from China relative to domestic output in all other countries and the average value of exports to China relative to domestic output in all other countries, both lagged one year, are used as IVs for corresponding variables. Columns (1)-(3) excludes sample period prior to China's WTO accession (2001 and earlier). Column (4)-(6) further excludes EU member countries. Country-sector as well as country-year fixed effects are included in all columns. Robust standard errors clustered at country-sector level are provided in parentheses. Corresponding first stage estimates are reported in the lower panel.

\*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .

**Table 3. 2SLS Estimates of Trade on Employment**

| Dependent variable: $[\ln(\text{EMP})_{ist}]$          | <i>baseline sample</i> |                  |                       | <i>post-China's WTO accession</i> |                     |                       |
|--|------------------------|------------------|-----------------------|-----------------------------------|---------------------|-----------------------|
|  | (1)                    | (2)              | (3)                   | (4)                               | (5)                 | (6)                   |
| (Imports from China/Total output)*100 <sub>ist-1</sub> | -0.019 ***<br>(0.003)  |                  | -0.023 ***<br>(0.003) | -0.014 ***<br>(0.002)             |                     | -0.016 ***<br>(0.002) |
| (Exports to China/Total outputs)*100 <sub>ist-1</sub>  |                        | 0.015<br>(0.013) | 0.055 ***<br>(0.019)  |                                   | 0.046 **<br>(0.019) | 0.048 **<br>(0.019)   |
| Obs  | 3,133                  | 3,133            | 3,133                 | 1,809                             | 1,809               | 1,809                 |

Note: The dependent variable is log total employment in country  $i$  and sector  $s$  in year  $t$ . Independent variables are corresponding country-sector-level imports from China (as a ratio to total domestic output) and total exports to China (as a ratio to total domestic output), both lagged one year. The average value of imports from China relative to domestic output in all other countries and the average value of exports to China relative to domestic output in all other countries, both lagged one year, are used as IVs for corresponding variables. Columns (1)-(3) are based on the baseline sample included in Table 1. Column (4)-(6) excludes sample period prior to China's WTO accession (2001 and earlier). Country-sector as well as country-year fixed effects are included in all columns. Robust standard errors clustered at country-sector level are provided in parentheses. Corresponding first stage estimates are reported in Table 1 and Table 2.

\*  $p < 0.10$ ; \*\*  $p < 0.05$ ; \*\*\*  $p < 0.01$ .