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The China shock and job reallocation in Japan

Masahiro Endoh[1]

Faculty of Business and Commerce, Keio University, 2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan

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ABSTRACT

This study investigates the characteristics of manufacturing job reallocation in Japan induced by import shocks from China during 1996–2016. Three types of import shocks are considered: direct, upstream, and downstream. Some salient features of job reallocation include decrease in total jobs from direct import, increase in small establishments' jobs from downstream import, and job changes mainly induced establishments' entry and exit. The sizeable difference of implied job changes in industry-level analysis and those in region-level analysis attributes to the local reallocation and aggregate demand effects determined by regional characteristics. The total job effect of three import shocks is negative in all cases examined. The method of decomposing job changes into detailed job flows and further into industry and regional factors, proposed in this study, enabled obtaining a clearer view of job reallocation and how import shocks travel through labor market.

1. Introduction

The impact of import shocks on our economy has long been investigated steadily, and the interest in this research field was reignited by Autor et al. (2013) (hereafter, ADH). One of the key reasons for the success of this study is that they focused on the impacts on region-level outcomes. Using region as an observation unit allows for a comprehensive view of trade impacts including the direct impact of import shocks on exposed industries, indirect impact from input–output linkages, reallocation effects of the factors of production, and demand effects through regional multipliers, as classified by Acemoglu et al. (2016) (hereafter, AADHP). This benefit is enhanced by using well-defined, autonomous regions that have little mutual interaction in terms of the dependent variable of interest, such as commuting zones in the case of local employment. Recent studies have succeeded in uncovering the local impact of import shocks on a wide spectrum of topics, including the economic, political, and social outcomes of such shocks.[2]

After ADH's publication, which used import from China as an import shock (the "China shock") to observe the effect on the number of U.S. regional manufacturing jobs competing directly with Chinese imports, many researchers extended their analysis to incorporate the aspects of (a) indirect import effects from upstream and downstream industries through input–output linkage and (b) job creation and destruction using establishment- or firm-level data. AADHP and Asquith et al. (2019) are two examples of this extension using U.S. data. AADHP conducted both region- and industry-level analyses to examine how the China shock directly and indirectly brought about changes in the number of jobs, revealing that the indirect import effect from downstream industries (they call it "upstream effect") additionally decreased the number of jobs, whereas the indirect import effect from upstream industries ("downstream effect") had little impact. Asquith et al. (2019) claimed that the China shock to the local labor market accelerated job destruction mainly by promoting establishment exits and additionally

E-mail address: endoh@keio.jp.

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[2] Examples of region-level analyses concerning import impacts include works on the effect of import shocks by ADH, Dauth et al. (2014), and AADHP on manufacturing employment; Autor et al. (2020) and Blanchard et al. (2019) on election results; Fan et al. (2020), Pierce and Schott (2020), and Fernández Guerrico (2021) on health outcomes and mortality; Dix-Carneiro et al. (2018) and Dell et al. (2019) on crime levels; and Autor et al. (2019) on marriage.

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by accelerating job contractions in the surviving establishments, but it had little effect on job creation. The present study is on this strand of literature, and the aim is to incorporate two directions in which this analysis of the Japanese local labor market is extended: the characteristics of local manufacturing job reallocation induced directly and indirectly by the China shock, using Japanese data.[3]

Some studies have clarified that the reactions of the Japanese local labor markets to the China shock were different from those of the U.S. The most salient difference is that the downstream effect or the intermediate import increased the number of manufacturing jobs in Japan as reported by Taniguchi (2019) and Kainuma and Saito (2022) using region-level data; Kiyota et al. (2021), industry-level data; and Hayakawa et al. (2021), firm-level data. Their interpretation is that intermediate input goods for Japanese production occupy a large share of imports from China, and they help Japanese firms in downstream industries to compete and survive. This view is supported by the fact that Japanese multinational firms have developed dense production networks in Asia through foreign direct investment and outsourcing, and China occupies a pivotal place in the network. Regarding the impact of the China shock on job flows, Hayakawa et al. (2021) reported that it decreased Japanese manufacturing jobs by promoting firms' exit but had little effect on the number of jobs in firms maintaining operation. This finding is different from that accounted by Asquith et al. (2019), who show that the China shock promoted both exit of establishments and job contractions in surviving establishments in the U.S. However, it is similar to the results of Tomiura (2004), who used Japanese industry-level dataset to find that the employment adjustment associated with plant entry and exit is significantly sensitive to import price changes, but the adjustment by surviving plants within the same industries is not.

Industry-level approach has long been utilized for investigating the impact of import shocks on the number of domestic employment while region-level data are used frequently in recent studies. AADHP explain the difference of spheres where these two analyses cover the components of the employment effect. Industry-level approach captures the direct impact on exposed industries plus the indirect impact on linked industries, and region-level approach encompasses the reallocation effect of employment from contracting to expanding industries and the aggregate demand effect representing the impact of Keynesian-type local multipliers as well as direct and indirect impacts. This perspective enables to observe the local adjustment of import shocks, and AADHP calculate the magnitude using the U.S. data. Based on their estimation, industry-level analysis provides the implied number of job losses owing to the increase of the China shock as 1.98 million, including both manufacturing and non-manufacturing industries, between 1999 and 2011; the region-level analysis calculates the number as 2.35 million. Then the sum of regional reallocation effect and aggregate demand effect corresponds to the modest loss of 0.37 million jobs. Asquith et al. (2019) also estimate the net change of job loss in the U.S. owing to direct import shocks from China from 1992 to 2007, using both industry-level and region-level analyses. The former result reveals a decrease of 0.48 million jobs in manufacturing sector and the latter, a decrease of 1.93 million jobs in tradable industries, indicating that the sum of two regional effects in manufacturing sector is 1.45 million jobs, much larger than the result of AADHP.

Based on these results, this study aims to present a comprehensive argument about the impact of the China shock on the dynamics of Japanese manufacturing job reallocation. Both industry- and region-level job flow observations are used in the analysis of direct, upstream, and downstream China shocks. Concerning job flows, by dividing net job flows into categories of job creation and job destruction and further dividing them into groups of job flows in continuing establishments and those entering or exiting the market by establishment-size groups, a better understanding can be obtained of the channels through which trade shocks influence net job flows and the extent of the effect. This research framework will help to establish that (a) direct import shock decreases manufacturing jobs in both small and large establishments to a similar degree, (b) downstream shock increases jobs especially in small establishments in region-level analysis, and (c) job changes are mainly induced by establishments' entry and exit. Implied employment changes induced by three import shocks are different between industry- and region-level analyses. This indicates that local reallocation and aggregate demand effects are relatively large in Japan, consistent with Asquith et al. (2019).

For a more precise understanding of how the three types of import shock affect job flows, this study proposes a useful method: decompose each job flow into industry- and region-specific factors and use them as dependent variables. This helps in observing how direct and indirect import shocks affect job flows based on industry and regional characteristics. The methodology of decomposition proposed by Amiti and Weinstein (2018) (hereafter, AW) is applied here. AW used this method to investigate bank–firm loan movements through a separate identification of time-varying bank-supply shocks and firm-borrowing shocks. This study is one of the first to apply this methodology to another field of interest. By applying this method, the present study finds that regional direct import additionally decreases employment in both small and large establishments by activating their job destruction, and regional downstream import additionally reduces small establishments' job reallocation by impeding both job creation and destruction.

Besides the impact of the China shock on Japanese manufacturing jobs, three threads of research are also closely related to the subject of this paper: (a) the impact of trade with China on the number of jobs in the economy, (b) job creation and destruction by establishments, and (c) worker reallocation attributable to international trade.

The first is the impact of trade with China on the number of jobs in the whole economy. ADH's influential study and the works of several other researchers have extended this topic in various directions to understand the comprehensive employment effect of international trade. One of the earliest examples is Dauth et al. (2014), who considered both import and export sides and found that a sharp increase in German trade with China and Eastern Europe increased German manufacturing jobs. Additionally, some studies proposed that the direct negative effect of import shocks on manufacturing employment was more than offset by the positive effect of import shocks on the non-manufacturing sector and export shocks (Donoso et al., 2015; Feenstra and Sasahara, 2018; Wang et al., 2018; Feenstra et al., 2019; Kiyota et al., 2021). Since job flows play a key role in the causal link between international trade and welfare, this study aims to provide a detailed argument on local manufacturing job flows by considering domestic input–output linkage to obtain a more balanced view of the China shock.

One feature that differentiates this study from the extant literature is that it uses industry and regional factors of job flows as dependent variables, obtained from the decomposition method proposed by AW. An advantage of applying the AW decomposition method is that the aggregation of estimated industry and regional factors exactly replicates the economy-wide net change in manufacturing jobs, even accounting for the establishment of a new industry in a region. Another related and noteworthy benefit is that the inclusion or exclusion of an industry–region interaction term will not affect the magnitude of industry and regional factors as long as the interaction term is defined to vary at both industry and regional levels.

The second thread is related to job flows attributed to international trade. Davis and Haltiwanger (1992) produced a seminal work on job creation and destruction, and Davis et al. (1996) developed a

[3] In this study, "job" means "employment" or "worker" but emphasizes the aspect of the "post" occupied by an employee. Therefore, "job reallocation" does not represent intrafirm relocation or interfirm transfer of an employee. It rather means the increase ("job creation") and decrease of posts ("job destruction") in a firm or an establishment.

comprehensive analysis of job flows. These works also revealed that the magnitude and characteristics of job flows are affected by firms' ages and sizes, industry characteristics, and macroeconomic performance. Subsequent works analyzed the effect of other factors such as labor market regulations (Haltiwanger et al., 2014) and oil prices on job flows (Davis and Haltiwanger, 2001; Herrera and Karaki, 2015; Herrera et al., 2017). International transactions also affect job reallocation. Analyzing U.S. industry-level data, Klein et al. (2003) indicated that appreciation of the dollar resulted in a significant increase in the job destruction rate and a reduction in the net employment growth rate. Tomiura (2004) observed the heterogeneous effect of import price among various job flow modes in Japanese industries. Baumgarten (2015) showed that an increase in exports by German firms increased their local job flows. A trade model demonstrated by Kondo (2018) rationalized the finding that an increase in foreign competition is correlated with higher job destruction and lower job creation in the U.S.

Given the above, the present study on Japan and the study by Asquith et al. (2019) on the U.S. share the same interest as studies by Klein et al. (2003), Tomiura (2004), Baumgarten (2015), and Kondo (2018) regarding the effects of import shocks on job reallocation, and this study complements each analysis. First, as a supplementary analysis to the studies by Klein et al. (2003) and Tomiura (2004), which used import price variables as exogenous import shocks, import values are independent variables in this study. This is a more comprehensive way of examining the job effects of international transactions, considering that the change in import values represents the change in import quantities under the realistic assumption that a fall in import price would induce a large increase in import volume, enough to increase total import values as well. Second, the endogeneity problem of trade is addressed more directly by this method than Baumgarten (2015) by using export supplies from China as the instrumental variables (IV) for Japanese imports from the country. Third, Kondo (2018) proposed a calibration result stating that an increase in foreign competition hinders job creation in import-competing industries, a finding that is confirmed in this study from the industry-level analysis in Japan, but not observed in the U.S. by Asquith et al. (2019).

The third thread deals with worker reallocation. Empirical research analyzing trade impacts on worker reallocation has ranged from reduced-form regressions with longitudinal worker data (Autor et al., 2014; Ebenstein et al., 2014; Hummels et al., 2014) to structural estimation of the underlying parameters (Artuç et al., 2010; Dix-Carneiro, 2014; Artuç and McLaren, 2015; Coşar et al., 2016; Caliendo et al., 2019). While job destruction and job creation numbers may indicate the minimum sum of possible workers leaving and obtaining jobs over a certain period, analyzing job flows is beneficial in that it enables direct observation of the behavior of labor-demand entities. The next section shows how more than half the job creation or destruction is generated by the entry or exit of establishments. However, the dynamics of establishments as entities of labor demand are sometimes hard to grasp in the structural estimation, either because the setup of establishments is modeled but does not feature significantly, or because the behavior of establishments is estimated for those larger than a given threshold. Thus, the analysis of job flows complements that of worker reallocation to understand the labor adjustments induced by international trade.

The rest of the study is organized as follows: Section 2 provides an overview of job flows in Japan, followed by the methodology of the empirical analysis and its background information in Section 3. Section 4 presents the regression results of the import effects on each job flow and the numbers of implied job change based on the industry- and region-level analyses, which demonstrate the regional propagation effect of import shocks. Section 5 further decomposes the changes in job flows into industry and regional factors by using the AW method and uses them in regression analyses to identify salient features of local job reallocation. Finally, Section 6 concludes the research.

