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China's Impact on Regional Employment: Propagation through Supply Chains and Co-agglomeration Pattern [1]

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Abstract

How does import from China affect local labor markets in Japan? We examine this question using commuting zones as regional units, incorporating shock propagation through supply chains, as well as co-agglomeration patterns. Applying the method proposed by Autor, Dorn and Hanson (2013) and Acemoglu, et al. (2016), we investigate the impact on regional manufacturing employment. Employing the input-output table allows us to analyse how the shocks propagate to upstream/downstream industries and how regional impact is related to co-agglomeration patterns. We find that the negative direct effect on local employment is underestimated in previous studies that do not consider regional propagation of the shock through supply chains, especially the positive shock to downstream industries. Downstream industries significantly benefit from imports from China due to low input prices, which increases local employment. We find no significant impact on upstream industries. Our results imply that the direct effect on local labor markets is weakened by effects on downstream industries within the same region.

Keywords: International Trade, Local Labour Markets, Co-Agglomeration, Import Competition, Input-Output Linkage

JEL classification: E24, F14, F16, R23

[1]This study is conducted as a part of the Project "Dynamics of Inter-organizational Network and Firm Lifecycle" undertaken at the Research Institute of Economy, Trade and Industry (RIETI). This study utilizes the micro data of the questionnaire information based on the "Census of Manufacture" which is conducted by the Ministry of Economy, Trade and Industry (METI) and the "Economic Census for Business Frame," the "Economic Census for Business Activity" and the "Establishment and Enterprise Census of Japan" which are conducted by the Ministry of Internal Affairs and Communications (MIC). The author is grateful for helpful comments and suggestions by Discussion Paper seminar participants at RIETI.

1 Introduction

Developed countries have seen a surge in imports, primarily manufacturing, from China since the 1990s. This so-called *China Shock* has largely transformed the realm of international trade and drastically altered socioeconomic circumstances in the importing countries. As other affected economies, Japan has observed its shrink in domestic manufacturing employment compared to other sectors, along with its growing dependency on the Chinese economy for goods production (Taniguchi, 2019). These simultaneous trends have created concern that Chinese import penetration to Japan contributed to the labor displacement in the manufacturing sector. Did these increased imports really cause the manufacturing employment contraction?

In this paper, we seek to uncover the effects of increased Chinese import penetration on local labor markets, more precisely, regional manufacturing employment, in Japan between the late 1990s and early 2010s. Methodologically, our empirical investigation builds on the framework developed by Autor, Dorn, and Hanson (2013) and Acemoglu, Autor, et al. (2016). To quantify the effects, our analysis considers two perspectives: shock propagation through supply chains and co-agglomeration of the industries with input-output linkage. We employ the Japanese input-output table to take sectoral linkages into account. Specifically, we consider two channels of the shock propagation: *downstream* and *upstream* effects. The downstream effect is defined as the effect of imports on the customer industries, while the upstream effect is on the supplier industries, as in Fabinger et al. (2017). Adding their measures to our specification allows us to see if any differential effects through supply chains and how a net effect depends on their mixture. Besides, we further decompose the industries based on their co-location pattern with their suppliers to infer if co-agglomeration pattern matters or not.

Why should we consider supply chains and co-agglomeration in the first place? In contrast to the US whose imports from China are largely final goods, the intermediate goods account for a relatively large share of Japan's imports from China (Taniguchi, 2019). Because of this, the import penetration may result in both negative and positive impacts on the Japanese manufacturing sector: on the one hand, the intensified, direct, import competition with the imported goods can deteriorate the corresponding industries as observed in other countries such as the US (Autor, Dorn, and Hanson, 2013); on the other hand, the increased imports in intermediate goods can benefit the industries that use imported goods as their inputs through better access to the inputs (Acemoglu, Autor, et al., 2016; Pierce and Schott, 2016). Since the mixture of these opposing forces determines the net effects, this is an empirical matter.

In this context, the local labor market point of view should be incorporated into the evaluation of Chinese import penetration. Since regional economies are composed of multiple industries agglomerated in a region and the industries with input-output linkage are known to *co*-agglomerate (Ellison, Glaeser, and Kerr, 2010; Fujii et al., 2017), a negative shock to one industry may be mitigated at a regional-level through a positive impact on another. Hence, omitting the co-agglomeration pattern and supply chain perspectives may mislead our understanding of how the import penetration influenced Japanese economy.

Employing the above specification, we estimate the impact on manufacturing employment at the commuting-zone level. Our dependent variable is a change in manufacturing employment, which comes from the Japanese Census of Manufacture. Time period-wise, this study covers the years between the late 1990s to early 2010s. We mainly focus on long difference between them and additionally divide it into three shorter-term periods to examine if any time variation in the import penetration effects. On top of them, we employ commuting zone (CZ, hereafter) in Japan as a regional unit, proposed by Adachi et al. (2020)[1]. The CZ is constructed by clustering municipalities based on inter-municipality commuting patterns. Compared to a prefecture, the CZ is geographically smaller but justifiable as a local labor market. Hence, compared to previous studies of Japan, this paper covers longer time periods and employs a smaller and appropriate regional unit.

This empirical setting provides us with the two main results. First, as opposed to Taniguchi (2019) that uses the similar specifications with prefecture-level data, we find the net *negative* effects of the increase in imports from China on Japanese local labor market, in the long run as well as in some of the short-run periods. Running long difference regressions between 1997 and 2014, the coefficient estimate on the simple import penetration is negative with statistical significance at the conventional-levels. Within this relatively long-run period, we also find that heterogeneity of the net effects of the import penetration across shorter-run periods. Specifically, our period-wise regression analysis provides negative significant results for two shorter time periods, one from 1997 to 2002 and another from 2009 to 2014, but not during 2002-2007. This might be due to the time-variant trade structure between Japan and China. These results, nonetheless, exhibit that, as a whole, Chinese import penetration reduced local employment in Japan in the long run.

Second, however, we do observe that the increase in the imports from China benefited in manufacturing industries in Japan through supply chains. Once accounting for downstream as well as upstream import penetration channels, we obtain a significant negative estimate on the direct penetration and a positive estimate on the downstream penetration, while the coefficient of the upstream measure is statistically indistinguishable from zero at conventional levels, in the long difference. Similar patterns are observed in the shorter-term periods, indicating that only the relative quantitative sizes of these effects are heterogeneous across time periods but not qualitatively. This is consistent with previous research finding a positive influence of inputs imported from China at the industry, firm, and product-levels (Antràs, Fort, et al., 2017; Fabinger et al., 2017; Hayakawa et al.,

[1]This paper is amongst the first applications of Japanese CZ.

2019). Also, our result is in line with the finding by Taniguchi (2019) as the intermediate imports may benefit Japanese manufacturers. Since the estimated coefficients on the direct penetration are larger when controlling for the upstream and downstream measures compared to the simplest case, one would underestimate the (direct) impact of the import penetration without taking this supply chain channel into account.

Our additional analysis suggests that the mitigated negative net effect seems partly driven by the co-agglomeration of the industries with input-output linkage. To see if the co-agglomeration pattern can explain this mitigation, we construct the input share-weighted co-location index for each industry and decompose the industries into two groups: high and low co-location industries with their suppliers. By construction, if co-agglomeration matters, we expect to observe that for high co-location industries, the net effect would be close to zero as negative direct and positive downstream effects cancel out each other, while low co-location industries might not exhibit such a pattern. This is supported by our analysis, implying that at the local labor-market level, the industry co-agglomeration works to relieve the shock in this case of Japan.

Our study contributes to the literature on the implications of the *China Shock* to a wide range of issues. Amongst all, labor market implications have attracted much attention. On its negative side, empirical studies have shown that the *China Shock* exhibited detrimental impacts on the US manufacturing employment, arguably causing the large decline in the US manufacturing sector employment, both at regional- and industry-levels. Although it is pointed out that the import shock seemed amplified by the other factors such as housing market (Xu et al., 2019), the contribution of the shock to the decline in the manufacturing sector in the US is now well-established. The consistent negative impacts on the manufacturing employment are observed in other countries too, including France (Malgouyres, 2017), Spain (Donoso et al., 2015), Germany (Dauth et al., 2014), Norway (Balsvik et al., 2015).

On the other hand, some researchers argue that the net effect may not be so obvious once taking supply chains into account. The shock may propagate negatively to the upstream industries as customers are now likely closing down or curtailing its business, as observed in the US manufacturing case (Acemoglu, Autor, et al., 2016). On the contrary, as has been discussed above, the positive shock propagation may happen to the downstream industries plausibly through lower prices or better quality of inputs, as the US non-manufacturing sectors exhibit (Wang et al., 2018). In this line of the literature, we show that in the case of Japan whose intermediate imports accounts for a relatively large share in total, the positive downstream effect realizes even amongst the manufacturing industries, and together with the co-agglomeration pattern, this may mitigate the net labor displacement in the local labor market.

This paper is particularly related to the research on Japan within this literature. Our results are consistent with firm-level as well as product-level analyses that show the positive employment effect on the industries whose inputs experienced a larger growth in imports from China, while directly competing industries reduced their employment (Hayakawa et al., 2019). Similar results, s positive impact on downstream industries, are found with respect to firm performance (Fabinger et al., 2017). Similar to this paper, there is the study on how the China Shock affected the manufacturing employment at Japanese prefectural-level (Taniguchi, 2019). She shows that between 1995 and 2007, the import from China had a positive impact on local employment in Japan, primarily because of intermediate goods imports. In relation to her paper, we re-examine the regional-level impact at CZ-level for a longer period, finding opposite, negative, net effects even in the local labor market. Building on the observation by Taniguchi (2019) that the intermediate imports from China seem to have driven a positive employment effect of the imports, we affirm that the input-output linkage worked favorably to the downstream industries in manufacturing. In this sense, this paper complements hers to argue that the characteristics of Japan's imports from China, relatively a larger portion of intermediate imports to the manufacturing sector, benefited even the manufacturing sector through supply chains. This presents a stark contrast to the US case where the positive downstream effects are not observed in the manufacturing sector (Acemoglu, Autor, et al., 2016) but in the *non*-manufacturing sector (Wang et al., 2018).

Besides the labor market consequences, the literature has examined the China Shock effects on: firm performance (Acemoglu, Akcigit, et al., 2016; Fabinger et al., 2017); innovation (Autor, Dorn, Hanson, Pisano, et al., 2017; Bloom et al., 2016; Yamashita and Yamauchi, 2020); political polarization and nationalism (Autor, Dorn, Hanson, and Majlesi, 2017; Colantone and Stanig, 2018a,b); and marriage market and family structure (Autor, Dorn, and Hanson, 2019). They are essentially connected to labor market aspects, especially political and social issues seem to be partially a consequence of the labor displacement, emphasizing the importance of the employment effect in a broader sense.