2. Overview of job flows in Japan

This study employs three different censuses to construct panel data that cover the population of Japanese establishments from 1996 to 2016: *the Establishment and Enterprise Census* from 1996, 1999, 2001, 2004, and 2006, *the Economic Census for Business Frame* of 2009 and 2014, and *the Economic Census for Business Activity* conducted in 2012 and 2016 (hereafter, *the Economic Census*). These censuses were conducted periodically by the Statistics Bureau, Ministry of Internal Affairs and Communications of Japan (and the Ministry of Economy, Trade, and Industry of Japan, for *the Economic Census for Business Activity*).[4] The recorded information contains details of the name, address, identification (ID) number, and the number of workers of all establishments and firms in Japan.[5] Though a different ID number is assigned to each establishment in every census, establishment panel data from 1996 to 2016 can be constructed because the censuses of 1999 and thereafter contain ID numbers of all establishments for both current and previous censuses. The establishment panel data compiled for this study comprise private establishments, displaying the number of jobs in each establishment at around five-year intervals: 1996–2001–2006–2012–2016. The number of establishment pairs recorded in each five-year period (including entries and exits) adds up to 29.3 million over all four periods (1996–2001, 2001–2006, 2006–2012, and 2012–2016) for all industries, and to 2.8 million for manufacturing industries. The corresponding numbers for the ten-year period panel data (1996–2006 and 2006–2016) are 16.6 million and 1.6 million over the two periods, respectively.[6]

Panel A in Fig. 1 shows the number of manufacturing establishments by size from 1996 to 2016. In 1996, there were about 763,000 establishments. Around half of them belonged to the category of the smallest establishments (4 or fewer jobs), while the largest category (100 or more jobs) accounted for as little as 2.4 percent of the total sample. In 2016, the total number of establishments declined by 40 percent, to about 460,000. The rates of decline during the two decades differed by establishment size category: small size categories showed

[4] The three sets of data are proprietary information of the Japanese Government and require special authorization for access, for which the necessary procedures were followed. Since the information in these datasets are confidential, no individual entry can be made public.

[5] More specifically, *the Establishment and Enterprise Census* was conducted every two to three years to collect basic information on all Japanese establishments and to serve as a master sampling framework for other official statistical surveys. This census was incorporated into two newly launched economic censuses following its last implementation in 2006. (1) *The Economic Census for Business Frame* launched in 2009, conducted around every five years, with its survey items similar to those of *the Establishment and Enterprise Census*; and (2) *the Economic Census for Business Activity* launched in 2012, also conducted approximately every five years, designed to integrate not only *the Establishment and Enterprise Census* but also other government surveys. Therefore, *the Economic Census for Business Activity* encompasses a wider range of survey items on both establishments and their head offices, including items regarding their business activities. These censuses cover all establishments except individual proprietorships in the agriculture, forestry, and fisheries sectors and establishments in the household services and foreign public affairs sectors. A combination of these three censuses is used as one census that extends across a wider period of time, because the definition of survey items is almost consistent across the three censuses used for the study and any slight change in the definition of a few items is clarified using questionnaires.

[6] Intervals for evaluating job flows are not standardized because the survey dates changed during 2012 and thereafter. The censuses in 1996, 2001, and 2006 were conducted on October 1, whereas those in 2012 and 2016 were conducted on February 1 and June 1, respectively. Therefore, the interval of evaluating job flows from 2006 to 2012 was actually 64 months, and the period of job flows from 2012 to 2016 was 52 months. For convenience, though, this study uses the terms "a five-year period" and "a ten-year period" throughout.

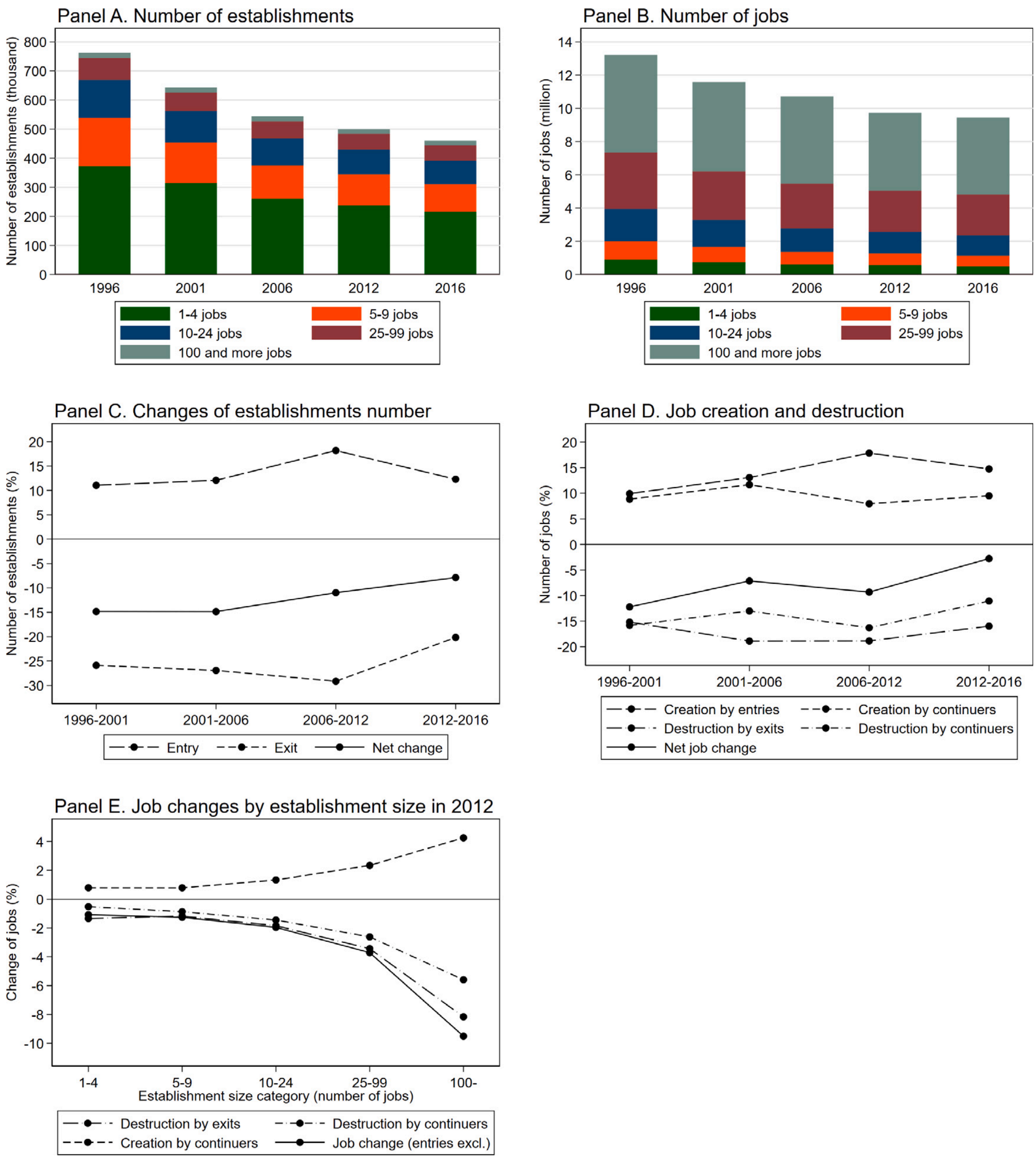

Fig. 1. Manufacturing job flows in Japan.

the largest rates of decline (43 percent for establishments with 5–9 jobs and 42 percent for establishments with 1–4 jobs), whereas the largest size category showed the lowest rate of decline (18 percent for those with 100 and more jobs).

Panel B shows the total number of jobs by establishment size during the same period. The number of jobs in an establishment is defined as the total posts occupied by workers who engaged themselves in economic activities at that establishment. These include individual proprietors, unpaid family workers, paid directors, full-time employees, contract employees, part-time workers, temporary employees, and employees loaned or dispatched from other establishments under a separate management. Employees loaned or dispatched to other establishments under separate management are excluded because they do not actually work for that establishment. There were 13.2 million manufacturing jobs in 1996, which decreased by 30 percent to 9.4 million in 2016. This rate of decline was smaller than the decline in the number of establishments (40 percent) as presented in Panel A. Thus, the average number of jobs provided by establishments increased during this period. The share of jobs by establishment size is inversely related to the rank order of the number of establishments. In 1996, jobs in the largest establishments (100 and more jobs) accounted for 44 percent, the largest share among the five establishment-size categories, whereas jobs belonging to the smallest establishments (1–4 jobs) accounted for 7 percent, the smallest. This order is the same across all five years.

Active job reallocation occurred during the steady phase of decline of both manufacturing establishments and jobs over two decades. Panel C shows the change in the number of establishments during each five-year period, defined as the ratio of change compared to the total number of establishments in the first year of the period. For example, the net decrease in establishments from 1996 to 2001 was 14.8 percent of the total number of establishments recorded in 1996, which is the sum of 11.0 percent of new business entries and 25.9 percent of recorded business exits.[7] Nearly 10 percent or more establishments entered the manufacturing sector during each period, equal to almost half the number of exits. The active entry of establishments was observed even in a sector that showed constant diminishing during the period.

Job creation and destruction across each five-year period is summarized in Panel D.[8] Created jobs are categorized into those created in new (entry) establishments and those created by continuing establishments, while destroyed jobs are divided into those eliminated by exiting establishments and those eliminated by continuing establishments.[9] Each of the four groups had a sizeable ratio compared with the ratio of net change, which vividly demonstrates the active job reallocation. For example, the total number of jobs decreased by a net of 12.2 percent from 1996 to 2001; this comprised 9.9 percent jobs created by entries, 8.8 percent created by continuers, offset by 15.2 percent jobs eliminated by exits, and 15.8 percent eliminated by continuers. The change in the number of jobs as a result of establishments' entry and exit was larger than that of continuing establishments. The increase in jobs induced by entries was larger than that of continuers in all four five-year periods, and the decrease in the number of jobs by exits was larger than that of continuers in three of the four periods. Thus, entry and exit of establishments are the dominant forces of job reallocation. In other words, the change in establishments' extensive margin is larger than the change in their intensive margin with respect to the number of manufacturing job reallocation.

The impact of job flows per establishment-size category on total job flows is illustrated in Panel E. The horizontal axis represents the five size categories of establishments (i.e., number of jobs in each establishment) in 2012, and the vertical axis represents the ratio of job flows from 2012 to 2016 to total jobs in 2012. These are induced by the continuing and exiting establishments in each category. The increase in jobs caused by entering establishments between 2012 and 2016 is not reported in Panel E because these entries did not yet exist in 2012. Panel E shows that the impact of each category on the total change in job increases as that category covers establishments with more jobs. This corresponds to the fact that the category for larger establishments has the larger share of jobs, as depicted in Panel B. The category of the largest establishments (100 or more jobs) has the largest impact on total changes in jobs. Exits and continuers in this category decrease jobs existing in 2012 by as much as 8.2 percent and 5.6 percent, respectively. The decrease of jobs by exits is larger than the decrease by continuers in all categories, implying that exits dominate in producing job losses at all establishment scales. The data in other years share the same characteristics as those recorded in Panel E.

The big picture regarding the changes in both manufacturing jobs and manufacturing establishments in Japan, as illustrated in Fig. 1, is that the extent of these changes has remained fairly stable over the past two decades, notwithstanding the many macroeconomic shocks and economic regulations. Panel C depicts the relatively large ratio of establishment entries and exits during the 2006–2012 period, which resulted from the global financial crisis of 2007–2009 and the Great East Japan Earthquake of 2011. However, establishment entries and exits do not differ greatly from the preceding or the following periods. Although some changes in labor regulations were made over the past two decades, such as modification of the employment insurance system and the imposition of working hour limits, the effects of such changes are difficult to observe in the panels, most likely owing to the piecemeal nature of their implementation.

The main findings from Fig. 1 are twofold. First, while the steady decline in manufacturing jobs is noteworthy, the job reallocation underlying this trend is more vital. Since international trade could affect both the creation and destruction of jobs, analyzing the effect of import shocks on both sides helps in illustrating a clearer picture of trade impacts on job flows. Second, the entry and exit of establishments predominate the increase and decrease of jobs through the continuing establishments. This leads to the inference that import impacts on jobs through change in establishments' extensive margin are larger than those through change in establishments' intensive margins, assuming that the import shock affects entry, exit, expansion, and contraction of establishments proportionally to their sizes.

3. Estimation method

3.1. Job flows

This study examines job flows across the ten-year windows, 1996–2006 and 2006–2016, following previous studies: most of the literature on the China shock employ decennial or longer-period job changes based on the perception that job reallocation induced by trade shocks takes years to become fully observable owing to the time-absorbing adjustment process of establishments. Let $E^e_{i,r,t}$ denote the total number of jobs in an establishment e, which is an element in a set of industry i, a set of region r, and a set of time t.[10] The total jobs in industry i at time t is defined as $E_{i,t} \equiv \sum_{e\in(i,t)} E^e_{i,r,t}$, and the total jobs in region r at time t is $E_{r,t} \equiv \sum_{e\in(r,t)} E^e_{i,r,t}$. Let $DE_{i,t}$ and $DE_{r,t}$ denote the change ratio of $E_{i,t}$ and $E_{r,t}$, respectively, from time t to $t+1$. Therefore,

$$DE_{i,t} \equiv \frac{E_{i,t+1} - E_{i,t}}{E_{i,t}} \quad \text{and} \quad DE_{r,t} \equiv \frac{E_{r,t+1} - E_{r,t}}{E_{r,t}}. \tag{1}$$

Though the definition of job changes in this study is different from that in previous China shock literature (e.g., ADH; Dauth et al., 2014; Taniguchi, 2019), where the difference in the manufacturing employment per working age population is considered, this definition is advantageous in that it allows evaluating industry and regional job changes using the same definition and therefore make them easily comparable. In addition, this definition is applicable to AW decomposition in a straightforward manner, as explained later in Section 5.