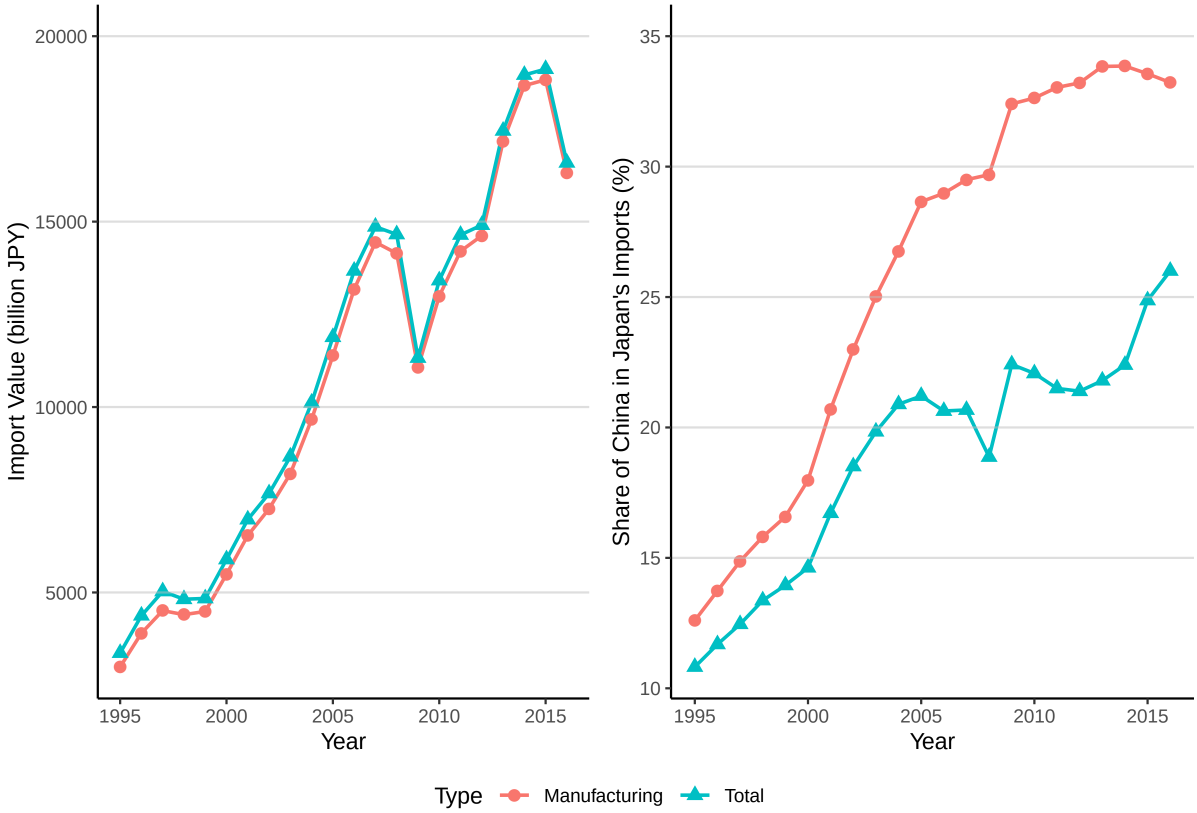
The remainder of this paper is structured as follows. section 2 describes the evolution of Japanese aggregate and industry-level imports from China and shows the time-heterogeneous nature of the industry-level import penetration from the late 1990s to the early 2010s. section 3 introduces our empirical strategy and data. We present the results in section 4. Finally, section 5 concludes.

2 Japan's Imports from China

2.1 Evolution of Japan's Imports from China

Before embarking on a rigorous analysis, we briefly take a look at how the imports from China to Japan has evolved over the last two decades. Owing to China's reform towards market economy, its accession to WTO, and technological development, developed coun-

Figure 1: Japan's Imports from China (Value and Share in Total) in All and Manufacturing Sectors

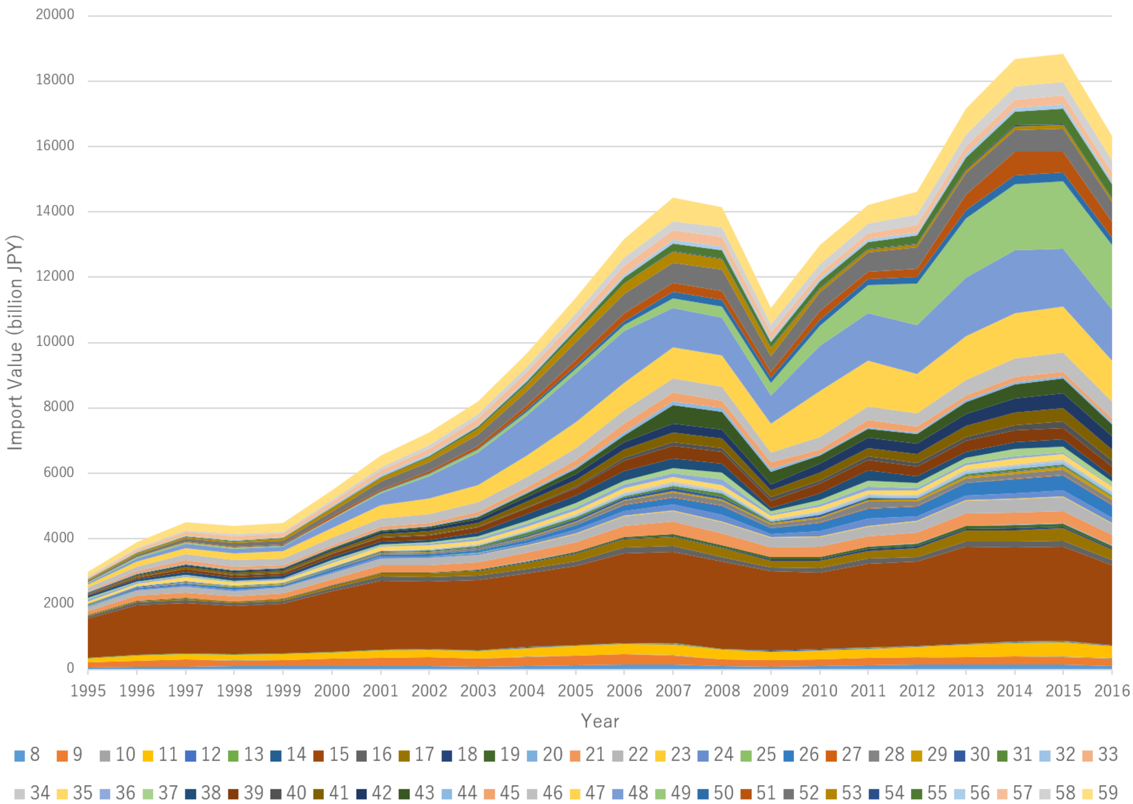


Notes: The figure presents the yearly data on Japan's imports from China. The left panel presents the value of the imports in nominal JPY, while the right one shows the share of China in Japan's total imports. Both are created using Japan's import data in the JIP Database (RIETI). *Manufacturing sector* is thus defined at the JIP2006 industry-level. The list of the industries in the sector is presented in the Appendix.

tries have seen a surge in the imports, primarily manufacturing, from China since 1990s (Branstetter and Lardy, 2008). This is now widely recognized as the *China Shock* to developed countries such as the US and European countries. Japan is amongst these largely affected economies. Interacted with this China's economic transformation, Japanese firms also have deepened their relationships with China through offshoring, integrating the emerging economy into their supply chains.

How have Japan's imports from China evolved since the late 1990s? Figure 1 shows Japanese aggregate import value from China, in total and specifically in the manufacturing sector. The left panel presents the values of the imports from China while the right represents the shares of China in Japanese total imports. Time period-wise, both continued to increase, except the years of the Financial Crisis in the late 2000s. Even after the crisis, we observe the recovering growth in imports until 2015. Comparing total and manufacturing imports, it is undeniable to see that almost all the imports from China

Figure 2: Japanese Import from China (Nominal JPY) by Manufacturing Industries



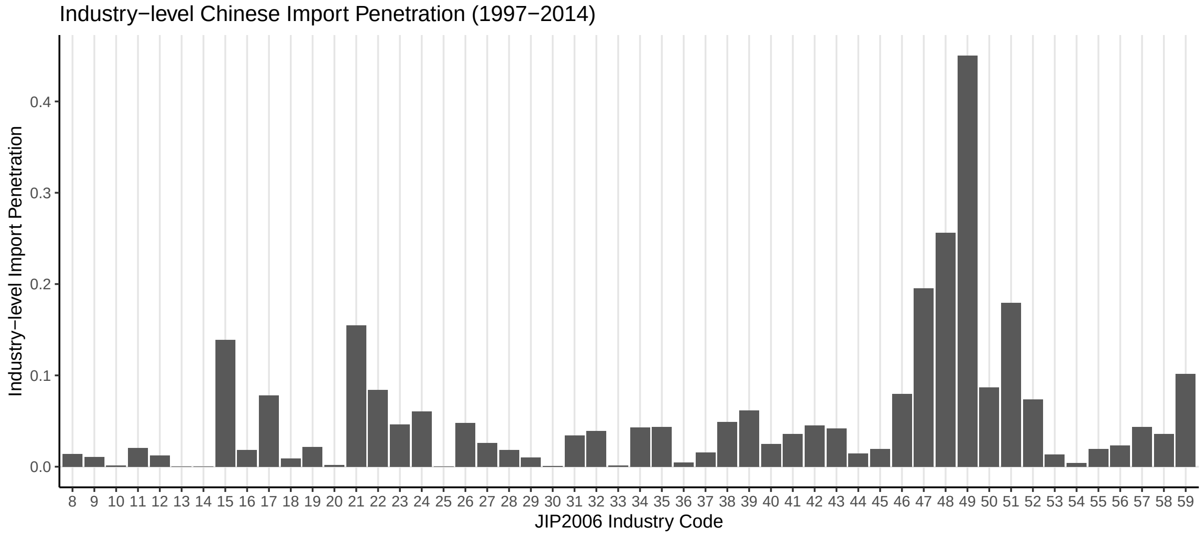
Notes: The figure presents the yearly data on Japan's imports from China by industry in the manufacturing sector. The numbers from 8 to 59 in the figure are the JIP2006 Industry codes. We create using Japan's import data in the JIP Database (RIETI). The list of the JIP2006 industries in Manufacturing sector, with their codes, is in the Appendix.

are manufacturing goods and thus their movements govern the total imports. The right panel indicates that in the manufacturing sector China accounts for a significantly larger share than in total. The share in the manufacturing sector exhibits a considerable growth, doubling from around 15% in the late 1990s to a slightly below 35% in the early 2010s. It did not decrease even during the last Financial Crisis. These trends overall suggest that Japan has also been exposed to the rapidly growing Chinese import penetration as well as the presence of China in Japan's manufacturing imports.

What about the industry composition of the imports from China? Figure 2 exhibits Japanese imports from China by industry. We focus on the manufacturing sector since it comprises almost all the imports from China as Figure 1 shows. We employ the JIP2006 industry classification developed by the Research Institute of Economy, Trade and Industry (RIETI).[2] The figure indicates that *Textile products* (coded with 15) accounts for a large share of the imports throughout the years and increased especially in the late 1990s and early 2000s. In contrast, we can also observe sharp growth in some industries

[2]The numbers in the legend of the figure indicate the JIP2006 industry code. The complete list of the manufacturing industries in JIP2006 industry classification is provided in the Appendix.