Net job changes $DE_{i,t}$ and $DE_{r,t}$ can be divided into subgroups based on establishment sizes, job creation, and job destruction. Let $E^{s,e}_{i,r,t}$ be

[7] Establishments' exit and entry include relocations to different base survey districts. When an establishment moves from one base survey district to another, it is recorded as an exit from the former district and an entry to the latter district. This definition is the same as that used in the censuses before 2006. The definition was changed in 2009, and establishments that moved are now treated as continuers, as long as they are connectable to corresponding establishments from a prior census. For consistency of definition, in this study, continuing establishments that actually moved from a different base survey district are treated as exits from their previous districts and as entries in the new districts. Though readers may reasonably observe that geographic movement of establishments should not be treated as establishment entry and exit, this study follows this definition for two reasons. First, it is impossible to distinguish the relocated establishments from observations until 2006. Second, the geographical relocation of establishments often accompanies relieving and hiring of employees, which are important factors of job reallocation.

[8] In this study, the establishment is chosen as the unit to define job creation and job destruction. Using both establishments and firms as units of analysis has benefits in that it enables us to observe reallocation both across and within firms, as Fort et al. (2018) described. However, in this research, the establishment is used as a unit to perceive the total impact of trade shocks on job flows, regardless of whether these are recorded across or within firms.

[9] Throughout this research, job destruction is indicated by negative figures. Many previous studies about job reallocation, such as Davis and Haltiwanger (1992), Davis et al. (1996), Herrera and Karaki (2015), and Asquith et al. (2019), expressed job destruction using positive figures while in this study, negative figures are used to maintain consistency with job creation by applying the framework explained in the next section and interpreting the results.

[10] This study uses establishment-level industry classification in preference to firm-level classification. When the industry of an establishment at the beginning of a ten-year period differs from that at the end of a period, that establishment is classified as an industry in the beginning year.

the number of jobs in an establishment e of size s. $E^s_{i,t} \equiv \sum_{e\in(i,t)} E^{s,e}_{i,r,t}$ and $E^s_{r,t} \equiv \sum_{e\in(r,t)} E^{s,e}_{i,r,t}$ are the total jobs in establishments of size s in industry i and in region r, respectively, at time t. Then, the change ratio of $E^s_{i,t}$ and $E^s_{r,t}$ from time t to $t+1$, expressed as $DE^s_{i,t}$ and $DE^s_{r,t}$, are defined as

$$DE^s_{i,t} \equiv \frac{E^s_{i,t+1} - E^s_{i,t}}{E_{i,t}} \quad \text{and} \quad DE^s_{r,t} \equiv \frac{E^s_{r,t+1} - E^s_{r,t}}{E_{r,t}}.$$

$DE^s_{i,t}$ and $DE^s_{r,t}$ are not the change ratios of $E^s_{i,t}$ and $E^s_{r,t}$ themselves, but these definitions can be conveniently expressed as $\sum_s DE^s_{i,t} = DE_{i,t}$ and $\sum_s DE^s_{r,t} = DE_{r,t}$.

Job creation and job destruction, by all establishments and by establishment size s specifically, are defined as follows. When comparing the number of jobs in each establishment of size s in the beginning year, $E^{s,e}_{i,r,t}$, and in the end year, $E^{s,e}_{i,r,t+1}$, of each ten-year period, we denote $E^{s,e+}_{i,r,t}$ and $E^{s,e+}_{i,r,t+1}$ if $E^{s,e}_{i,r,t} < E^{s,e}_{i,r,t+1}$ (job creation) and $E^{s,e-}_{i,r,t}$ and $E^{s,e-}_{i,r,t+1}$ if $E^{s,e}_{i,r,t} > E^{s,e}_{i,r,t+1}$ (job destruction). The procedure of summation and the definition of changes in job creation and destruction of establishments of size s are the same as those for net job flows, which are explained here in terms of industry-level changes. For establishments of size s in industry i at time t, $E^{s+}_{i,t} \equiv \sum_{e\in(i,t)} E^{s,e+}_{i,r,t}$ for job creation and $E^{s-}_{i,t} \equiv \sum_{e\in(i,t)} E^{s,e-}_{i,r,t}$ for job destruction. In addition, their change ratios are:

$$DE^{s+}_{i,t} \equiv \frac{E^{s+}_{i,t+1} - E^{s+}_{i,t}}{E_{i,t}} \quad \text{and} \quad DE^{s-}_{i,t} \equiv \frac{E^{s-}_{i,t+1} - E^{s-}_{i,t}}{E_{i,t}}.$$

$DE^s_{i,t} = DE^{s+}_{i,t} + DE^{s-}_{i,t}$ holds from the definitions. Summing these values over establishment sizes in industry i at time t, we derive $E^+_{i,t} \equiv \sum_s E^{s+}_{i,t}$, $E^-_{i,t} \equiv \sum_s E^{s-}_{i,t}$,

$$DE^+_{i,t} \equiv \frac{E^+_{i,t+1} - E^+_{i,t}}{E_{i,t}} \quad \text{and} \quad DE^-_{i,t} \equiv \frac{E^-_{i,t+1} - E^-_{i,t}}{E_{i,t}}.$$

Again, from the definition, $DE_{i,t} = DE^+_{i,t} + DE^-_{i,t}$. The same procedure is applicable for the sum of the establishments in region r.

3.2. Import variables

Fig. 2 represents the change in the manufacturing import values in Japan from 1996 to 2015. Japan's trading partners can be categorized into three: China, Asia excluding China and the Middle East, and the rest of the world. Japanese trade data are obtained from Japan Customs, and their nominal values are deflated to their equivalent 2005 values by Japanese GDP deflators.[11]

As depicted in Fig. 2, the growth of Japanese manufacturing imports from China has outpaced the increase of imports from other Asian countries and from the rest of the world over the last two decades, when China acceded to the World Trade Organization (December 2001). The total value of Japanese imports from China was smaller than those from the other two regions in 1996, but it topped imports from other Asian countries in 2003 and from the rest of the world in 2010. Illustrating this quantitatively, the total value of imports from China was 3.3 trillion Japanese Yen (JPY) in 1996, which then increased and reached 13.9 JPY by 2008, and then plummeted to 11.1 trillion JPY next year because of the global economic downturn. Later, the imports increased again and hit a peak of 19.3 trillion JPY in 2014, about six times the value in 1996. By comparison, the manufacturing imports from the other Asian countries had increased 2.4 times (from 5.6 to 13.4 trillion JPY), and those from the rest of the world had increased 1.5 times (from 11.9 to 17.8 trillion JPY) from 1996 to 2015.

This study conducts both industry- and region-level analyses and uses two sets of import indices: one is defined from import penetration ratios and the other, per-worker regional imports. Import penetration

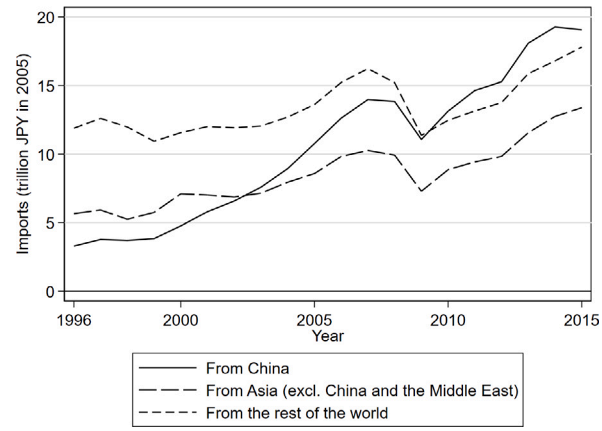

Fig. 2. Value of manufacturing imports to Japan.

ratios are often used in industry-level analysis, and per-worker regional imports in region-level analysis. This study starts with using both sets of import indices in either analysis to compare the results. That is, four set of results are reported in each regression. If the differences of the results are modest, the usual choice of import variables would be used later in this study. In either definition of import shocks, each set of import indices is composed of three types of imports: direct, upstream, and downstream. Among them, upstream import index for a certain industry is defined as the indirect import effect from the industries to which that industry sells their products. In other words, the upstream import index represents the indirect import shocks propagating upward from downstream industries through input–output linkage. Similarly, downstream import index refers to the indirect import shocks coming downward from upstream industries.[12]

There are six import indices, $\Delta T^{k,l}_{i,t}$, for industry-level analysis at time t, where k indicates how to construct indices and l shows the type of import effects. The index of direct import effect ($l = di$) using an import penetration ratio ($k = ip$) is as follows:

$$\Delta T^{ip,di}_{i,t} \equiv \frac{\Delta M^C_{i,t}}{Y_{i,t} + M_{i,t} - X_{i,t}}, \tag{2}$$

where $\Delta M^C_{i,t} \equiv M^C_{i,t+1} - M^C_{i,t}$ is the total change in Japanese import of goods classified under manufacturing industry i from China between time period t ($M^C_{i,t}$) and $t+1$ ($M^C_{i,t+1}$), and $Y_{i,t}$, $M_{i,t}$, and $X_{i,t}$ are the domestic output, total imports, and total exports, respectively, of industry i' goods at time t, all components being deflated to their equivalent 2005 values by Japanese GDP deflators.[13,14] The index $\Delta T^{ip,di}_{i,t}$ is widely used in studies analyzing industry-level trade shocks (e.g., Autor et al., 2014; Ebenstein et al., 2014; AADHP; Kiyota et al., 2021). By using a

[11] Japanese trade data are provided by Japan Customs at http://www.customs.go.jp/toukei/info/index_e.htm. Petroleum and non-ferrous metals refining are not included in manufacturing import values.

[12] This definition of upstream and downstream effects is the same as that in AADHP and Kainuma and Saito (2022), for example. Other researchers such as Hayakawa et al. (2021), however, use the word "upstream" and "downstream" to mention where the industries affected by imports are located in input–output linkage, not the direction of propagation of indirect import effects. Therefore, the terms "upstream import" and "downstream import" in Hayakawa et al. (2021) are "downstream import" and "upstream import", respectively, in this study. Readers need to be cautious in the use of this terminology as it can lead to confusion.

[13] Domestic output is obtained from *The Census of Manufactures* by the Ministry of Economy, Trade and Industry.

[14] Job flows from 1996 to 2006 correspond to import changes from 1996 to 2006. The interval in which job flows were evaluated from 2006 to 2016 was 116 months. Thus, the corresponding change in annual imports is obtained by multiplying import changes between 2006 and 2015 by $\frac{29}{27}$.

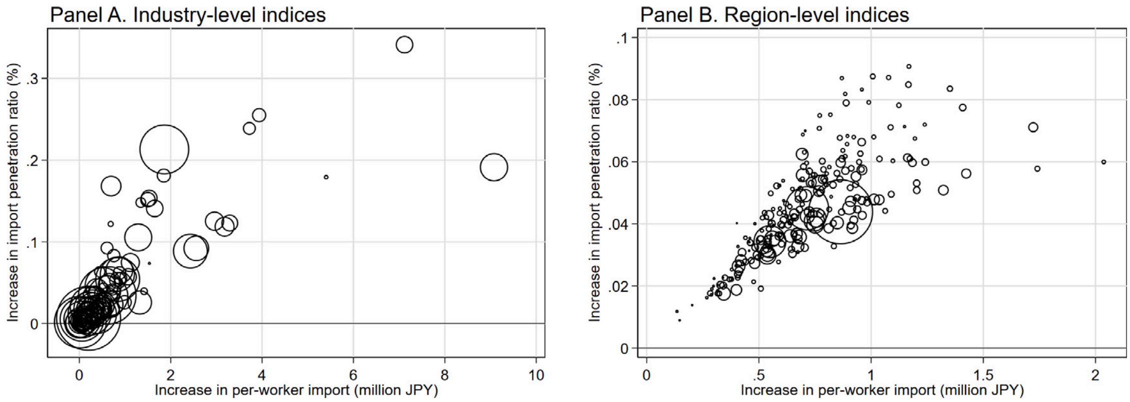

Fig. 3. Direct import indices: 1996–2006.

per-worker import ($k = pw$) instead, the industry-level direct import index ($l = di$), $\Delta T^{pw,di}_{i,t}$, is defined as

$$\Delta T^{pw,di}_{i,t} \equiv \frac{\Delta M^{C}_{i,t}}{E_{i,t}}. \tag{3}$$

Upstream import index ($l = us$) for each k ($k = ip, pw$) for industry-level analysis, $\Delta T^{k,us}_{i,t}$, is expressed as

$$\Delta T^{k,us}_{i,t} \equiv \sum_{j} \frac{y_{j,i}}{\sum_h y_{h,i}} \Delta T^{k,di}_{j,t}. \tag{4}$$

This is the weighted sum of direct import shocks faced by purchasers of industry i's output goods, where $y_{j,i}$ is the value of industry i's output purchased by industry j.[15] The summation in the denominator of Eq. (4) runs over manufacturing and nonmanufacturing industries.[16] Similarly, downstream import index ($l = ds$) for each k, $\Delta T^{k,ds}_{i,t}$, is expressed as

$$\Delta T^{k,ds}_{i,t} \equiv \sum_{j} \frac{y_{i,j}}{\sum_h y_{i,h}} \Delta T^{k,di}_{j,t}. \tag{5}$$

These industry-level indices can be converted into region-level indices, $\Delta T^{k,l}_{r,t}$, following the definition of a shift-share instrument:

$$\Delta T^{k,l}_{r,t} \equiv \sum_{i} \frac{E_{i,r,t}}{E_{r,t}} \Delta T^{k,l}_{i,t}, \tag{6}$$

where $E_{i,r,t}$ is the total jobs in industry i and $E_{r,t}$ is the total number of manufacturing jobs, both in region r at time t.[17] This definition assumes that the national change in trade shock in an industry is apportioned equally among all jobs within that industry.[18] The shift-share instrument of direct import, $\Delta T^{pw,di}_{i,t}$, is widely used in the literature on the regional impact of the China shock, after ADH.