Figure 3: Import Penetration at JIP Industry-level in 1997-2014



Notes: The figure presents the industry-level Chinese import penetration, defined in Equation 1, for the period between 1997 and 2014. The x-axis is the code of JIP2006 industries in the manufacturing sector. We create this using Japan's import data in the JIP Database (RIETI) and the industry absorption computed with the input-output table in each start of period, taken from the JIP Database (RIETI). The list of the JIP2006 industries in Manufacturing sector, with their codes, is in the Appendix.

during other periods. For instance, *Household electric appliances* (47) and *Electronic data processing machines, digital and analog computer equipment and accessories* (48) dramatically rose in their imports from the early 2000s. There is also an evident contrast between the periods before and after the Financial Crisis in the late 2000s. Industries such as *Communication equipment* (49) and *Semiconductor devices and integrated circuits* (51) exhibit a substantial growth specifically after the Crisis. Hence, while the aggregate imports have increased continuously in most of the years, the industry composition has also changed largely over time. This varying structure in imports from China to Japan may reflect their changing relationship in supply chains.

2.2 Industry-level Import Penetration

Moving from the raw import values shown in the last section, we here focus on Chinese *import penetration* at the JIP2006 industry-level. This is the measure to quantify the size of the *China Shock* to Japanese manufacturers at the industry level. Following Acemoglu, Autor, et al. (2016), our measure of industry-level trade exposure is defined as the penetration ratio for industry j at year t in the following way:

$$\Delta IP_{jt} = \frac{\Delta M_{jt}^{CHN \to JP}}{Y_{jt-1} + M_{jt-1} - E_{jt-1}}, \tag{1}$$

Table 1: Industries with Highest Penetration: 1997-2014

JIP	Name	Imp.Penet.	Final.Share	Upstream	EG.Agglome
49	Communication equipment	0.4502	0.8279	1.3448	0.0065
48	Electronic data processing machines, digital and analog computer equipment and accessories	0.2563	0.8790	1.1794	0.0147
47	Household electric appliances	0.1956	0.8133	1.3076	0.0045
51	Semiconductor devices and integrated circuits	0.1795	0.3578	2.3047	0.0064
21	Leather and leather products	0.1551	0.7819	1.7222	0.0518
15	Textile products	0.1392	0.5806	2.0511	0.0083
59	Miscellaneous manufacturing industries	0.1017	0.5405	2.0001	0.0040
50	Electronic equipment and electric measuring instruments	0.0866	0.8600	1.2197	0.0113
22	Rubber products	0.0844	0.2480	2.7100	0.0065
46	Electrical generating, transmission, distribution and industrial apparatus	0.0798	0.7249	1.4631	0.0029
	Sample Mean	0.0541	0.4443	2.5219	0.0100

Notes: This table shows the ten industries that exhibit the highest import penetration, defined in Equation 1, in the period between 1997 and 2014. The industries are ordered descendingly by the import penetration abreviated as *Imp. Penet.* *Final.Share* the share of final demand to which each industry's output goes, *Upstream* the upstreamness of each industry computed based on Antràs, Chor, et al. (2012), and *EG.Agglome* the Ellison and Glaeser industry agglomeration index proposed by Ellison and Glaeser (1997). The import penetration measure, the final demand share and the upstreamness index are computed with the input-output table in the JIP Database (RIETI). We calculate EG agglomeration index using the establishment data of the Census of Manufacture (METI). All of these values except the import penetration are computed as of 1997. The last column shows the sample mean of the corresponding measures.

where $\Delta M_{jt}^{CHN \to JP}$ is the difference in the real import value from China to Japan in industry j at time t and $t-1$ $\left(= M_{jt}^{CHN \to JP} - M_{jt-1}^{CHN \to JP}\right)$. $Y_{jt-1} + M_{jt-1} - E_{jt-1}$ is industry j's initial absorption (meansured as industry shipments, Y_{jt-1}, plus industry imports, M_{jt-1},minus industry exports, E_{jt-1}). We use real domestic output in the input-output table as Y_{jt-1} as well as real export and import values in the same table as M_{jt-1} and E_{jt-1}, respectively.[3]

Figure 3 shows this industry-level import penetration measure for manufacturing sector in the period between 1997 and 2014. The premise of this measure is that the industries have experienced different levels of the exposure to the imports from China. Indeed, we can see the variation in the degree of the import penetration across industries. *Communication Equipment* (49) exhibits the largest penetration in this relatively long-run period. Other industries follow it, such as *Electronic data processing machines, digital and analog computer equipment and accessories* (48) and *Household electric appliances* (47). This cross-industry variation is exploited in the subsequent analysis.

To take a closer look at how the highly penetrated industries look like, Table 1 presents the ten industries that experienced the highest import penetration in the period between 1997 and 2014. In addition to the level of the import penetration, we also show the measures to capture the industries' characteristics with respect to supply chains and geographical agglomeration.[4] We here compute the final demand share and the upstreamness proposed by Antràs, Chor, et al. (2012) using the Japanese input-output Table, and the industry agglomeration index developed by Ellison and Glaeser (1997). This shows that

[3]We provide more detailed descriptions on the variable construction and data source in section 3.
[4]Their corresponding sample mean is shown at the bottom row for reference.

the highly penetrated industries seem rather to be those with relatively higher final demand shares and with relatively low upstreamness.[5] In terms of industry agglomeration, more than half of them exhibit the degrees of agglomeration smaller than the sample mean, indicating that these industries does not simply locate in some specific regions.[6]

We presents the corresponding figure and tables in the shorter-term periods (1997-2002, 2002-2007, and 2009-2014) in the Appendix. As can be seen from Figure 2 showing the time-variant trade structure between Japan and China, the magnitude of the import penetration in total (or on average) and the highly penetrated industries indeed differ over time. Since different industries with different characteristics may generate different effects of the import shock, this time-variance may imply some heterogeneity in the import penetration effects across time periods. Therefore, we also examine in our econometric analysis whether any such heterogeneity exists.

3 Empirical Approach

3.1 Econometric Specification

We seek to uncover the impact of Chinese import penetration on Japanese regional-level employment. For this purpose, we first estimate the following first-difference model:

$$\Delta labour_{ct} = \alpha + \beta \Delta IP_{ct} + \gamma \mathbb{X}_{ct-1} + \varepsilon_{ct} \tag{2}$$

where

$$\Delta IP_{ct} = \sum_j \frac{L_{cjt-1}}{L_{ct-1}} \frac{\Delta M_{jt}^{CHN \to JP}}{Y_{jt-1} + M_{jt-1} - E_{jt-1}}, \tag{3}$$

L_{cjt} represents the number of manufacturing workers in industry j in region c at time t, L_{ct} the number of manufacturing workers in region c at time t (total manufacturing employment in region c)[7], $\Delta M_{jt}^{CHN \to JP}$ is the difference in the real import value from China to Japan in industry j at time t and $t-1$ $\left(= M_{jt}^{CHN \to JP} - M_{jt-1}^{CHN \to JP}\right)$, and $Y_{jt-1} + M_{jt-1} - E_{jt-1}$ is initial absorption (meansured as industry shipments, Y_{jt-1}, plus industry imports, M_{jt-1},minus industry exports, E_{jt-1}). Comparing to Equation 1, we can see that the regional level measure in Equation 3 is constructed by taking weighted average

[5]Indeed, the correlation coefficients between the import penetration and the final demand share as well as upstreamness in the whole industry sample, are positive and negative, respectively. Yet, the correlation seems not strong in either case as the coefficients are 0.37 and -0.27.

[6]With the whole industry sample, the import penetration and local agglomeration do not exhibit any significant relationship.

[7]Instead of *total employment*, we use total manufacturing employment as denominator so that the sum of the weights is equal to one. Because in the regression we control the manufacturing employment share in total employment (total manufacturing employment divided by total employment), the regression results would not be different whichever is used.

of the industry level import penetration using each industry's employment share in a region as a weight. We use the JIP2006 industry classification and consider only the manufacturing sector imports from China.[8]. Hence, j corresponds to each JIP industry in the manufacturing sector. In this paper, we sometimes refer to Equation 3 as the *direct* import penetration measure to distinguish this with the other penetration measures introduced below.

Our dependent variable in Equation 2 is the log-difference of manufacturing employment:

$$\Delta labour_{ct} = \log L_{ct} - \log L_{ct-1}. \tag{4}$$

Though this is slightly different from Taniguchi (2019), we obtain similar results in terms of the coefficient estimate's sign and statistical significance when we apply her measure.

When running regressions, however, the OLS estimates are possibly biased due to the demand component of the shock. It is plausible that Japanese firms increased imports from China regardless of Chinese technological development through outsourcing or FDI. Hence, in order to address this endogeneity of ΔIP_{ct}, we follow the identification strategy proposed by Autor, Dorn, and Hanson (2013) and instrument it for the following variable:

$$\Delta IP^{O}_{ct} = \sum_{j} \frac{L_{cj1994}}{L_{j1994}} \frac{\Delta M^{CHN \to Other}_{jt}}{Y_{j1990} + M_{j1990} - E_{j1990}}, \tag{5}$$

where $\Delta M^{CHN \to Other}_{jt}$ is the difference in the real import value from China to 8 other countries: Australia, Denmark, Finland, Germany, New Zealand, Spain, Switzerland, and the United States. To avoid a simultaneity bias, our instrument uses the employment data as of 1994 as well as the industry absorption in 1990. Employing this instrument, we can identify the supply component of the Chinese import growth.

This, however, only provides net effects of the import penetration at the regional-level, which is the mixture of the direct import competition effect and indirect effects propagated through input-output linkages. Whereas the industries directly competing with imports from China are likely to be adversely affected, the increased imports can have differential effects on other industries through *downstream* and *upstream* channels.[9] As the *downstream* channel, the industries may gain from the trade if the imports improve the availability of cheaper or higher-quality inputs in their production, possibly resulting in positive employment effects. In contrast, there can be the *upstream* channel that supplier industries may lose their sales from customers if their customers get negatively affected by the import penetration. To incorporate these channels, we also estimate the following first-difference model:

[8]This is justifiable since manufacturing goods account for almost all of Japanese imports from China as in Figure 1

[9]Note that we refer to downstream and upstream as a location of input-output relationships from an industry directly affected by the import penetration.

$$\Delta labour_{ct} = \eta + \beta^{Direct}\Delta IP_{ct} + \beta^{Up}\Delta IP^{Up}_{ct} + \beta^{Down}\Delta IP^{Down}_{ct} + \delta\mathbb{X}_{ct-1} + \epsilon_{ct}. \tag{6}$$

Referring to Acemoglu, Autor, et al. (2016) and Wang et al. (2018), we construct the downstream and upstream import penetration measures in the following way. For the downstream measure,

$$\Delta IP^{Down}_{ct} = \sum_{j} \frac{L_{cjt-1}}{L_{it-1}} \Delta Down_{jt}, \tag{7}$$

where

$$\Delta Down_{jt} = \sum_{-j} w^{Down}_{gjt-1} \frac{\Delta M^{CHN\to JP}_{gt}}{Y_{gt-1} + M_{gt-1} - E_{gt-1}}, \quad w^{Down}_{gjt-1} = \frac{Z^{U}_{gjt-1}}{\sum_h Z^{U}_{hjt-1}}, \tag{8}$$

and Z^{U}_{gjt-1} is the value of the input for industry j that is produced by indutry g at year $t-1$, taken from the Japanese input-output table. Hence, in this sense, $\Delta Down_{jt}$ is based on the import penetration of industry j's suppliers industries weighted by a share of j's inputs purchased from each supplier.