The relationship between the change in direct import index constructed from import penetration ratio and that of the index from per-worker import from 1996 to 2006 is illustrated in Fig. 3. Panel A shows industry-level indices and Panel B, region-level indices. The size of the symbols represents the number of jobs in each observation in 1996. Both panels depict the positive and strong correlation between two indices, implying that the choice of import indices may not influence the results critically. The pattern of scattering observations is quite different, though: industry observations are densely scattered at the bottom-left of Panel A, very skewed compared with region observations in Panel B.

Each of the industry-level changes in manufacturing jobs defined in Section 3.1 is regressed on a set of three industry-level import indices to estimate how direct, upstream, and downstream China shocks affect the number of manufacturing jobs in each industry, using the following form:

$$Y_{i,t} = \beta_1 \Delta T^{k,di}_{i,t} + \beta_2 \Delta T^{k,us}_{i,t} + \beta_3 \Delta T^{k,ds}_{i,t} + \boldsymbol{X}'_{i,t}\boldsymbol{\beta_4} + \epsilon_{i,t}, \tag{7}$$

where $Y_{i,t}$ is $DE_{i,t}$ or any of its subgroups defined in Section 3.1, and $\boldsymbol{X}_{i,t}$ contains period dummies and other industry-level controls. Similarly, each of the region-level changes in manufacturing jobs is regressed on region-level China shocks.

$$Y_{r,t} = \beta_1 \Delta T^{k,di}_{r,t} + \beta_2 \Delta T^{k,us}_{r,t} + \beta_3 \Delta T^{k,ds}_{r,t} + \boldsymbol{X}'_{r,t}\boldsymbol{\beta_4} + \epsilon_{r,t}, \tag{8}$$

[15] These two values are obtained from *the 1995 Input–Output Tables for Japan* by the Ministry of Internal Affairs and Communications.

[16] AADHP formulated the upstream impact of imports in all industries on industry i's output through first-order input–output linkages. Calculating the full chain of implied responses requires a Leontief inverse matrix. However, the inverse matrix cannot be obtained because coefficients of some industries among the 108 are obtained from the same industry in the Input–Output Tables; therefore, the rank of the matrix is less than 108. AADHP showed that the results of using the full indirect upstream effect differ insignificantly from those using a first-order trade index, which supports the view that the approach for upstream effects using first-order trade index in the present study does not undermine the credibility of the outcome. The same argument applies to the first-order and full indirect downstream effects.

[17] Eq. (6) is different from the definition of ADH in that ADH use the total number of regional jobs including non-manufacturing jobs, instead of the total number of regional manufacturing jobs, as a denominator. ADH's formulation of the index is consistent with their dependent variable—the change in manufacturing employment as a share of the total labor force. However, in this study, the change in jobs is defined as a share of the total number of manufacturing jobs, so its number is chosen as a denominator to make the index consistent with the theoretical explanation of ADH.

[18] The characteristics of estimators obtained from using the shift-share instrument were explored recently, especially by Adão et al. (2019), Goldsmith-Pinkham et al. (2020), and Borusyak et al. (2022). Adão et al. (2019) exemplified that regression residuals are correlated across regions with similar employment shares, even though industry-level trade shocks are randomly assigned. Since the correlation generally leads to a downward bias in the standard error estimate, both Adão et al. (2019) and Borusyak et al. (2022) proposed novel inference methods to construct a confidence interval. In addition, Goldsmith-Pinkham et al. (2020) proposed that the sufficient condition for the estimator's consistency is a strict exogeneity of region-level industry shares. In response to this remark, Borusyak et al. (2022) mentioned that the estimator's consistency could also emerge from the exogeneity of industry-level shocks with some assumptions. However, noticing the possible downward bias in the standard error estimate, this study employs the usual estimation method. This is because the formulation and module to obtain the exposure-robust standard error and the corresponding inference are not yet provided when plural independent variables constructed by using the shift-share instrument are used simultaneously in the regression.

Table 1
Means and standard deviations of main variables.

	I. Levels			II. Ten-year changes	
	1996	2006	2016	1996–2006	2006–2016
	(1)	(2)	(3)	(4)	(5)
	Import indices from import penetration ratio				
Direct index	0.021	0.058	0.073	0.043	0.029
(Std. dev., industry-level)	(0.050)	(0.107)	(0.119)	(0.060)	(0.067)
(Std. dev., region-level)	(0.010)	(0.019)	(0.020)	(0.010)	(0.009)
Upstream index	0.009	0.040	0.052	0.027	0.019
(Std. dev., industry-level)	(0.022)	(0.064)	(0.070)	(0.036)	(0.024)
(Std. dev., region-level)	(0.005)	(0.015)	(0.017)	(0.008)	(0.005)
Downstream index	0.006	0.023	0.032	0.016	0.014
(Std. dev., industry-level)	(0.005)	(0.015)	(0.018)	(0.009)	(0.011)
(Std. dev., region-level)	(0.001)	(0.003)	(0.004)	(0.002)	(0.002)
	Import indices from per-worker import				
Direct index	0.265	1.248	2.150	0.749	0.684
(Std. dev., industry-level)	(0.535)	(2.417)	(4.385)	(1.291)	(1.834)
(Std. dev., region-level)	(0.099)	(0.414)	(0.715)	(0.202)	(0.270)
Upstream index	0.135	1.028	1.849	0.636	0.482
(Std. dev., industry-level)	(0.216)	(1.769)	(2.926)	(1.193)	(0.646)
(Std. dev., region-level)	(0.048)	(0.420)	(0.714)	(0.237)	(0.129)
Downstream index	0.105	0.580	1.031	0.343	0.370
(Std. dev., industry-level)	(0.071)	(0.336)	(0.626)	(0.210)	(0.360)
(Std. dev., region-level)	(0.011)	(0.061)	(0.119)	(0.041)	(0.062)
	Job flows (percent)				
Net job flows				−18.33	−12.34
(Std. dev., industry-level)				(16.06)	(13.49)
(Std. dev., region-level)				(9.88)	(7.00)
Job creation				29.03	34.44
(Std. dev., industry-level)				(10.11)	(9.41)
(Std. dev., region-level)				(5.70)	(5.77)
Job destruction				−47.36	−46.78
(Std. dev., industry-level)				(8.94)	(8.12)
(Std. dev., region-level)				(6.35)	(6.73)

Notes: $N = 108$ for industry-level figures and $N = 228$ for region-level figures. The unit of region-level import indices is million Japanese Yen at 2005 values. Industry- and region-level variables in Columns (1)–(3) are weighted by the number of manufacturing jobs in the industry and in the region, respectively, and their decadal changes in Columns (4) and (5) are weighted by the corresponding number at the beginning year of each term. Trade indices in 2015 are used for calculating the levels of import indices in 2016.

where $Y_{r,t}$ is $DE_{r,t}$ or any of its subgroups defined in Section 3.1, and $\boldsymbol{X}_{r,t}$ contains period dummies and other region-level controls.[19]

Industry- and region-level regressions use same controls to eliminate the possibility that the different results of two regressions mainly come from the different choice of controls. Thus, both industry $\boldsymbol{X}_{i,t}$ in Eq. (7) and region controls $\boldsymbol{X}_{r,t}$ in Eq. (8) contain five sets of variables: period dummies, lagged log average number of workers per establishment originally defined in industry, lagged log intermediates per worker originally defined in industry, lagged female share in employment originally defined in region, and lagged log total employment originally defined in region.[20] A control defined in industry $x_{i,t}$ and a control defined in region $x_{r,t}$ can be converted to each other by using the formula $x_{r,t} = \sum_i \frac{E_{i,r,t}}{E_{r,t}} x_{i,t}$ and $x_{i,t} = \sum_r \frac{E_{i,r,t}}{E_{i,t}} x_{r,t}$.

Basic statistics of the two sets of import indices from China and job reallocation are summarized in Table 1. For either set of import indices, the decreasing order of the index level and change is direct, upstream, and downstream for each year. The standard deviation of the import index is smaller at the region level than at the industry level, naturally because the region-level index is the weighted sum of the industry-level index. In terms of job flows, net job flows, job creation, and job destruction are reported. As explained in Section 2, underlying the steady decline in net manufacturing jobs over two decades, active job reallocation through job creation and destruction has been observed.

3.3. Instrumental variables

The present study follows the approach proposed by ADH for the construction of IV for growth in Japanese imports from China. One reason for using this approach is to maintain consistency with other related studies, which simplifies making a direct comparison with the results of this study. ADH chose eight developed countries to use their contemporaneous imports from China as an IV for the U.S. imports: Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland. Here, the present study substitutes Japan for the U.S. for constructing an IV for Japan. The sum of the decadal changes in the eight countries' import from China from time t in industry i, $\Delta W_{i,t}$, is used for constructing an IV for Japanese imports from China in the same period and industry.[21] The IV constructed from imports by

[19] This study does not employ an export variable in addition to three import variables to avoid the problem of overcontrol. The exogenous changes of three import variables potentially cause the change of exports, and regression results presented later represent the employment effect of the China shock, including the indirect effect owing to the change of exports. If an export variable to China is employed in addition to import variables, an import effect on Japanese employment through the change of exports is absorbed by the export variable, which would hinder the understanding of the overall employment effect of imports from China.

[20] Two lagged variables originally defined in industry are obtained from *the Census of Manufacture*. They are calculated from all establishments of and above four workers according to the design of *the Census*. Although fixed capital is employed to control industries in econometric research, this study does not use fixed capital because it is available only for establishments of and above 30 workers in *the Census of Manufacture*. These two variables are employed instead presuming that fixed capital per worker has a positive correlation with the average number of workers per establishment and with intermediate inputs per worker. Two lagged variables originally defined in region are obtained from *the Economic Census*.

[21] World trade data are provided by World Integrated Trade Solution at https://wits.worldbank.org.

developed countries geographically far from China possesses the benefit of representing China's export capabilities accurately and exogenously. Asian countries' imports from China partly reflect the importing countries' role as nodes in the Asian supply chain. Japan also shares this role, which may produce some endogeneity between Asian countries' imports from China and Japanese regional and industry factors, and not using Asian countries for constructing the IV therefore has the additional advantage of avoiding the conceivable endogeneity.

The IV for Japanese direct import index in the industry i using import penetration ratio is defined by Eq. (2) as

$$\Delta IV_{i,t}^{ip,di} \equiv \frac{\Delta W_{i,t}}{Y_{i,t-1} + M_{i,t-1} - X_{i,t-1}},$$

where $Y_{i,t-1}$, $M_{i,t-1}$, and $X_{i,t-1}$ are Japanese output, imports, and exports of goods in industry i ten years before the time t.[22] The denominator of a decade prior to the trade data is used when constructing the IV for imports, because contemporaneous output and trade are presumably affected by anticipated imports from China. The IV for direct import index in the industry i using per-worker import is defined by Eq. (3) as

$$\Delta IV_{i,t}^{pw,di} \equiv \frac{\Delta W_{i,t}}{E_{i,t-1}}.$$

The lagged number of workers is employed for the IV since contemporaneous jobs are likely to be influenced by anticipated imports from China, the same logic as the IV using import penetration ratio.

The IVs for upstream and downstream import shocks in the industry i using import penetration ratio ($k = ip$) and per-worker import ($k = pw$) are obtained similarly by using the definitions of Eqs. (4) and (5):

$$\Delta IV_{i,t}^{k,us} \equiv \sum_j \frac{y_{j,i}}{\sum_h y_{h,i}} \Delta IV_{j,t}^{k,di},$$

$$\Delta IV_{i,t}^{k,ds} \equiv \sum_j \frac{y_{i,j}}{\sum_h y_{i,h}} \Delta IV_{j,t}^{k,di}.$$

These industry-level IVs in any k and l are converted into region-level IVs in the region r by using the form of Eq. (6):

$$\Delta IV_{r,t}^{k,l} \equiv \sum_i \frac{E_{i,r,t-1}}{E_{r,t-1}} \Delta IV_{i,t}^{k,l}.$$

3.4. Employment areas and industries

Regional economic units in Japan are defined based on the concept of local labor markets. For this, the concept of urban employment areas developed by the Center for Spatial Information Service at the University of Tokyo is adopted.[23] The demarcation of metropolitan and micropolitan employment areas in 2010 is employed as the definition of regions in this research. There are 228 regions per period, in which the sizes vary.[24] The Tokyo metropolitan area had around 3 million manufacturing jobs in 1996, the largest among all regions, whereas the Kutchan micropolitan area in Hokkaido had as little as 476 manufacturing jobs in the same year. Some municipalities did not belong to any region: the coverage of jobs in all regions was about 95 percent. For example, the total number of manufacturing jobs in Japan was 13.2 million nationwide, whereas that in the 228 study regions was 12.6 million in 1996.[25]

Among the 108 manufacturing industries, the number of jobs in 1996 ranged from 524 in fur skins to 939,575 in motor vehicles, parts, and accessories. Petroleum and non-ferrous metals refining industries are excluded from the analysis. This is because domestic production of mineral resources is scarce in Japan, and refining is the least labor-intensive industry; therefore, the ratio of import to workers is exceptionally high in these refining industries. The job information about each industry was collected from establishments in metropolitan and micropolitan employment areas. The sum of jobs across industries is the same as that across regions.[26]

Job changes in industries and employment areas are briefly reviewed by using some figures. Fig. 4 illustrates the net job flows and the increase in the direct index of Chinese import in Japan from 1996 to 2006. Panels A and B use industry-level observations and Panels C and D use region-level observations. The size of the symbols represents the number of jobs in each observation in 1996. The vertical scale for net job flows is the same in all four panels but the horizontal scale for direct import index is different; Panels A and C are the import penetration ratio, and Panels B and D are per-worker import. The variation of net job flows is larger in industry-level observations (Panels A and B) than in region-level ones (Panels C and D), as can be seen in Table 1. In Panels C and D, among three dominant regions in Japan (Tokyo, Osaka, and Nagoya, depicted as the three largest circles), Nagoya has the lowest ratio of net job decrease (−14.5 percent), while Osaka has the largest (−28.8 percent). This reflects the difference in industry shares in each region: Nagoya had a higher share of motor vehicle industries, which saw an increase in jobs during the decade (as shown in Panels A and B), than Tokyo and Osaka, while Osaka had a higher share of industries manufacturing outer garments and shirts, which decreased their jobs by as much as 60 percent (see Panels A and B).[27]

Fig. 5 depicts through graphs job creation and job destruction by industry and by region from 1996 to 2006. Panel A shows the figures of 34 industries, which have 100,000 jobs or more in 1996, among all the 108 industries. These 34 industries account for more than three quarters of the total jobs in the 108 industries. The ratio of job creation ranges from 9.9 percent in woven fabric mills to 45.7 percent in miscellaneous food industries, whereas job destruction ranges from −70.5 percent for outer garments and shirts to −34.7 percent in the motor vehicles industry. Industries are dispersed across these sectors. Panel B exhibits distributions on the same scale as Panel A by region. The panel reports 107 metropolitan employment areas among all 228 regions. The three largest regions are located within a narrower range for job creation (24.6 to 28.4 percent) than that of job destruction (−53.4 to −42.9 percent). This implies that the difference in net job flows between them are attributable to job destruction.

4. Import effects on job flows

4.1. Regression results on net job flows

Table 2 presents the second-stage estimation results of regression when dependent variables are the decadal change ratios of the number of total jobs. Panel A summarizes the results of the China shock on net job changes in industries ($DE_{i,t}$). Columns (1)–(4) are the results when import indices constructed from import penetration index are used.

[22] When t is 1996, $t-1$ is 1988, since Japanese trade data of 1986 are not available in digital form with Japan Customs.

[23] The definitions and the code tables of urban employment areas are available on http://www.csis.u-tokyo.ac.jp/UEA/uea_code_e.htm.

[24] When grouping establishments into urban employment areas, establishments in 11 municipalities were deleted since more than a quarter of the area was designated an evacuation zone owing to a disaster outbreak during some time in the period of analysis. There were two disasters that led to municipalities designated as evacuation zones: the Miyake Island volcano eruption (an evacuation zone was designated for 2000–2005) and the Fukushima nuclear disaster (2011–present).

[25] The list of the 20 largest metropolitan areas and 5 smallest micropolitan areas among the 228 regions and their number of jobs appears in Appendix Table A.1.

[26] The list of the 108 manufacturing industries and their number of jobs is in Appendix Table A.2.

[27] The name of the metropolitan employment area called "Nagoya" in the text is "Nagoya-Komaki", to put it precisely.

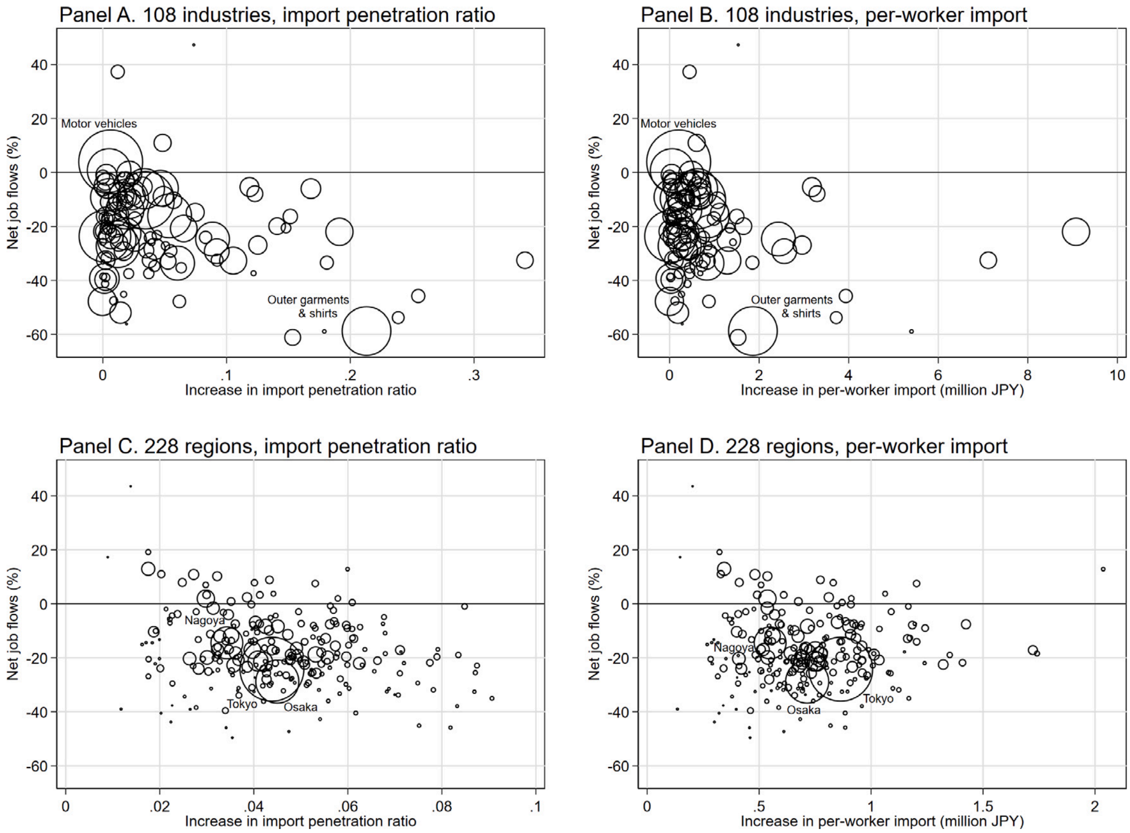

Fig. 4. Net job flows and direct import index: 1996–2006.

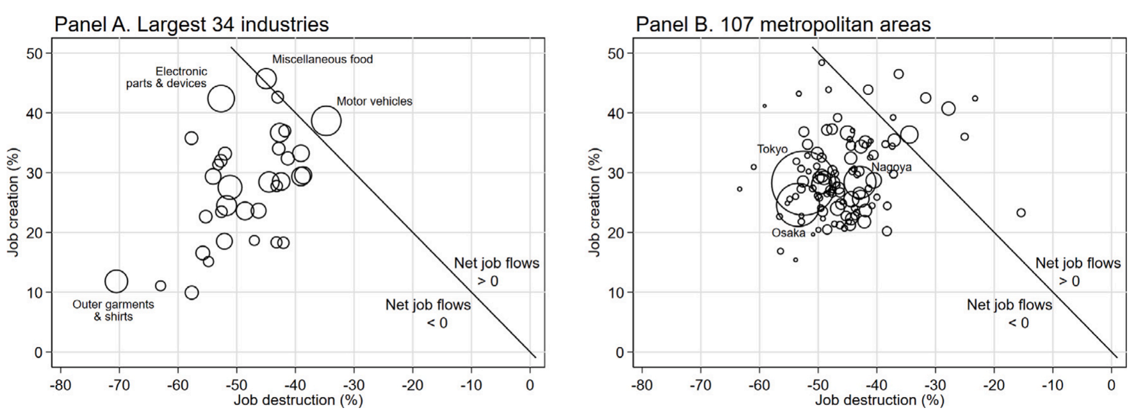

Fig. 5. Job creation and destruction: 1996–2006.

As for import variables, Columns (1)–(3) use direct, upstream, and downstream import indices separately, whereas Column (4) employs all three indices simultaneously. The difference between each point estimate of the two indirect import indices in Columns (2) or (3) and that in Column (4) is relatively large, representing the fact that using three import indices at once would reduce omitted variable bias. In Column (4), both direct and upstream imports have negative effects on the number of jobs in industries and the estimate for direct import is statistically highly significant. Downstream import has a positive effect though its statistical significance is low, the same result as Kiyota et al. (2021), implying that the import of intermediate products from China could support the business of Japanese firms by lowering production costs or increasing productivity. Kleibergen–Paap F statistics are all larger than the rule-of-thumb number of 10, meaning that a possible weak identification does not produce biased results. The set of counterparts of Columns (1)–(4) when import indices constructed from per-worker import are used is Columns (5)–(8). The characteristics mentioned above also apply to Columns (5)–(8), except that the estimate of upstream import is positive in Column (8).

Panel B corresponds to Panel A when the dependent variable is net job changes in regions ($DE_{r,t}$). Two panels share the same characteristics that the estimates of direct import index are negative and statistically highly significant and that those of downstream import index are positive but statistically not significant in Columns (4) and (8). The positive result of downstream import on the number of regional jobs is the same as the finding by Taniguchi (2019) and Kainuma and Saito (2022). Again, Kleibergen–Paap F statistics are sufficiently large.

First-stage results of Table 2 when three import indices are used simultaneously (Columns (4) and (8) in Panels A and B) are summarized in Table 3, which proves that the IV method is appropriately conducted. Partial R–squared are used later for discounting implied employment

Table 2
Second-stage IV estimates for net job flows.

Panel A. Industry-level analysis (dependent variable: $DE_{i,t}$)

	Using import penetration index					Using per-worker import			
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
$\Delta T^{ip,di}_{i,t}$	−1.163***			−1.165***	$\Delta T^{pw,di}_{i,t}$	−0.034***			−0.037***
	(0.264)			(0.272)		(0.007)			(0.008)
$\Delta T^{ip,us}_{i,t}$		−1.056**		−0.415	$\Delta T^{pw,us}_{i,t}$		−0.023*		0.004
		(0.509)		(0.644)			(0.012)		(0.012)
$\Delta T^{ip,ds}_{i,t}$			−3.644**	0.832	$\Delta T^{pw,ds}_{i,t}$			−0.071	0.014
			(1.834)	(2.452)				(0.063)	(0.054)
K-P F stat.	72.7	104.8	92.1	48.9	*K-P F stat.*	24.8	350.5	69.9	17.7

Panel B. Region-level analysis (dependent variable: $DE_{r,t}$)

	Using import penetration index					Using per-worker import			
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
$\Delta T^{ip,di}_{r,t}$	−2.351***			−2.764***	$\Delta T^{pw,di}_{r,t}$	−0.100***			−0.102***
	(0.793)			(0.962)		(0.028)			(0.029)
$\Delta T^{ip,us}_{r,t}$		−0.806		−0.051	$\Delta T^{pw,us}_{r,t}$		−0.083**		−0.037
		(0.811)		(0.978)			(0.036)		(0.036)
$\Delta T^{ip,ds}_{r,t}$			−4.318	3.642	$\Delta T^{pw,ds}_{r,t}$			−0.139	0.200
			(3.275)	(4.734)				(0.138)	(0.151)
K-P F stat.	221.4	302.0	826.5	61.2	*K-P F stat.*	158.5	240.5	440.9	64.2

Notes: The number of observations is 216 for Panel A and 456 for Panel B. The sample includes 108 industries in Panel A and 228 employment areas in Panel B, each observed in two periods (1996–2006 and 2006–2016). Industry- and region-level regressions use same controls: period dummies, lagged log average number of workers per establishment defined in industry, lagged log intermediates per worker defined in industry, lagged female share in employment defined in region, and lagged log total employment defined in region. An industry-level control and a region-level control can be converted to each other by using job shares as weights. Industry- and region-level regressions are weighted by the number of workers in each industry and in each region, respectively, at the start of the period. Robust standard errors in parentheses are clustered by industries for the industry-level analysis and by regions for the region-level analysis. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

Table 3
First-stage IV estimates.