Likewise, the upstream penetration measure is constructed as follows:

$$\Delta IP^{Up}_{ct} = \sum_{j} \frac{L_{cjt-1}}{L_{it-1}} \Delta Up_{jt}, \tag{9}$$

where

$$\Delta Up_{jt} = \sum_{-j} w^{Up}_{jgt-1} \frac{\Delta M^{CHN\to JP}_{gt}}{Y_{gt-1} + M_{gt-1} - E_{gt-1}}, \quad w^{Up}_{gjt-1} = \frac{Z^{U}_{jgt-1}}{\sum_h Z^{U}_{jht-1}}, \tag{10}$$

and Z^{U}_{jgt-1} is the value of industry j's sales purchased by industry g at year $t-1$ found in the Japanese input-output table. Again, similar to the downstream measure, ΔUp_{jt} is the import penetration of industry j's customer industries weighted by a share of j's outputs purchased by each customer.

These measures are no exceptions of the endogeneity concern. Hence, we construct the corresponding instruments by replacing $\Delta M^{CHN\to JP}_{gt}$ with $\Delta M^{CHN\to Other}_{gt}$ in Equation 8 and Equation 10, analogous to ΔIP^{O}_{ct}.

Note that when computing the penetration measures in Equation 8 and Equation 10, we exclude intra-industry input-output flows as indicated in the equations. This is meant to avoid high correlations between the three penetration measures because the intra-industry input-output linkages are typically strong.[10] Furthermore, while we consider

[10]Presumably, this is partly due to the *roughness* of the industry classification that we use. In this sense, the input-output flows incorporated in our analysis are lower bounds when compared to more detailed industry classifications.

only manufacturing industries in direct and indirect import penetration from China, the denominators of w_{gjt-1}^{Down} and w_{gjt-1}^{Up} also run over non-manufacturing industries and final demand as in Acemoglu, Autor, et al. (2016).

3.2 Data

This paper combines the manufacturing employment data, industry-level imports from China, the industry input-output table, and demographic characteristics for the years between the late 1990s and the early 2000s. As a main source of data on employment, we rely on the Census of Manufacture by the Ministry of Economy, Trade and Industry (METI).[11] This is the annual survey of all the establishments engaged in manufacturing activities, based on Japanese Standard Industry Classification (JSIC), and having more than three employees in Japan.[12] Since our regional unit is *commuting zone* (CZ), we aggregate the original data at the CZ-level.

For the data of trade between Japan and China, we rely on the Japanese Industry Productivity (JIP) Database, constructed by RIETI. The JIP Database provides values of Japanese trade with partner countries at their original industry classification (the JIP 2006 industry classification).[13] For the instrumental variables, we use the trade data on UN Comtrade Database, constructed by the United Nations Statistics Division (UNSD).[14] We convert nominal trade values into real values using the GDP deflator in SNA provided by the Cabinet Office, Government of Japan.

For the construction of downstream and upstream import penetration measures, we use the JIP input-output table provided by the JIP Database. This is the table at the JIP industry-level in each year. In addition to the input-output linkages, we use the total output, export, and import of the JIP industries in the input-output table to compute the industry absorption in the import penetration variables.

For the demographic and technological controls, we follow the literature: manufacturing employment share[15], female labor force participation rate, college graduate share in population, foreign-born population share, and IT investment flow. The municipality-level demographic data are all taken from the Population Census built by the Ministry of Internal Affairs and Communication (MIC).[16] The real IT investment flow data come

[11] For the year 2011, we use the Economic Census for Business Activity because this census was conducted instead of the Census of Manufacture at that time.

[12] Some years' surveys cover all manufacturing establishments irrespective of employment size, though we construct the data based on this *more than three employees* criterion.

[13] The JIP 2006 industry classification consists of 52 manufacturing industries, hence larger than JSIC 3-digits but smaller than JSIC 2-digits classifications.

[14] We take COMTRADE data with SITC classification and connect it to the JIP industries via ISIC with their concordances.

[15] The denominator is total employment from the Establishment and Enterprise Census and the Economic Census for Business Frame, both by the Ministry of Internal Affairs and Communication (MIC). We linearly interpolate the missing values.

[16] Since the Population Census is conducted in every five years ended with zero and five, except for

from the JIP Database at the JIP industry-level, which we transform into the CZ-level by taking weighted average with the local employment share as in the case of the import penetration measure construction. In addition to these variables, we take the annual municipality-level population based on the Residential Basic Book by MIC.

As a regional unit, we employ the CZ in Japan proposed by Adachi et al. (2020). Japanese CZs are constructed by integrating municipalities using the method developed by Tolbert and Sizer (1996). They cover the whole country[17] and define the regional level at a smaller scale compared to prefectures. The CZ seems to be an appropriate unit as a local labor market as discussed in Adachi et al. (2020). Inter-municipality commuting patterns in Japan rejects a municipality as an independent regional unit when it comes to the labor market. Besides, the prefecture, a typical regional unit, may contain multiple local labor markets, and thus employing them could lose some regional heterogeneity within prefectures. This paper specifically uses the CZ as of October 1, 2005 that defines about 330 CZs across Japan.[18]

Using these data, we construct the three Chinese import penetration measures in Equation 3, Equation 7, and Equation 9. Figure 4 shows the distribution of the CZ-level import penetration measures in the period 1997-2014.[19] As you can see, the direct penetration measure takes, by construction, larger values and is more varied than the other two measures. In terms of the direct measure, it suggests that there are a large variation across CZs. The other two measures also have some variations though smaller than the direct measures. Table 2 presents the summary statistics of these penetration measures by period: 1997-2014, the long period, and three shorter periods, i.e., 1997-2002, 2002-2007, and 2009-2014. Comparing the downstream and upstream measures, the former takes the larger values than the latter does in all periods, though the differences become smaller as the periods proceed. We can also see the heterogeneity across time periods in the measures. The first period 1997-2002 exhibits the smallest penetration in any form. When it comes to the comparison between the second and third periods, they look relatively similar but we can find the differences. The direct penetration is slightly larger in second period but the third period exhibits the higher downstream penetration. Our regression analysis attempts to clarify whether these differences result in distinct impacts on local labor markets.

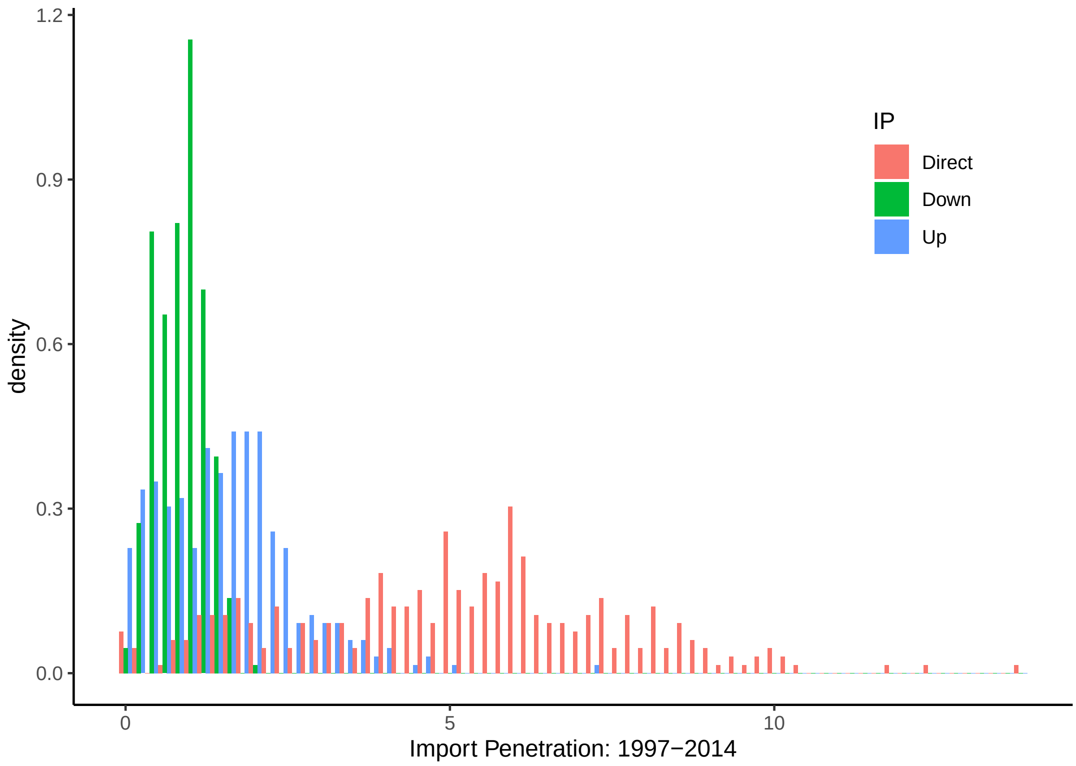
education that is asked in the Census in every 10 years, we estimate the other years' values by linear interpolation.

[17]Similar concepts such as Urban Employment Area (Kanemoto and Tokuoka, 2002) do not have this feature.

[18]The conversion of the municipalities in each year to the CZ involves the municipality mapping to the ones as of October 1, 2005 using *Municipality Map Maker* (Kirimura et al., 2011).

[19]Again, we refer to the measure defined in Equation 3 as *direct* import penetration in comparison with the others.

Figure 4: Imoprt Penetration at Commuting Zone-level: 1997-2014



Notes: The figure presents the industry-level Chinese import penetration, defined in Equation 1, for three different periods: 1997-2002, 2002-2007, and 2009-2014. The industries shown are all in the manufacturing sector, coded with the JIP2006 Industry Classification. We create this using Japan's import data and the industry absorption computed with the input-output table in each start of period, both taken from the JIP Database (RIETI). The list of the JIP2006 industries in Manufacturing sector, with their codes, is in the Appendix.

4 Results

4.1 Manufacturing Employment

We first show the estimation results of Equation 2 for the long difference (1997-2014) and three shorter-term periods.[20] [21] Though the stacked first difference specification is shown below as in the previous researches, we here pay more attention to the period-wise specifications to see the long-run dynamics and if there is any heterogeneity across shorter-term periods. Table 3 presents the results of estimating Equation 2 with two stage least squares (2SLS).[22] We instrument the import penetration measure by the contemporaneous import shock to the other countries, as described in section 3. Here, we estimate the model

[20] We multiply the explanatory variables of interest by 100 as in Acemoglu, Autor, et al. (2016).

[21] Although the results are not shown here, as robustness checks, we run the same regressions for the other years between 1997 and 2014, too.

[22] The results of OLS as well as of the first stage regressions are shown in the Appendix. Though not substantially different, the OLS estimates indicate that the effect on the local employment might be biased upwards by the demand side components.