Panel A. Industry-level analysis

2nd stage:	Column (4), Panel A, Table 2			2nd stage:	Column (8), Panel A, Table 2		
Dep. var.:	$\Delta T^{ip,di}_{i,t}$	$\Delta T^{ip,us}_{i,t}$	$\Delta T^{ip,ds}_{i,t}$	Dep. var.:	$\Delta T^{pw,di}_{i,t}$	$\Delta T^{pw,us}_{i,t}$	$\Delta T^{pw,ds}_{i,t}$
	(1)	(2)	(3)		(4)	(5)	(6)
$\Delta IV^{ip,di}_{i,t}$	0.174***	−0.010	−0.002	$\Delta IV^{pw,di}_{i,t}$	0.248***	−0.002	−0.006*
	(0.021)	(0.006)	(0.002)		(0.050)	(0.011)	(0.003)
$\Delta IV^{ip,us}_{i,t}$	−0.011	0.156***	0.002	$\Delta IV^{pw,us}_{i,t}$	−0.055	0.170***	−0.009***
	(0.020)	(0.016)	(0.003)		(0.044)	(0.013)	(0.003)
$\Delta IV^{ip,ds}_{i,t}$	−0.146	−0.025	0.174***	$\Delta IV^{pw,ds}_{i,t}$	−0.091	0.025	0.298***
	(0.121)	(0.061)	(0.026)		(0.111)	(0.039)	(0.029)
R^2	0.633	0.774	0.661	R^2	0.740	0.835	0.842
Partial R^2	0.604	0.752	0.642	*Partial* R^2	0.725	0.807	0.826

Panel B. Region-level analysis

2nd stage:	Column (4), Panel B, Table 2			2nd stage:	Column (8), Panel B, Table 2		
Dep. var.:	$\Delta T^{ip,di}_{r,t}$	$\Delta T^{ip,us}_{r,t}$	$\Delta T^{ip,ds}_{r,t}$	Dep. var.:	$\Delta T^{pw,di}_{r,t}$	$\Delta T^{pw,us}_{r,t}$	$\Delta T^{pw,ds}_{r,t}$
	(1)	(2)	(3)		(4)	(5)	(6)
$\Delta IV^{ip,di}_{r,t}$	0.113***	−0.020***	−0.005***	$\Delta IV^{pw,di}_{r,t}$	0.172***	−0.023***	−0.008***
	(0.010)	(0.005)	(0.001)		(0.015)	(0.008)	(0.002)
$\Delta IV^{ip,us}_{r,t}$	0.038***	0.129***	0.008***	$\Delta IV^{pw,us}_{r,t}$	−0.027*	0.150***	−0.003
	(0.011)	(0.009)	(0.002)		(0.014)	(0.011)	(0.002)
$\Delta IV^{ip,ds}_{r,t}$	−0.013	0.106***	0.186***	$\Delta IV^{pw,ds}_{r,t}$	0.037	0.114***	0.257***
	(0.058)	(0.040)	(0.009)		(0.055)	(0.039)	(0.013)
R^2	0.758	0.809	0.817	R^2	0.630	0.757	0.754
Partial R^2	0.472	0.672	0.682	*Partial* R^2	0.530	0.582	0.636

Notes: The number of observations, the structure of the sample, controls for industry- and region-level regressions, and weights in regressions are the same as the corresponding ones for Table 2. Robust standard errors in parentheses are clustered by industries for the industry-level analysis and by regions for the region-level analysis. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

changes as Acemoglu et al. (2016), Asquith et al. (2019), and Kainuma and Saito (2022) did.

4.2. Regression results on job creation and destruction

Trade effects on net job flows depicted in Table 2 can be decomposed into subcategories of job flows. In this subsection, industry-level net job flow ($DE_{i,t}$) is decomposed into four job flows: job creation in small establishments ($DE^{Small+}_{i,t}$), job destruction in small establishments ($DE^{Small-}_{i,t}$), job creation in large establishments ($DE^{Large+}_{i,t}$), and job destruction in large establishments ($DE^{Large-}_{i,t}$). An establishment is classified as small if it has less than 100 workers, and an establishment of 100 workers or more is classified as large. Region-level net job flow

Table 4
Second-stage IV estimates for job creation and destruction.

Panel A. Industry-level analysis

	Decomposition of Column (4), Panel A, Table 2					Decomposition of Column (8), Panel A, Table 2			
Dep. var.:	$DE_{i,t}^{Small+}$	$DE_{i,t}^{Small-}$	$DE_{i,t}^{Large+}$	$DE_{i,t}^{Large-}$	Dep. var.:	$DE_{i,t}^{Small+}$	$DE_{i,t}^{Small-}$	$DE_{i,t}^{Large+}$	$DE_{i,t}^{Large-}$
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
$\Delta T_{i,t}^{ip,di}$	−0.251***	−0.544**	−0.392***	0.023	$\Delta T_{i,t}^{pw,di}$	−0.009***	−0.012*	−0.013***	−0.003
	(0.070)	(0.213)	(0.093)	(0.155)		(0.002)	(0.007)	(0.004)	(0.006)
$\Delta T_{i,t}^{ip,us}$	−0.228	−0.090	0.269	−0.366	$\Delta T_{i,t}^{pw,us}$	−0.001	0.004	0.020***	−0.019**
	(0.249)	(0.287)	(0.313)	(0.228)		(0.004)	(0.008)	(0.007)	(0.009)
$\Delta T_{i,t}^{ip,ds}$	0.533	1.239	0.637	−1.577*	$\Delta T_{i,t}^{pw,ds}$	0.028	0.003	−0.016	−0.001
	(0.708)	(1.396)	(1.270)	(0.912)		(0.018)	(0.027)	(0.030)	(0.027)

Panel B. Region-level analysis

	Decomposition of Column (4), Panel B, Table 2					Decomposition of Column (8), Panel B, Table 2			
Dep. var.:	$DE_{r,t}^{Small+}$	$DE_{r,t}^{Small-}$	$DE_{r,t}^{Large+}$	$DE_{r,t}^{Large-}$	Dep. var.:	$DE_{r,t}^{Small+}$	$DE_{r,t}^{Small-}$	$DE_{r,t}^{Large+}$	$DE_{r,t}^{Large-}$
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
$\Delta T_{r,t}^{ip,di}$	0.286	−1.868***	−0.353	−0.830	$\Delta T_{r,t}^{pw,di}$	0.011	−0.050***	−0.007	−0.057**
	(0.294)	(0.471)	(0.572)	(0.729)		(0.009)	(0.016)	(0.022)	(0.022)
$\Delta T_{r,t}^{ip,us}$	0.172	−1.168**	0.190	0.755	$\Delta T_{r,t}^{pw,us}$	0.013	−0.024	−0.029	0.003
	(0.313)	(0.522)	(0.687)	(0.619)		(0.011)	(0.019)	(0.029)	(0.024)
$\Delta T_{r,t}^{ip,ds}$	−3.675**	9.871***	−0.893	−1.661	$\Delta T_{r,t}^{pw,ds}$	−0.161***	0.317***	0.097	−0.053
	(1.567)	(2.079)	(3.376)	(3.354)		(0.045)	(0.069)	(0.097)	(0.093)

Notes: The number of observations, the structure of the sample, controls for industry- and region-level regressions, weights in regressions, and Kleibergen–Paap F statistics are the same as the corresponding ones for Table 2. Small establishments are the ones with less than 100 workers and large establishments are the ones with 100 workers or more. Robust standard errors in parentheses are clustered by industries for the industry-level analysis and by regions for the region-level analysis. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

($DE_{r,t}$) is also decomposed in the same way. Panel A of Table 4 presents the second-stage estimation results of regression when dependent variables are four subcategories of $DE_{i,t}$ and three import indices are all used as independent variables. Columns (1)–(4) use import penetration ratio as import indices, therefore the sum of the four estimates of each import index is the estimate of the index in Column (4) in Table 2 from the definition. For example, the sum of four point estimates of direct index using import penetration ratio, −0.251, −0.544, −0.392, 0.023, from Columns (1) to (4) in Panel A of Table 4, is equal to the corresponding estimate, −1.165 in Column (4) in Panel A of Table 2 (with a rounding figure). Similarly, Columns (5)–(8) in Panel A are decomposed results of Column (8) in Panel A of Table 2. Panel B of Table 4 summarizes the results of the region-level analysis in the same manner as Panel A.[28]

The difference in results obtained from industry- and region-level analyses demonstrates how industry-level trade shocks on employment are mitigated, intensified, or transformed in the local labor market. For the industry-level analyses in Panel A, there is one finding, statistically significant, observed in both sets of results. That is, rising direct import from China $\Delta T_{i,t}^{k,di}$ decreases job creation in both small and large establishments (Columns (1), (3), (5), and (7)). Interestingly, this feature disappears in region-level analyses. Instead, direct import activates job destruction in small establishments statistically significantly in Panel B (Columns (2) and (6)). Since region-level analysis additionally encompasses the reallocation and aggregate demand effects of import shocks, based on the discussion in AADHP, it implies that the local effects alleviate the negative impact of direct import on job creation in regional establishments while they aggravate the negative impact on job destruction in small establishments. The reason behind this adjustment might be that workers who would otherwise be employed in industries heavily affected from intensifying direct import from China are actually employed in industries less affected in the same region, while this regional job reallocation would be accompanied with the outflow of workers especially from small establishments to other less-affected establishments.[29]

As for the downstream import index, it is intriguing that Panel A does not have estimates of statistical significance, while in Panel B the estimate for job creation in small establishments is negative (Columns (1) and (5)) and the estimate for job destruction in small establishments is positive (Columns (2) and (6)), both statistically highly significant. It indicates that, after having two regional effects of import shocks, the import of intermediate goods from China reduces job reallocation in small establishments by impeding job creation and deterring job destruction. Comparing two estimates of downstream import for small establishments revealed that small establishments increase their jobs, thanks to downstream import from China. Since large establishments tend to be part of large, internationalized Japanese firms, it seems natural to expect that large establishments would reap the benefit of importing intermediate goods and then increase their employment, which is actually not observed in Table 4, however. Rather, small establishments receive the positive effect of abating job destruction. It may be interpreted from two points. First, rising Chinese export of intermediate goods to Japan increases the availability of imported inputs for small establishments which would otherwise have limited access to them, and it empowers small establishments to survive. Second, the increase in surviving small establishments has a positive ripple effect on other small establishment in the same region through regional production network.

4.3. Implied number of job changes

The actual number of job changes and the implied changes induced by Chinese imports between 1996 and 2016 are reported in Panels A

[28] By definition, the negative sign of an estimate implies negative employment effect of an import index on both job creation and destruction. In other words, job creation is deterred, and job destruction is promoted, owing to import shocks. Conversely, the positive sign of an estimate implies the opposite effect.

[29] When summing the estimates of regional direct import in small and large establishments to observe the total job creation effect (the sum of Columns (1) and (3) in Panel B of Table 4 in the case of using import penetration ratio) and the destruction effect (the sum of Columns (2) and (4) in the same case), it is found that regional import shocks have smaller impact on job creation (−0.067 in the case of using import penetration ratio) than on job destruction (−2.698 in the same case). This finding is in line with Asquith et al. (2019), reporting that the China shock had only a small and insignificant impact on job creation whereas it exacerbated job destruction significantly in the local labor markets in the U.S.

Table 5
Actual and implied number of job changes in Japan: 1996–2016.