Table 2: Summary Statistics of Import Penetration Measures: 1997-2014

IP	Period	Mean	Sd	Min	Max
Direct	1997-2014	5.524	1.527	0.000	13.790
Down	1997-2014	1.060	0.246	0.000	1.980
Up	1997-2014	1.802	0.732	0.000	7.254

Direct	1997-2002	1.147	0.402	0.000	3.395
	2002-2007	3.027	0.690	0.000	6.853
	2009-2014	2.739	0.635	0.000	6.642
Down	1997-2002	0.163	0.040	0.000	0.315
	2002-2007	0.642	0.122	0.000	1.083
	2009-2014	0.703	0.105	0.000	1.033
Up	1997-2002	0.300	0.115	0.000	1.041
	2002-2007	0.726	0.194	0.000	2.605
	2009-2014	0.668	0.245	0.000	2.469

Notes: This table reports the summary statistics of the import penetration measures at the CZ-level. The measures are defined in Equation 3, Equation 7, and Equation 9. When computing the measures, we use the data from the following sources: for employment, the Census of Manufacture (METI); and for the import value from China and the industry absorption, the JIP Database (RIETI). The upper panel presents the long difference between 1997 and 2014, while the lower panel reports the three periods (1997-2002, 2002-2007, and 2009-2014), respectively. The unit of observation is the CZ. When computing each statistic, observations are weighted by the start of period share of the national population.

for the long difference, to capture the long-run dynamics, and by each shorter-term period. The first column indicates the result of the long difference (1997-2014). This shows a negative and statistically significant effect at the conventional levels, implying that the CZ-level impact of the import shock is a net negative. We here observe the opposite result to what Taniguchi (2019) finds, as she shows at the prefectural-level the estimated effect is statistically significantly positive between the mid-1990s and late 2000s before the financial crisis. Since our specification is slightly different from hers with different regional units and time periods covered, we may not be able to simply compare these opposite estimates.

The rest of the columns (from second to fourth) of Table 3 presents the estimates by periods for the shorter-run between 1997 and 2014. As you can see, the results are not identical in size and statistical significance across these periods. In terms of the size, the first period (1997-2002) exhibits a large negative coefficient on the import penetration, while the coefficient sizes are smaller, in an absolute sense, in the other two periods (2002-2007 and 2009-2014). Moreover, whereas the first and third periods show statistically significant estimates, that is not the case for the second. These results imply the presence of the heterogeneous net effects across time periods. Though it is not obvious what drives this difference, it may account for it that the across-period differences in the penetration intensity in total as well as the industries that were highly affected. Hence, although

Table 3: Log-Difference of Manufacturing Employment: 2SLS

	1997-2014	1997-2002	2002-2007	2009-2014
Import Penetration	-0.06^{***}	-0.11^{***}	-0.03	-0.05^{***}
	(0.01)	(0.02)	(0.03)	(0.02)
CZ-level Control	✓	✓	✓	✓
R^2	0.38	0.29	0.22	0.27
Adj. R^2	0.37	0.27	0.21	0.25
Num. obs.	331	331	331	331

Notes: This table reports the result of estimating Equation 2 for the four different time periods: 1997-2014, 1997-2002, 2002-2007, and 2009-2014, separately. The unit of observation is the CZ as of October 1, 2005. All columns are estimated with two stage least squares with which the import penetration variables are instrumented as discussed in the text. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

the effect on the local employment differs by which periods we focus on, the net effect is that Chinese import penetration to the Japanese economy plausibly reduced the local employment at the CZ-level for the long-run between the late 1990s and early 2010s.[23]

While Table 3 shows the *net* effect on local labor markets, this does not clarify how the shock affected the local labor markets in the presence of industry input-output linkages, i.e., if there was any shock propagation through supply chains, in addition to the direct import competition channel. For this, Table 4 presents the results of estimating Equation 6 for the same periods as Table 3. Import Penetration in the table indicates the explanatory variable in Equation 3 as used, and the other two (Upstream IP and Downstream IP) correspond to Equation 9 and Equation 7. Again, we here estimate the model with 2SLS.[24] Though the sizes of the estimated coefficients do not seem exactly the same in these different time periods, we observe a clear and consistent pattern in this table: statistically significant estimated coefficients of the direct (the first row) and downstream (the third row) import penetration measures have opposite signs, but statistically insignificant estimate on the upstream measure. This pattern confirms our conjecture that whereas there is likely the direct import competition, which works negatively to employment, the industries whose suppliers get affected actually benefited from this import shock. In the long difference specification (the first column), the absolute value of estimated coefficient of the direct measure is larger than the one in Table 3 once we add the other two measures, in particular, the downstream measure. It plausibly implies that the

[23] Our findings are consistent with the papers in the other countries (Autor, Dorn, and Hanson, 2013; Balsvik et al., 2015; Dauth et al., 2014; Donoso et al., 2015; Malgouyres, 2017).

[24] As in the simple case above, we put the OLS and first stage results in the Appendix. The first stage regression confirms that each instrument predicts the corresponding endogenous regressor well even in the presence of correlation between these measures.

Table 4: Log-Difference of Manufacturing Employment: 2SLS with Up/Downstream

	1997-2014	1997-2002	2002-2007	2009-2014
Import Penetration	-0.12^{***}	-0.18^{***}	-0.06^{**}	-0.07^{***}
	(0.02)	(0.03)	(0.02)	(0.02)
Upstream IP	0.00	-0.10	-0.02	-0.04
	(0.02)	(0.06)	(0.06)	(0.03)
Downstream IP	0.61^{***}	0.96^{***}	0.27^{*}	0.21^{*}
	(0.15)	(0.25)	(0.16)	(0.11)
CZ-level Control	✓	✓	✓	✓
R^2	0.39	0.24	0.24	0.26
Adj. R^2	0.37	0.22	0.22	0.24
Num. obs.	331	331	331	331

Notes: This table reports the result of estimating Equation 6 for the four different time periods: 1997-2014, 1997-2002, 2002-2007, and 2009-2014, separately. The unit of observation is the CZ as of October 1, 2005. All columns are estimated with two stage least squares with which the import penetration variables are instrumented as discussed in the text. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

direct effect of the import shock is underestimated without taking the shock propagation through supply chains into account.

As in all the three shorter-term periods, it is coherent that the direct import shock is negative and the downstream channel works positively. Given the time-variant structure of Japan's imports from China in which different industries experienced different degrees of the import shock at different times, it indicates that these two effects are qualitatively not industry-specific. The varying coefficient sizes across periods in Table 4 as well as Table 3 further implies that the local net impact of the import shock, at least partly, depends on the relative degrees of these opposite forces and they likely differ across time periods.

In addition to these two tables, we lastly look at the one estimated with the stacked first difference specification, that is, we pool the three shorter-term periods and jointly estimate them with period-fixed effects. Table 5 presents its result. As opposed to the above, the first column here shows the negative estimate that is statistically indistinguishable from zero, though we still observe the result in the second column indicates that the direct, detrimental import competition and the positive downstream shock propagation. In this stacked specification, we try to estimate some common components of the shock across time periods in contrast to the period-wise specifications. In other words, we could say that we effectively impose stronger assumptions on this specification about how the import shock affects the employment as well as how controls work, compared to the period-wise specifications. Particularly in our case where the net effect seems time-

Table 5: Log-Difference of Manufacturing Employment: Stacked 2SLS

	3 Periods	3 Periods
Import Penetration	-0.02	-0.06^{***}
	(0.02)	(0.02)
Upstream IP		-0.04
		(0.03)
Downstream IP		0.37^{***}
		(0.13)
CZ-level Control	✓	✓
Period FE	✓	✓
R^2	0.46	0.47
Adj. R^2	0.45	0.47
Num. obs.	993	993

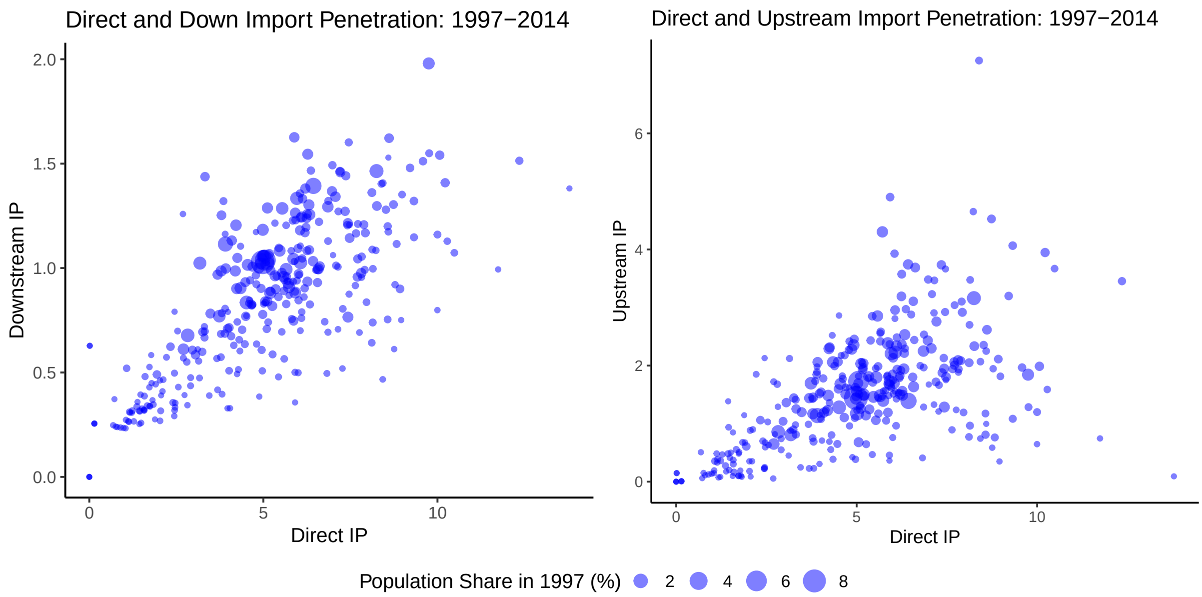
Notes: This table reports the result of estimating Equation 6. We estimate this by pooling three time periods: 1997-2002, 2002-2007, and 2009-2014 with the period dummies (denoted as *Period FE* in the table). The unit of observation is the CZ as of October 1, 2005. All columns are estimated with two stage least squares with which the import penetration variables are instrumented as discussed in the text. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are clustered at the commuting zone-level. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

variant, pooling them together may obscure significant results in some periods. Hence, in comparison to the above results, we do not interpret this null result as evidence of the non-existence of the net negative effect but rather in a way that this specification does not capture the negative and statistically significant net effect in the long and shorter-term periods observed in Table 3 and Table 4.

Whereas our estimates of the net employment consequences do not coincide with Taniguchi (2019), the implication from our downstream channel findings benefits from her results. She shows that the positive employment effect of the import penetration, at the prefecture-level, comes from the imports of intermediate goods from China. Though her finding is indirect, our result together with hers indicates the characteristics of Japan-China trade, which involves larger intermediate inputs used in the subsequent production, may work favorably to the downstream manufacturing industries. This may also be one possible explanation to the difference in our result and the US case investigated in Acemoglu, Autor, et al. (2016) in which the negative direct and upstream effects, but no positive downstream effects are observed. Hence, the trade structure, in particular, the imports of intermediate goods can consistently explain our findings as well as the difference from the US case.

Overall, as opposed to the previous study by Taniguchi (2019), we find that the net employment impact of Chinese import penetration is likely negative in the relatively long

Figure 5: Correlations Across Import Penetration Measures (1997-2014)



Notes: The figure presents the correlations of the direct import penetration measure with the downstream and upstream penetration measures, respectively, at the CZ-level for the period 1997-2014. The measures are defined in Equation 3, Equation 7, and Equation 9, and computed using the data from the Census of Manufacture (METI) and the JIP Database (RIETI). Each point corresponds to a CZ, with the size indicating its share of national population as of 1997.

run and in some shorter time periods. Yet, we still find the evidence in line with hers that local labor markets also benefited from the imports through the improved availability of intermediate inputs, possibly mitigating the adverse impact through the intensified import competition.