Panel A. Actual job changes	Total	Small establishments		Large establishments	
	job change	Creation	Destruction	Creation	Destruction
Actual job flows	−3,531	3,639	−5,825	3,462	−4,807
Panel B. Implied job changes: industry-level analysis, import penetration ratio					
Total import effect	−561	−98	−36	49	−476
Direct effect	−579	−125	−271	−195	11
Upstream effect	−163	−90	−35	106	−144
Downstream effect	181	116	270	138	−343
Panel C. Implied job changes: industry-level analysis, per-worker import					
Total import effect	−305	68	−68	−59	−247
Direct effect	−437	−103	−136	−158	−40
Upstream effect	39	−12	46	203	−198
Downstream effect	93	184	22	−104	−9
Panel D. Implied job changes: region-level analysis, import penetration ratio					
Total import effect	−250	−678	1,145	−276	−441
Direct & local effects	−1,074	111	−726	−137	−323
Upstream & local effects	−18	60	−410	67	265
Downstream & local effects	841	−849	2,281	−206	−384
Panel E. Implied job changes: region-level analysis, per-worker import					
Total import effect	−139	−630	1,007	219	−734
Direct & local effects	−880	95	−427	−59	−488
Upstream & local effects	−278	96	−182	−218	26
Downstream & local effects	1,019	−822	1,616	496	−272

Notes: All implied numbers of jobs are calculated correspondingly by using the method explained for the case of the industry-level analysis with the import penetration ratio in footnote 29. Units are thousand.

to E of Table 5. In the dataset of 108 industries and 228 regions, manufacturing jobs in Japan decreased by 3.5 million over two decades, and small and large establishments contribute to a similar extent in this change: small establishments created 3.6 million jobs and destroyed 5.8 million jobs, resulting in a job loss of 2.2 million, while large establishments created 3.5 million jobs and destroyed 4.8 million jobs, resulting in a job loss of 1.3 million.

Implied numbers from the industry-level analysis using import indices constructed from import penetration ratio are reported in Panel B.[30] Based on this estimation, 579,000 manufacturing jobs disappeared owing to Chinese direct import between 1996 and 2016, which accounts for 16 percent of the actual number of decreased jobs. Breaking down this number into small and large establishments, 396,000 jobs decreased in small establishments and 184,000 jobs, large establishments (with a rounding figure). This is consistent with the prediction that a direct import shock reduces a greater number of jobs in small establishments, postulating three factors: the empirically proven fact of a positive correlation between firm size and productivity, the theoretical background of Melitz-style firm exits and expansions, and the observation that smaller firms have fewer and smaller establishments. Additionally, the negative upstream effect on job change is 163,000 and the positive downstream effect is 181,000. Therefore, the total manufacturing job loss owing to all three trade indices is 561,000. The estimated total job loss is larger in large establishments ($-427,000$) than in small establishments ($-134,000$). This order is opposite to the one of job loss owing to direct import effect since small establishments receive a large positive employment effect from downstream import. Panel C summarizes the implied number of job changes obtained from the industry-level analysis using import indices of per-worker import. These figures are calculated following the corresponding way it is done in Panel B. The estimated numbers are similar to those in Panel B in general.

Panels D and E present the implied job changes from the region-level analysis using import penetration ratio and per-worker import, respectively. Implied job changes owing to three import shocks are similar between Panels D and E. Though region-level analyses report the negative total import effect on employment in Panels D and E, which is the same as industry-level analyses in Panels B and C, there are stark differences in the implied job changes from direct and downstream imports between region- and industry-level analyses. That is, negative total job changes from direct import and positive total job changes from downstream import are much larger in region-level analyses than the corresponding ones obtained from industry-level analyses. For instance, implied total job loss from direct import when using import penetration ratio is 579,000 in industry-level analysis (Panel B), and this figure almost doubles to 1,074,000 in region-level analysis (Panel D). Also, implied total job gain from downstream import when using per-worker import is 93,000 in industry-level analysis (Panel C) and 1,019,000 in region-level analysis (Panel E), the latter being more than 10 times larger than the former.

AADHP discussed that the results of region-level regressions capture two local components in addition to the results of industry-level regressions: the reallocation effect and the aggregate demand effect. For example, when an establishment halts its business because of intensifying direct or indirect import competition, some establishments

[30] They are calculated using the changes in import indices in Columns (4) and (5) of Table 1, estimates in Column (4) of Panel A in Table 2 and in Columns (1)–(4) of Panel A in Table 4, partial R-squared in Columns (1)–(3) of Panel A in Table 3, and the number of manufacturing workers at the beginning year of each term. The estimated number is obtained as follows. Take total job change by direct import as an example. The estimate of the direct index is −1.165, the partial R-squared is 0.604, the change in the direct import index is 0.0428 in 1996–2006 and 0.0287 in 2006–2016, and the number of manufacturing workers is 12,457,908 in 1996 and 10,116,405 in 2006. The implied total number of jobs decreased by strengthening the direct import effect is then $-1.165 \times 0.604 \times (0.0428 \times 12,457,908 + 0.0287 \times 10,116,405) = -579,492$.

in the same region may hire some of the dismissed workers (the reallocation effect) and other establishments in the same region may suffer from the decrease in local consumption and investment owing to the decrease in employment and the number of establishments (the aggregate demand effect). Thus, each figure in Panels D and E includes the local reallocation and aggregate demand effects induced by direct and indirect effects in Panels B and C in addition to direct and indirect effects themselves. The sizeable difference of estimated changes in each job flow between industry-level analyses and region-level analyses, especially the one in job destruction in small establishments owing to the downstream shock, demonstrates that most part of implied regional job changes attributes to two local effects.[31]

Since the results of industry-level analysis using different set of import indices reveal the same characteristics (Panel A in Table 4 and Panels B and C in Table 5) as presented above, and so is the region-level analysis (Panel B in Table 4 and Panels D and E in Table 5), hereafter two out of four cases are employed: industry-level analysis with import indices using import penetration ratio and region-level analysis with import indices using per-worker import. This is to avoid the complicatedness of a more detailed estimation and discussion after this subsection without undermining the significance of this study. They are chosen simply because this combination of observation units and import indices are generally used in previous studies.[32]

It is worth noting that Taniguchi (2019), Kiyota et al. (2021), Kainuma and Saito (2022), and this study all present supporting evidence that the import of intermediate goods from China has increased Japanese manufacturing jobs. This study explores further to find that large establishments are the source of the positive job effects: the industry-level downstream effect increases the employment of large establishments by helping them increase their workforce and preventing them from dismissing some of their workforce, both statistically significantly (Panel A in Table 4), the region-level downstream effect discourages their job destruction significantly (Panel B in Table 4), and the number of increased employment in large establishments excels other job flows induced by import shocks (Table 5).

4.4. Regression results excluding largest regions

Some readers might think that these results come mainly from Tokyo, Osaka, and Nagoya, the three largest, dominant regions of Japan, and therefore do not represent the job reallocation of other areas. This concern is legitimate since the distribution of not only population but also manufacturing jobs is concentrated in these regions. Among the total 12.5 million manufacturing jobs in 1996, the Tokyo area, the capital region of Japan, has 3.0 million jobs, which represent one-quarter of the total manufacturing jobs in the country. Moreover, the three largest areas have 5.0 million total jobs, accounting for 40 percent of the national manufacturing jobs. It is natural to suspect that establishments in Tokyo, Osaka, and Nagoya may react to import shocks differently from those in non-metropolitan areas because of some possible reasons, including that these three metropolitan areas enjoy more industry agglomeration as a result of their centripetal force or that they are affected more from import shocks owing to main international ports of Japan located therein.

Table 6 presents the estimates of regressions when dependent variables are job creations and destructions, same as Table 4, and establishments in dominant metropolitan areas are excluded from the dataset. Two sets of regressions are chosen from Table 4 for the purpose: industry-level analysis using import penetration index and region-level analysis using per-worker import. Panel A shows the results when Tokyo is excluded, and Panel B presents the results when the three largest cities are all excluded. Overall, these results differ only slightly from those in Table 4, indicating that there is little peculiar impact of imports on the labor market in dominant cities. Therefore, this study mainly uses the dataset including all 108 industries and 228 regions in the analyses hereafter.

There is, however, one noticeable difference in the industry-level analysis. That is, downward import subdues job destruction in small establishments but promotes it in large establishments, located outside of Tokyo, Osaka, and Nagoya. In Panel A of Table 4, the estimate of $\Delta T_{i,t}^{ip,ds}$ is 1.239 in Column (2) and −1.577 in Column (4), both not being statistically significant at a conventional level. In Panel B of Table 6, these effects become larger to 2.573 in Column (2) and −2.851 in Column (4), both with statistical significance. This contrast between small and large establishments might be explained as follows. For small establishment in non-metropolitan areas, newly imported intermediate goods from China provides them an opportunity to increase their productivity and empower them to maintain their business. For large establishments, a probable reason for the increase of job destruction is that establishments in metropolitan areas make the most of the accessibility to imported intermediate goods (thanks to the nearby large international ports) and switch their source of intermediate inputs from domestic large establishments located in non-metropolitan areas, once a major supplier to Japanese firms, to China.

4.5. Import effect on extensive and intensive margins

The effect of import shocks on job creation and destruction, summarized in Table 4, is further divisible into groups of what kind of establishments cause the job change. Each of the dependent variables of job creation in Table 4 can be divided into two groups: job creation by establishments surviving all through the decadal period ("continuers"), and job creation by establishments that newly start their business during the decadal period ("entries"). Similarly, each of the dependent variables of job destruction can be divided into that by continuers and by establishments that halted their business during the period ("exits"). In this decomposition, job changes by continuers represent establishments' intensive margin and those by entries and exits represent establishments' extensive margin.

Table 7 summarizes the results. Since there are four columns in each industry- and region-level analysis in Table 4, each set of analysis has eight columns in this table. By partitioning each job flow into that by continuers and by entries or exits and comparing their estimates of each import shock, the absolute value of the estimate for job creation or destruction through establishments' turnover (entry/exit) is generally larger than that by continuing establishments in each job

[31] Though this is truly an intriguing finding of the present study, there is a factor that may produce the overestimation in region-level analysis and is worth considering in the Japanese context: inter-region, intra-industry job reallocation. Consider that one establishment relocates to another region wherein import shocks affect less and it restarts its old business there with the same number of workers as before. Then, region-level analysis produces a negative relationship between import shocks and local employment, and the implied total job changes becomes negative, though the sum of the number of workers over these two regions is constant. Compared with the land area of the whole nation of the U.S. or each of its commuting zones which AHP and AADHP used as their unit of regions, the land area of Japan or each employment area used in this study is quite small. Therefore, it is reasonable to assume that some Japanese firms rearranged their plants across regions in response to the China shock, which produced a part of the large implied job loss in region-level analysis in Panels D and E of Table 5. Though inter-region, intra-industry job reallocation may occur to some extent in Japan, it is hard to calculate the size of this type of reallocation; therefore this study just draws the readers' attention to this aspect by mentioning the possible overestimation of job loss in region-level analysis.

[32] The list of top 10 and bottom 5 industries affected negatively by the China shock over 1996–2016, both in the number of implied changes in jobs and in its ratio to the actual number of manufacturing jobs in 1996, among the 108 industries, based on the estimation of industry-level analysis with using import penetration ratio, are as shown in Appendix Table A.3. Similarly, the list of top 20 and bottom 10 regions affected negatively over 1996–2016, among the 228 regions, based on the estimation of region-level analysis with using per-worker import, are as shown in Appendix Table A.4. The results of all the 108 industries or 228 regions are available upon request.

Table 6
Second-stage IV estimates using regional subsamples.

	Industry-level analysis, import penetration ratio					Region-level analysis, per-worker import			
Dep. var.:	$DE^{Small+}_{i,t}$	$DE^{Small-}_{i,t}$	$DE^{Large+}_{i,t}$	$DE^{Large-}_{i,t}$	Dep. var.:	$DE^{Small+}_{r,t}$	$DE^{Small-}_{r,t}$	$DE^{Large+}_{r,t}$	$DE^{Large-}_{r,t}$
	(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
Panel A. Excluding Tokyo									
$\Delta T^{ip,di}_{i,t}$	−0.265***	−0.623***	−0.453***	0.148	$\Delta T^{pw,di}_{r,t}$	0.013	−0.046***	−0.024	−0.040**
	(0.077)	(0.225)	(0.116)	(0.140)		(0.010)	(0.016)	(0.022)	(0.020)
$\Delta T^{ip,us}_{i,t}$	−0.329	−0.104	0.265	−0.360*	$\Delta T^{pw,us}_{r,t}$	0.012	−0.026	−0.031	0.020
	(0.297)	(0.335)	(0.349)	(0.204)		(0.012)	(0.017)	(0.029)	(0.024)
$\Delta T^{ip,ds}_{i,t}$	0.713	2.082*	1.683	−2.294**	$\Delta T^{pw,ds}_{r,t}$	−0.170***	0.300***	0.168*	−0.116
	(0.780)	(1.253)	(1.192)	(0.903)		(0.047)	(0.062)	(0.086)	(0.097)
Panel B. Excluding Tokyo, Osaka, and Nagoya									
$\Delta T^{ip,di}_{i,t}$	−0.289***	−0.629***	−0.526***	0.125	$\Delta T^{pw,di}_{r,t}$	0.010	−0.039***	−0.022	−0.033*
	(0.084)	(0.223)	(0.102)	(0.145)		(0.010)	(0.014)	(0.022)	(0.019)
$\Delta T^{ip,us}_{i,t}$	−0.277	−0.073	0.359	−0.337	$\Delta T^{pw,us}_{r,t}$	0.011	−0.025	−0.030	0.018
	(0.276)	(0.352)	(0.408)	(0.242)		(0.011)	(0.017)	(0.029)	(0.024)
$\Delta T^{ip,ds}_{i,t}$	0.476	2.573**	2.131	−2.851***	$\Delta T^{pw,ds}_{r,t}$	−0.165***	0.314***	0.187**	−0.103
	(0.757)	(1.259)	(1.304)	(0.988)		(0.047)	(0.060)	(0.085)	(0.095)

Notes: The number of observations is 216 for Columns (1)–(4) in Panels A and B, 454 for Columns (5)–(8) in Panel A, and 450 for Columns (5)–(8) in Panel B. Kleibergen–Paap F statistics are 36.3 for Columns (1)–(4) in Panel A, 54.9 for Columns (5)–(8) in Panel A, 35.6 for Columns (1)–(4) in Panel B, and 52.8 for Columns (5)–(8) in Panel B. The structure of the sample, the definition of small and large establishments, controls for industry- and region-level regressions, and weights in regressions are the same as those for Table 2. Robust standard errors in parentheses are clustered by industries for the industry-level analysis and by regions for the region-level analysis. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

Table 7
Second-stage IV estimates for extensive and intensive margins.