4.2 Co-agglomeration

Given the results in the previous section, we here try to see if industry co-agglomeration matters in determining local net effects of the import penetration. As has been shown in the last section, it seems to be the case in our setting that a shock to one industry has a negative implication to this industry while the shock propagation to another, downstream, industry generates a positive effect. We then hypothesize that given these two conflicting forces working on, a regional-level net effect is negative but mitigated through the co-agglomeration of one industry with another, its downstream, industry.[25] Since the industries with input-output linkages tend to co-locate in a region (Ellison, Glaeser, and Kerr, 2010; Fujii et al., 2017), this mechanism might matter in the regional labor market.

Indeed, the CZ-level import penetration measures exhibit moderate correlations with

[25] As the upstream effect seems negligible in our context from the above analysis, we here focus on the downstream channel in relation to the direct impact.

Table 6: Correlations Across Import Penetration Measures

Period	Direct & Downstream	Direct & Upstream
1997-2014	0.638	0.533
1997-2002	0.236	0.262
2002-2007	0.467	0.502
2009-2014	0.419	0.329

Notes: This table reports the correlation coefficients of the CZ-level import penetration measures as specified in the table. The measures are defined in Equation 3, Equation 7, and Equation 9, computed using the data from the Census of Manufacture (METI) and the JIP Database (REITI). When computing each statistic, observations are weighted by the start of period shares of the national population.

each other. Figure 5 shows their correlations despite intra-industry input-output flows being omitted. This pattern is also observed in each short-term period as shown in Table 6, though the degrees vary across time. The observed correlations may be driven by the co-agglomeration: the co-location pattern of the industries having input-output linkages with those affected by a large direct import shock can explain it.

Before embarking on a formal investigation, we take a look at a co-location pattern and the input-output connections. Figure 6 presents the relationship for the input and output shares for industry pairs, respectively.[26] Here, the co-location for each pair of industry j and g is measured by the simple correlation of $\frac{L_{cjt-1}}{L_{ct-1}}$ and $\frac{L_{cgt-1}}{ct-1}$ over CZs.[27] Although the relationships do not appear strong in the figure partly owing to the small variations of the input and output shares, there seems to be a positive correlation, especially for the input share.

Measurement To test if the industry co-agglomeration works in this context, we attempt to incorporate the co-agglomeration into our empirical framework. Specifically, we classify the industries according to their degree of co-location with their suppliers. The intuition behind this is that if co-agglomeration of a supplier and a customer matters, the customer industry that is highly co-agglomerated with its suppliers would exhibit a salient pattern of opposing direct and downstream effects as in the previous section. Motivated by the construction of our import penetration measures at the CZ-level, we define the measure of the degree of co-location/co-agglomeration with one's suppliers in the following way: for industry j at CZ c,

$$\gamma_{jt} = \text{Correlation}\left(\frac{L_{cjt}}{L_{ct}}, \sum_{-j} \frac{L_{cgt}}{L_{ct}} w_{gjt}^{Down}\right), \tag{11}$$

[26]The definitions of these two shares are shown in Equation 8 and Equation 10.

[27]This definition is different from the well-known EG co-agglomeration index (Ellison, Glaeser, and Kerr, 2010). However, this simple definition is favorable in our setting because the import penetration measures are calculated with the employment share, $\frac{L_{cjt-1}}{L_{ct-1}}$, as a weight.

Figure 6: Correlation between Co-location Measure and Input/Output Share in IO-Table

Notes: The figure presents the scatter plots of the industry pairwise co-location measure with the input and output shares. The left (right) panel shows the relationship with the input (output) share in the Japanese input-output table. The co-location measure is defined as Correlation $\left(\frac{L_{cjt-1}}{L_c t-1}, \frac{L_{cgt-1}}{ct-1}\right)$ over CZs. We define the input and output shares in Equation 8 and Equation 10, respectively. Each point represents a pair of industries. All variables are computed with the data from the Census of Manufacture (METI) and the JIP Database (RIETI). The blue line in each panel is the regression line. We omit the pairs of the same industries when computing the correlation.

where L_{cjt} represents the employment of industry j at CZ c, and w^{Down}_{gjt} is industry j input share from industry g computed in the input-output table.[28][29]

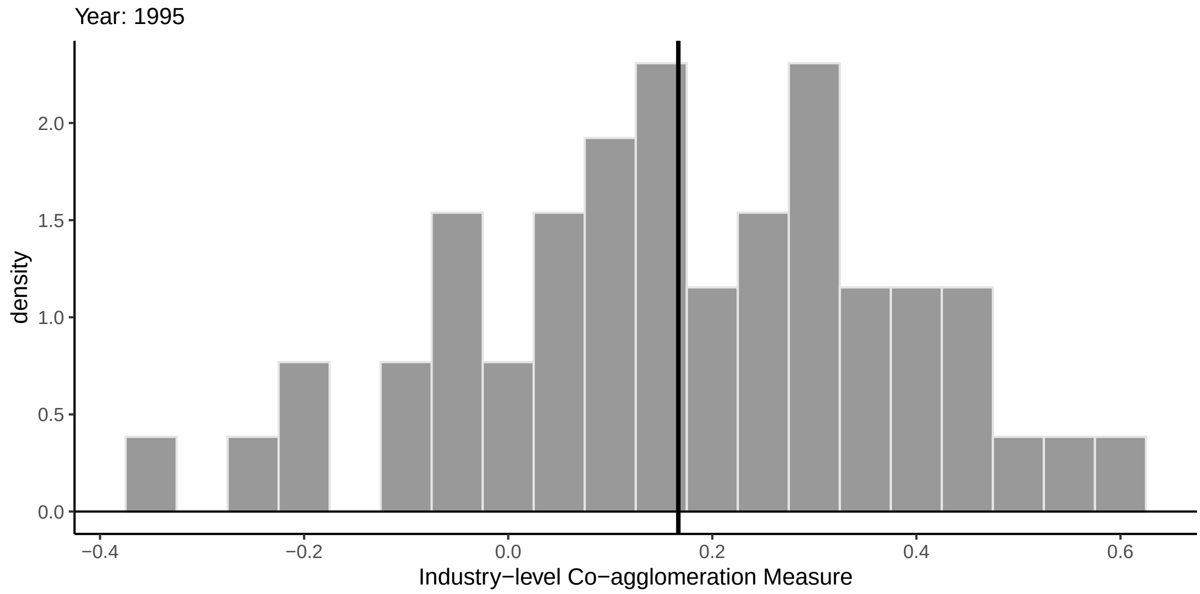
Thus, with this index, we are looking at how one industry's location in a region, measured by its employment share in the region, is correlated with other industries' weighted by the degree of their importance as inputs in one's production. Figure 7 shows the distribution of this industry-level co-location measure as of 1997. As can be seen, the degree of this co-location varies significantly across industries. Table 7 presents the list of JIP industries ordered by this measure.

Exploiting the variation of Equation 11, we classify the industries into two groups and decompose the import penetration measures based on the groups: those with high

[28]This is exactly the same weight used in constructing the downstream import penetration measure. Its formal definition is given in Equation 8.

[29]As indicated in Equation 11, the summation of industry g's employment share weighted by the input share (the right one in the bracket) does not run over industry j.

Figure 7: Distribution of Industry Co-location Measure



Notes: The figure presents the distribution of the co-location measure of each JIP industry as of year 1995, defined in Equation 11. It is computed using the data from the Census of Manufacture (METI) and the JIP Database (RIETI). The vertical black line represents its median value, hence the industries in the right part of the histogram from this line are classified into the high co-location group while the left is the low group.

co-location with the suppliers and the rest with relatively low co-location. Formally, we define the direct import penetration measure for each group as follows:

$$\Delta IP_{ct}^{HighColocacation} = \sum_j \frac{L_{cjt-1}}{L_{ct-1}} \Delta IP_{jt} \cdot \mathbb{1}\{\gamma_{j1995} \geq \text{Median}(\gamma_{h1995})\},$$

$$\Delta IP_{ct}^{LowColocacation} = \sum_j \frac{L_{cjt-1}}{L_{ct-1}} \Delta IP_{jt} \cdot (1 - \mathbb{1}\{\gamma_{j1995} \geq \text{Median}(\gamma_{h1995})\})$$

Likewise, the downstream and upstream import penetration measures, as well as the corresponding instruments, are all decomposed according to γ_{j1995}. Note that we set the year measuring the co-agglomeration to 1995 to exploit the industry characteristics in advance to the import penetration growth. Table 8 shows the summary statistics of these decomposed import penetration measures for the long run between 1997 and 2014.

Results Table 9 presents the results of estimating Equation 2 and Equation 6 by replacing the import penetration measures with the decomposed measures defined above. We here focus on the long run and pooled shorter-term dynamics between 1997 and 2014. The first and third columns, in which we simply include the direct import penetration

Table 7: List of JIP Industries Ordered by Co-agglomeration Measure

JIP Code: High	Coagg. Measure: High	JIP Code: Low	Coagg. Measure: Low
25	0.577	9	-0.345
19	0.566	33	-0.243
37	0.509	16	-0.202
44	0.444	11	-0.186
29	0.441	35	-0.105
43	0.440	31	-0.081
41	0.422	15	-0.042
47	0.411	8	-0.030
55	0.385	56	-0.027
45	0.367	34	-0.027
42	0.363	36	0.013
26	0.337	32	0.022
24	0.324	12	0.027
54	0.307	18	0.028
57	0.288	10	0.034
48	0.283	38	0.053
28	0.281	14	0.082
40	0.276	20	0.084
46	0.259	58	0.100
52	0.245	59	0.113
51	0.242	22	0.121
27	0.237	13	0.131
23	0.222	17	0.142
49	0.221	39	0.143
50	0.220	30	0.152
53	0.172	21	0.161

Notes: This table reports the list of JIP2006 manufacturing industries and their corresponding values of γ_{j1995}, defined in Equation 11. It is calculated with the data from the Census of Manufacture (METI) and the JIP Database (RIETI). The industries are ordered by their values of γ_{j1995} descendingly and ascendingly in the left and right columns, respectively.

Table 8: Summary Statistics of Decomposed IP: 1997-2014

IP	Co-agglomeration	Mean	Sd	Min	Max
Direct	High	3.225	1.585	0.000	13.005
	Low	2.299	1.038	0.000	9.462
Up	High	1.250	0.766	0.000	7.084
	Low	0.552	0.148	0.000	2.284
Down	High	0.726	0.289	0.000	1.843
	Low	0.334	0.076	0.000	1.071

Notes: This table reports the summary statistics of the decomposed import penetration measures at the CZ-level for the long difference (1997-2014). The decomposition is based on whether an industry's γ in Equation 11 is below its median value or not. These are computed using the data from the Census of Manufacture (METI) and the JIP Database (RIETI). When computing each statistic, observations are weighted by the start of period share of the national population.

measures in the model, show that while the estimated coefficient on both regressors are negative, the absolute values are smaller for high co-agglomeration group and the coefficient is statistically insignificant for pooled short-term specification. Once adding the

Table 9: Decomposing IP by Co-agglomeration: Long Difference & Stacked 2SLS

	1997-2014	1997-2014	3 Periods Pooled	3 Period Pooled
Direct IP: High Co-agg.	-0.04^{**}	-0.16^{***}	-0.02	-0.10^{***}
	(0.02)	(0.04)	(0.02)	(0.04)
Upstream IP: High Co-agg.		0.02		-0.06
		(0.03)		(0.04)
Downstream IP: High Co-agg.		0.72^{***}		0.51^{***}
		(0.21)		(0.18)
Direct IP: Low Co-agg.	-0.09^{***}	-0.07^{***}	-0.05^{***}	-0.03^{***}
	(0.02)	(0.02)	(0.01)	(0.01)
Upstream IP: Low Co-agg.		-0.18		0.03
		(0.13)		(0.22)
Downstream IP: Low Co-agg.		0.29		-0.18
		(0.37)		(0.43)
CZ-level Control	✓	✓	✓	✓
Period FE			✓	✓
R^2	0.39	0.40	0.46	0.43
Adj. R^2	0.38	0.38	0.46	0.42
Num. obs.	331	331	993	993

Notes: This table reports the result of estimating Equation 2 and Equation 6 by replacing the import penetration measures with the decomposed measures based on Equation 11 for the long difference (1997-2014) and three periods pooled (1997-2002, 2002-2007, and 2009-2014). The unit of observation is the CZ as of October 1, 2005. All columns are estimated with two stage least squares with which the import penetration variables are instrumented as discussed in the text. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are in parentheses while are clustered at the CZ-level in the pooled models. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

downstream and upstream measures to the model in the second and fourth columns, however, we observe that the absolute value of estimated coefficients on the direct measure for high co-agglomeration group become larger and that the coefficients of the downstream measure are positive and statistically significant, as we expect: direct effect is plausibly mitigated by the effect on downstream industries. This is the pattern that has appeared in the previous section. Yet, this is not the case for the low co-agglomeration group. We observe a statistically significant estimate only on the direct measure, i.e., no effect via downstream nor upstream channels. Hence, this indicates that the results obtained in the previous section are mainly driven by the industries in the high co-agglomeration group.

Table 10 shows the same analysis but for each shorter period. While there is heterogeneity across time periods in the estimation results, we still observe the similar patterns as in Table 9. Therefore, the shock mitigation mechanism through industry co-agglomeration seems to be a plausible explanation to the pattern we have observed in the previous section.

Table 10: Decomposing IP by Co-agglomeration: Period-wise 2SLS

	1997-2002	1997-2002	2002-2007	2002-2007	2009-2014	2009-2014
Direct IP: High Co-agg.	-0.077^{**}	-0.028	-0.017	-0.256	-0.046^{***}	-0.088^{***}
	(0.034)	(0.170)	(0.047)	(0.245)	(0.016)	(0.033)
Up IP: High Co-agg.		0.003		0.019		-0.081
		(0.096)		(0.145)		(0.050)
Down IP: High Co-agg.		0.561		1.026		0.307^{**}
		(0.772)		(0.830)		(0.143)
Direct IP: Low Co-agg.	-0.171^{***}	-0.499^{*}	-0.042^{***}	-0.004	-0.043^{**}	-0.033
	(0.037)	(0.257)	(0.012)	(0.025)	(0.019)	(0.022)
Up IP: Low Co-agg.		-0.537		0.004		0.336
		(0.380)		(0.328)		(0.382)
Down IP: Low Co-agg.		7.619		-0.016		-0.457
		(4.625)		(0.793)		(0.474)
CZ-level Control	✓	✓	✓	✓	✓	✓
R^2	0.267	-0.634	0.228	0.088	0.267	0.137
Adj. R^2	0.251	-0.690	0.211	0.056	0.251	0.107
Num. obs.	331	331	331	331	331	331

Notes: This table reports the result of estimating Equation 2 and Equation 6 by replacing the import penetration measures with the decomposed measures based on Equation 11 for the four different time periods: 1997-2014, 1997-2002, 2002-2007, and 2009-2014, separately. The unit of observation is the CZ as of October 1, 2005. All columns are estimated with two stage least squares with which the import penetration variables are instrumented as discussed in the text. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

5 Conclusion

In this paper, we examine the question of how the imports from China affect local labor markets, focusing on Japanese manufacturing employment. The recent several decades are characterized as the rapid and massive growth of the imports from China in developed countries, widely called the *China Shock*, involving the drastic transformation of the economies. To identify the regional-level impact of the increases in the imports from China, we employ the econometric method based on Autor, Dorn, and Hanson (2013) and Acemoglu, Autor, et al. (2016), exploiting the variations in the degree of the import penetration across industries and in the local industry structure across regions. The regional unit of our analysis is the commuting zone, a cluster of municipalities, proposed by Adachi et al. (2020). This is geographically smaller than typically-used prefecture that presumably contains multiple labor markets. Also, we use the input-output table to explicitly incorporate shock propagation through supply chains. Constructing the upstream and downstream measures in addition to the original penetration variable, we estimate the differential effects of the direct and indirect channels.

Through our empirical investigation, we find that in the relatively long term, the net local employment impact is plausibly negative, in contrast to the prefectural level research (Taniguchi, 2019). We further obtain the coefficient estimates in accordance with the negative direct import competition and the positive downstream effects but no such result for the upstream channel. From these two results, we argue that the lack of consideration on this shock propagation leads to the underestimation of the direct effect on local employment. Besides, we construct the industry-level co-agglomeration measure with their suppliers and use it to classify the industries into the relatively high and low co-agglomeration. Decomposing the import penetration measures based on this industry classification, we show the results suggesting that industry co-agglomeration possibly work as a mitigation channel against the import shock, offsetting the negative direct impact by the positive downstream effect.

This paper, therefore, presents evidence that while the import competition indeed reduces local employment, Japanese local labor markets also benefit from the improved availability of the intermediate inputs through imports. The net local employment effect seems to stem from the balance between these two opposite effects and, at least, the CZ-level employment impact is likely to be a net negative. Our result is in agreement with the establishment- and product-level analyses by Hayakawa et al. (2019), indicating that the direct and indirect propagated effects worked even at the local labor-market level. Moreover, we complement Taniguchi (2019)'s result that the intermediate imports from China may be favorable to the Japanese manufacturers, by explicitly showing the positive supply chain shock propagation to the downstream. Consistent with her emphasis on the intermediate imports as a possible key factor to distinguish Japan from other countries, our findings imply that the trade structure between Japan and China may drive the difference between our result in Japan and the US case, in which positive downstream effect is observed primarily in *non*-manufacturing but not in manufacturing sectors (Acemoglu, Autor, et al., 2016; Wang et al., 2018).

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6 Appendix

6.1 Import Penetration by Period

Table 11: Industries with Highest Penetration By Time Period

(a) 1997-2002

JIP	Name	Imp.Penet.	Final.Share	Upstream	EG.Agglome
48	Electronic data processing machines, digital and analog computer equipment and accessories	0.0709	0.8790	1.1794	0.0147
15	Textile products	0.0476	0.5806	2.0511	0.0083
47	Household electric appliances	0.0436	0.8133	1.3076	0.0045
21	Leather and leather products	0.0346	0.7819	1.7222	0.0518
52	Electronic parts	0.0216	0.1924	2.5705	0.0064
59	Miscellaneous manufacturing industries	0.0213	0.5405	2.0001	0.0040
17	Furniture and fixtures	0.0183	0.3344	2.1734	0.0051
57	Precision machinery and equipment	0.0169	0.7410	1.4726	0.0086
53	Miscellaneous electrical machinery equipment	0.0158	0.3259	2.4315	0.0033
46	Electrical generating, transmission, distribution and industrial apparatus	0.0153	0.7249	1.4631	0.0029

(b) 2002-2007

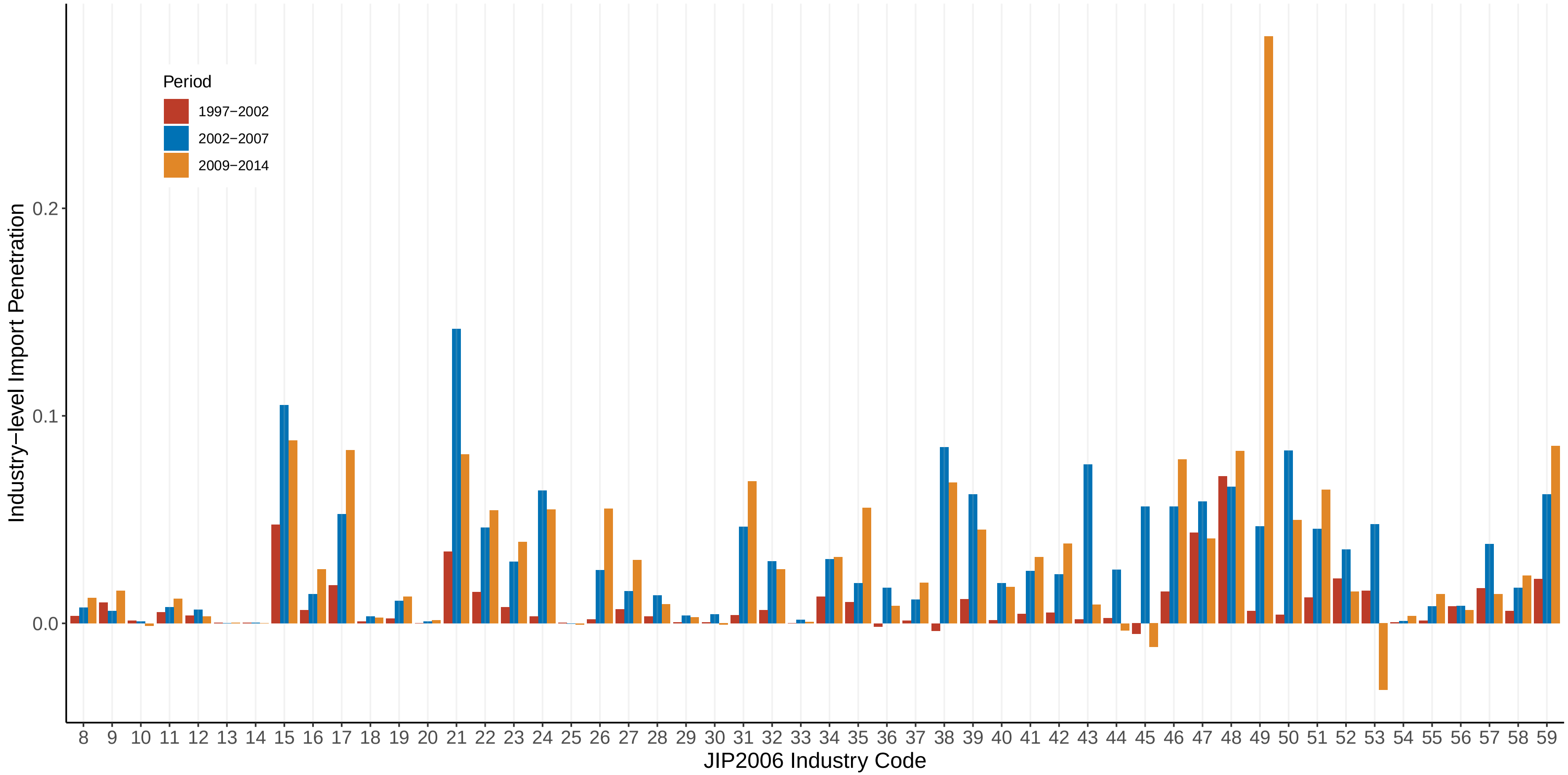
JIP	Name	Imp.Penet.	Final.Share	Upstream	EG.Agglome
21	Leather and leather products	0.1419	0.7840	1.9565	0.0555
15	Textile products	0.1053	0.5831	2.3151	0.0081
38	Smelting and refining of non-ferrous metals	0.0849	0.1115	5.9943	0.0035
50	Electronic equipment and electric measuring instruments	0.0833	0.8813	1.1972	0.0141
43	Special industry machinery	0.0767	0.8020	1.3421	0.0022
48	Electronic data processing machines, digital and analog computer equipment and accessories	0.0658	0.9322	1.1165	0.0096
24	Basic inorganic chemicals	0.0641	0.1093	3.7503	0.0064
59	Miscellaneous manufacturing industries	0.0622	0.5457	2.0370	0.0045
39	Non-ferrous metal products	0.0621	0.1698	2.8603	0.0033
47	Household electric appliances	0.0588	0.8173	1.3270	0.0055

(c) 2009-2014

JIP	Name	Imp.Penet.	Final.Share	Upstream	EG.Agglome
49	Communication equipment	0.2829	0.5679	1.9962	0.0087
15	Textile products	0.0882	0.6163	2.4644	0.0082
59	Miscellaneous manufacturing industries	0.0854	0.5814	1.9753	0.0036
17	Furniture and fixtures	0.0835	0.2281	2.6334	0.0024
48	Electronic data processing machines, digital and analog computer equipment and accessories	0.0830	0.9635	1.0556	0.0050
21	Leather and leather products	0.0815	0.8297	1.9867	0.0518
46	Electrical generating, transmission, distribution and industrial apparatus	0.0791	0.7509	1.4601	0.0017
31	Coal products	0.0684	0.0402	3.4543	-0.0021
38	Smelting and refining of non-ferrous metals	0.0678	0.2933	4.7517	-0.0002
51	Semiconductor devices and integrated circuits	0.0643	0.3427	2.5243	0.0048

Notes: This table shows the ten industries that exhibit the highest import penetration, defined in Equation 1, in each of the three shorter periid: 1997-2002, 2002-2007, and 2009-2014. The industries are ordered descendingly by the import penetration abreviated as *Imp. Penet. Final.Share* the share of final demand to which each industry's output goes, *Upstream* the upstreamness of each industry computed based on Antràs, Chor, et al. (2012), and *EG.Agglome* the Ellison and Glaeser industry agglomeration index proposed by Ellison and Glaeser (1997). The import penetration measure, the final demand share and the upstreamness index are computed with the input-output table in the JIP Database (RIETI). We calculate EG agglomeration index using the establishment data of the Census of Manufacture (METI). All of these values except the import penetration are computed as of 1997. The last column shows the sample mean of the corresponding measures.

Figure 8: Import Penetration at JIP Industry-level by Period



Notes: The figure presents the industry-level Chinese import penetration, defined in Equation 1, for three different periods: 1997-2002, 2002-2007, and 2009-2014. The industries shown are all in the manufacturing sector, coded with the JIP2006 Industry Classification. We create this using Japan's import data and the industry absorption computed with the input-output table in each start of period, both taken from the JIP Database (RIETI). The list of the JIP2006 industries in Manufacturing sector, with their codes, is in the Appendix.

6.2 Results of OLS and First-Stage of 2SLS

Table 12: Log-Difference of Manufacturing Employment: OLS

	1997-2014	1997-2002	2002-2007	2009-2014
Import Penetration	-0.05^{***}	-0.09^{***}	-0.02^{**}	-0.03^{***}
	(0.01)	(0.01)	(0.01)	(0.01)
CZ-level Control	✓	✓	✓	✓
R^2	0.39	0.29	0.22	0.28
Adj. R^2	0.37	0.28	0.21	0.27
Num. obs.	331	331	331	331

Notes: This table reports the result of estimating Equation 2 by OLS for the four different time periods: 1997-2014, 1997-2002, 2002-2007, and 2009-2014, separately. The unit of observation is the CZ as of October 1, 2005. All columns are estimated with ordinary least squares. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Table 13: Log-Difference of Manufacturing Employment: OLS with Up/Downstream

	1997-2014	1997-2002	2002-2007	2009-2014
Import Penetration	-0.08^{***}	-0.11^{***}	-0.03^{***}	-0.03^{***}
	(0.01)	(0.01)	(0.01)	(0.01)
Upstream IP	-0.01	-0.10^{*}	-0.04	-0.09^{***}
	(0.02)	(0.06)	(0.04)	(0.03)
Downstream IP	0.35^{***}	0.58^{***}	0.28^{***}	0.12^{*}
	(0.12)	(0.17)	(0.10)	(0.06)
CZ-level Control	✓	✓	✓	✓
R^2	0.42	0.32	0.26	0.32
Adj. R^2	0.41	0.31	0.24	0.30
Num. obs.	331	331	331	331

Notes: This table reports the result of estimating Equation 6 by OLS for the four different time periods: 1997-2014, 1997-2002, 2002-2007, and 2009-2014, separately. The unit of observation is the CZ as of October 1, 2005. All columns are estimated with two stage least squares with which the import penetration variables are instrumented as discussed in the text. Our CZ-level controls include manufacturing employment share, IT investment flow, female labor force participation rare, the share of college graduates in population, and the share of foreign-born population, all at the start of period. Observations are weighted by the CZ share of national population at each start of period. Robust standard errors are in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Table 14: 1st-Stage Regressions for Import Penetration Measures: 1997-2014

	Direct IP	Direct IP	Upstream IP	Downstream IP
IV: Direct IP	0.015^{***}	0.014^{***}	0.000^{*}	0.000^{**}
	(0.001)	(0.001)	(0.000)	(0.000)
IV: Upstream IP		0.006^{***}	0.016^{***}	-0.000^{***}
		(0.001)	(0.000)	(0.000)
IV: Downstream IP		-0.009	-0.006^{**}	0.022^{***}
		(0.011)	(0.002)	(0.001)
Manufacture-Emp Share	-2.300	-1.126	-0.866	-0.232
	(3.092)	(2.785)	(0.609)	(0.291)
IT Investment Flow	1.415	0.554	3.475^{***}	0.596
	(4.520)	(4.352)	(0.982)	(0.480)
Fem. Lab. Par. rate	1.680	1.068	0.227	0.146
	(2.122)	(2.161)	(0.348)	(0.168)
College graduate share	-9.007^{***}	-6.805^{***}	0.907	-0.139
	(2.201)	(2.573)	(0.581)	(0.302)
Foreign population share	-0.940	-0.296	-2.446	0.958
	(14.800)	(13.290)	(2.222)	(1.168)
Intercept	2.058^{**}	2.014^{**}	0.061	0.043
	(0.974)	(1.017)	(0.158)	(0.073)
R^2	0.777	0.796	0.953	0.951
Adj. R^2	0.773	0.791	0.951	0.950
Num. obs.	331	331	331	331

Notes: This table reports the result of the first stage regressions for each import penetration measure on the instruments and control, for the long difference (1997-2014). The unit of observation is the CZ. The rows with IV indicate the coefficients of the corresponding instruments described in the text. The other variables, except the period dummies and intercept, are the ones at the start of period. Observations are weighted by the CZ share of national population at the start of period. Robust standard errors are in parentheses. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

6.3 JIP 2006 Industry Classification

Table 15: List of JIP2006 Industry in Manufacturing Sector

JIP Code	JIP Name	1997-2014	1997-2002	2002-2007	2009-2014
8	Livestock products	0.014	0.004	0.008	0.012
9	Seafood products	0.010	0.010	0.006	0.016
10	Flour and grain mill products	0.001	0.001	0.001	-0.001
11	Miscellaneous foods and related products	0.021	0.005	0.008	0.012
12	Prepared animal foods and organic fertilizers	0.012	0.004	0.007	0.003
13	Beverages	0.000	0.000	0.000	0.000
14	Tobacco	0.000	0.000	0.000	0.000
15	Textile products	0.139	0.048	0.105	0.088
16	Lumber and wood products	0.018	0.006	0.014	0.026
17	Furniture and fixtures	0.078	0.018	0.053	0.084
18	Pulp, paper, and coated and glazer paper	0.009	0.001	0.003	0.003
19	Paper products	0.022	0.002	0.011	0.013
20	Printing, plate making for printing and bookbinding	0.002	0.000	0.001	0.001
21	Leather and leather products	0.155	0.035	0.142	0.082
22	Rubber products	0.084	0.015	0.046	0.055
23	Chemical fertilizers	0.046	0.008	0.030	0.039
24	Basic inorganic chemicals	0.061	0.003	0.064	0.055
25	Basic organic chemicals	-0.000	0.000	-0.000	-0.001
26	Organic chemicals	0.048	0.002	0.026	0.055
27	Chemical fibers	0.026	0.007	0.016	0.030
28	Miscellaneous chemical products	0.018	0.003	0.013	0.009
29	Pharmaceutical products	0.010	0.000	0.004	0.003
30	Petroleum products	0.001	0.000	0.004	-0.001
31	Coal products	0.034	0.004	0.047	0.068
32	Glass and its products	0.039	0.006	0.030	0.026
33	Cement and its products	0.001	0.000	0.002	0.001
34	Pottery	0.043	0.013	0.031	0.032
35	Miscellaneous ceramic, stone and clay products	0.043	0.010	0.019	0.056
36	Pig iron and crude steel	0.005	-0.002	0.017	0.008
37	Miscellaneous iron and steel	0.016	0.001	0.011	0.020
38	Smelting and refining of non-ferrous metals	0.049	-0.004	0.085	0.068
39	Non-ferrous metal products	0.062	0.012	0.062	0.045
40	Fabricated constructional and architectural metal products	0.025	0.002	0.019	0.018
41	Miscellaneous fabricated metal products	0.036	0.005	0.025	0.032
42	General industry machinery	0.045	0.005	0.024	0.038
43	Special industry machinery	0.042	0.002	0.077	0.009
44	Miscellaneous machinery	0.014	0.003	0.026	-0.003
45	Office and service industry machines	0.020	-0.005	0.056	-0.011
46	Electrical generating, transmission, distribution and industrial apparatus	0.080	0.015	0.056	0.079
47	Household electric appliances	0.196	0.044	0.059	0.041
48	Electronic data processing machines, digital and analog computer equipment and accessorties	0.256	0.071	0.066	0.083
49	Communication equipment	0.450	0.006	0.047	0.283
50	Electronic equipment and electric measuring instruments	0.087	0.004	0.083	0.050
51	Semiconductor devices and integrated circuits	0.180	0.012	0.046	0.064
52	Electronic parts	0.073	0.022	0.036	0.015
53	Miscellaneous electrical machinery equipment	0.013	0.016	0.048	-0.032
54	Motor vehicles	0.004	0.001	0.001	0.004
55	Motor vehicles parts and accessories	0.020	0.001	0.008	0.014
56	Other transportation equipment	0.023	0.008	0.008	0.006
57	Precision machinery and equipment	0.044	0.017	0.038	0.014
58	Plastic products	0.036	0.006	0.017	0.023
59	Miscellaneous manufacturing industries	0.102	0.021	0.062	0.085

Notes: This table presents the list of manufacturing industries in JIP2006 classification and the degrees of their import penetration at each specified period. For the classification of manufacturing and non-manufacturing, we follow Taniguchi (2019). We compute the degrees of the import penetration according to Equation 1, using the data from and the JIP Database (RIETI). The original list of the industry classification is available on the JIP Database (RIETI).