	Small establishments				Large establishments			
	Creation		Destruction		Creation		Destruction	
	Continuers	Entries	Continuers	Exits	Continuers	Entries	Continuers	Exits
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Industry-level analysis, import penetration ratio								
$\Delta T^{ip,di}_{i,t}$	−0.118***	−0.133***	−0.102***	−0.443**	−0.060*	−0.332***	−0.032	0.054
	(0.030)	(0.050)	(0.028)	(0.191)	(0.035)	(0.079)	(0.059)	(0.124)
$\Delta T^{ip,us}_{i,t}$	−0.062	−0.166	−0.041	−0.049	0.097	0.173	−0.106	−0.260
	(0.076)	(0.179)	(0.059)	(0.246)	(0.120)	(0.244)	(0.142)	(0.183)
$\Delta T^{ip,ds}_{i,t}$	0.122	0.411	0.544	0.695	−0.158	0.795	−0.337	−1.240*
	(0.267)	(0.506)	(0.378)	(1.059)	(0.380)	(0.996)	(0.391)	(0.685)
Panel B. Region-level analysis, per-worker import								
$\Delta T^{pw,di}_{r,t}$	−0.003	0.014*	−0.010**	−0.040***	−0.034***	0.027	0.001	−0.058***
	(0.004)	(0.008)	(0.004)	(0.013)	(0.010)	(0.022)	(0.013)	(0.021)
$\Delta T^{pw,us}_{r,t}$	0.002	0.011	−0.004	−0.020	−0.011	−0.018	0.007	−0.003
	(0.005)	(0.009)	(0.005)	(0.015)	(0.013)	(0.025)	(0.017)	(0.026)
$\Delta T^{pw,ds}_{r,t}$	0.004	−0.165***	0.052***	0.265***	0.114***	−0.017	−0.112**	0.058
	(0.019)	(0.039)	(0.016)	(0.059)	(0.039)	(0.094)	(0.054)	(0.083)

Notes: The number of observations, the structure of the sample, controls for industry- and region-level regressions, weights in regressions, and Kleibergen–Paap F statistics are the same as the corresponding ones for Table 2. Robust standard errors in parentheses are clustered by industries for the industry-level analysis and by regions for the region-level analysis. ***$p < 0.01$; **$p < 0.05$; *$p < 0.1$.

flow (job creation or destruction by small or large establishments). Take job creation by small establishments in Panel A (industry-level analysis, import penetration ratio) as an example: the absolute value of the estimate of direct import $\Delta T^{ip,di}_{i,t}$ for continuers, −0.118 (Column (1)), is smaller than that for entries, −0.133 (Column (2)). Combining this finding with the fact that entry and exit of establishments are the dominant forces of job reallocation (Panel C of Fig. 1), it can be conjectured that import shocks change job flows mainly through establishments' extensive margin. However, it should be noted that for large establishments in region-level analysis, some import shocks affect more on continuers than entries or exit. For example, the estimate of downstream import $\Delta T^{pw,ds}_{r,t}$ on job destruction is −0.112 for continuers, which is larger in absolute value than 0.058 for exits.

To verify the prediction that import shocks change job flows mainly through extensive margin, each of the actual and implied number of job changes in Panels B and E of Table 5 is also divided into intensive and extensive margins, the result of which is listed in Table 8. Naturally, each number in Table 5 is the same as the sum of job changes in its two subcategories (continuers and entries/exits) in Table 8. For example, the implied decrease in job creation in small establishments owing to direct import shocks using import penetration ratio in the industry-level analysis, −125,000, equals the sum of its effect on job creation by continuers, −59,000, and that on job creation by entries, −66,000.

For actual job changes, Panel A shows that job change by entries and exits is larger than that by continuers in all four pairs of job creation or destruction. For implied job changes from industry-level analysis in Panel B, implied job change owing to each of three types of import shocks through intensive margin (continuers) is smaller in absolute value than that through extensive margin (entries/exits) in all pairs of job flows. This feature is also found in small establishments in region-level analysis in Panel C, however, some pairs of job flows show the opposite order in large establishments. For example, downstream import shock aggravates job destruction in large continuers by 569,000, which is larger in absolute value than the number of jobs maintained by large establishments thanks to the decrease in exits, 297,000. However, from the whole picture, it is safe to say that the driving force of accelerating or decelerating job creation and destruction is establishments' entry and exit. Establishments' extensive margin is the main factor for actual and implied job changes, not their intensive margin.

Table 8
Actual and implied number of job changes: extensive and intensive margins.

	Small establishments				Large establishments			
	Creation		Destruction		Creation		Destruction	
	Continuers	Entries	Continuers	Exits	Continuers	Entries	Continuers	Exits
Panel A. Actual job flows								
Actual job flows	1,124	2,515	−1,667	−4,157	947	2,514	−1,917	−2,891
Panel B. Implied job changes: industry-level analysis, import penetration ratio								
Total import effect	−57	−42	52	−88	−26	75	−131	−345
Direct effect	−59	−66	−51	−220	−30	−165	−16	27
Upstream effect	−25	−65	−16	−19	38	68	−42	−102
Downstream effect	27	89	118	151	−34	173	−73	−270
Panel C. Implied job changes: region-level analysis, per-worker import								
Total import effect	8	−638	148	860	205	13	−509	−226
Direct & local effects	−25	121	−84	−343	−296	236	10	−499
Upstream & local effects	15	81	−31	−150	−80	−138	50	−25
Downstream & local effects	18	−840	263	1353	581	−85	−569	297

Notes: The implied number of jobs is calculated from the same as that for Table 5. Units are thousand.

5. Import effects through industry and regional factors

5.1. AW decomposition

The observation and discussion about industry and local job reallocation developed in Section 4 could have a sharper focus and become more accurate if the nature of industry- and region-level job flows is examined further. In this section, the method of AW decomposition (Amiti and Weinstein, 2018) is applied to job flows to extract more information from job flow data and to obtain a clearer picture.

Using the change ratio of industry- and region-level jobs, $DE_{i,t}$ and $DE_{r,t}$ in Eq. (1), the method of AW decomposition is explained as follows. This method decomposes job flows into three factors. First, industry-year-specific factor $\dot{a}_{i,t}$ is a set of factors that influences all manufacturing jobs in industry i in time t, such as the direct and indirect effects of market structure, technological progress, and demand shift. If the import shock of a particular industry causes reallocation and aggregate demand effects which affect all local employment in the same way regardless of their regions, that impact is expressed in $\dot{a}_{i,t}$.

Second, the region-year-specific factor $\dot{b}_{r,t}$ is a set of factors that affects all jobs in region r in time t. It includes, for example, regional demographic dynamics, the characteristics of the local goods, services, and factor market, employment effects of the local economic policy, and ripple effects that cover the particular region through a production network. If the import shock induces further employment change in a particular region in addition to the change in industry factor $\dot{a}_{i,t}$, it is absorbed into the regional factor $\dot{b}_{r,t}$. The change in $\dot{b}_{r,t}$ owing to import shocks may arise from the fact that a region with a local dense agglomeration of industries observes an amplifying promulgation of import shocks through seller–buyer transactions or that a particular region having a large international port is affected more by import shocks than are other areas.

Third, a common factor in year t, $\bar{c}_t$, is a factor that shifts jobs in all industries and all regions in time t. The effect of labor regulation changes that came into effect in Japan during the period under analysis, such as the modification of the employment insurance system and the imposition of working hour limits, is considered to fall under this factor, because such regulations are applied consistently irrespective of region and industry.

These three factors are obtained from the following system of moment equations:

$$DE_{i,t} \equiv \dot{a}_{i,t} + \sum_r \frac{E_{i,r,t}}{E_{i,t}} \dot{b}_{r,t} + \bar{c}_t, \tag{9}$$

$$DE_{r,t} \equiv \sum_i \frac{E_{i,r,t}}{E_{r,t}} \dot{a}_{i,t} + \dot{b}_{r,t} + \bar{c}_t, \tag{10}$$

where $E_{i,r,t} \equiv \sum_{e\in(i,r,t)} E^e_{i,r,t}$. Note that $\sum_r \frac{E_{i,r,t}}{E_{i,t}} = 1$ and $\sum_i \frac{E_{i,r,t}}{E_{r,t}} = 1$. The common factor in year t, $\bar{c}_t$, is defined as the sum of the median regional factor and the median industry factor in time t. The industry-year factor $\dot{a}_{i,t}$ and the region-year factor $\dot{b}_{r,t}$ are the differences between the actual factor and the median factor in time t. Eq. (9) states that the change ratio of employment in industry i is driven by its industry factor $\dot{a}_{i,t}$, a weighted average of all regional factors $\dot{B}_{i,t} \equiv \sum_r \frac{E_{i,r,t}}{E_{i,t}} \dot{b}_{r,t}$, and a common factor $\bar{c}_t$. Similarly, Eq. (10) shows that the change ratio of employment in region r is driven by its regional factors $\dot{b}_{r,t}$, a weighted average of all industry factors $\dot{A}_{r,t} \equiv \sum_i \frac{E_{i,r,t}}{E_{r,t}} \dot{a}_{i,t}$, and a common factor $\bar{c}_t$. After obtaining these factors, $\dot{a}_{i,t}$ and $\dot{B}_{i,t}$ are regressed on industry-level import indices by using each of them as the left-hand side variable in Eq. (7), and $\dot{A}_{r,t}$ and $\dot{b}_{r,t}$ are regressed on region-level import indices by using each of them in Eq. (8).[33] This procedure is also applicable to the subgroups of job flows such as job creation and destruction.

Import shocks affect $DE_{i,t}$ and $DE_{r,t}$ through industry factor $\dot{a}_{i,t}$ and regional factor $\dot{b}_{r,t}$. The effect through $\dot{a}_{i,t}$ is straightforward. Strengthening import shock in industry i changes its domestic production and therefore, its labor demand. In addition, $\dot{a}_{i,t}$ would change owing to local reallocation and aggregate demand effects. Regional factor $\dot{b}_{r,t}$ is also affected by import shocks if they have different job effect on region r than on other regions. This includes ripple effects on jobs in regional input–output spaces and industry agglomeration and dispersion, idiosyncratically different from other regions. The regressions of $\dot{a}_{i,t}$ on $\Delta T^{k,l}_{i,t}$ and of $\dot{A}_{r,t}$ on $\Delta T^{k,l}_{r,t}$ reveals the effect of import shocks on job changes through industry factors, while the regressions of $\dot{B}_{i,t}$ on $\Delta T^{k,l}_{i,t}$ and of $\dot{b}_{r,t}$ on $\Delta T^{k,l}_{r,t}$ shows that through regional factors.[34]

Panel A of Fig. 6 depicts the results of decomposing the change ratios of industry- and region-level net job flows ($DE_{i,t}$ and $DE_{r,t}$) from

[33] AW chose a median region and a median industry as numeraires for solving Eqs. (9) and (10). Choosing any other region and industry as numeraires can also solve this set of equations and provide regional and industry factors with the same variations. An alternation in a numerator for industry factors in Eqs. (9) and (10) changes all $\dot{a}_{i,t}$ by the same amount, as does $\hat{\beta}_4$ in Eq. (7). Therefore, it does not affect $\hat{\beta}_1$, $\hat{\beta}_2$, and $\hat{\beta}_3$. The same applies to regional factors.

[34] One might think it is better to use an industry–region interaction term for industry–region specific factors. However, proposition 1 of AW proved that the inclusion or exclusion of the term does not affect the magnitude of $\dot{a}_{i,t}$ and $\dot{b}_{r,t}$, as long as one is willing to define the components of an interaction term that varies only at the industry and regional levels. This is based on the fact that any interaction term can be divided into industry fixed effects, regional fixed effects, and residuals, being orthogonal to both effects. In this study, the variation in industry and regional levels is used and, therefore, the interaction term is not included.

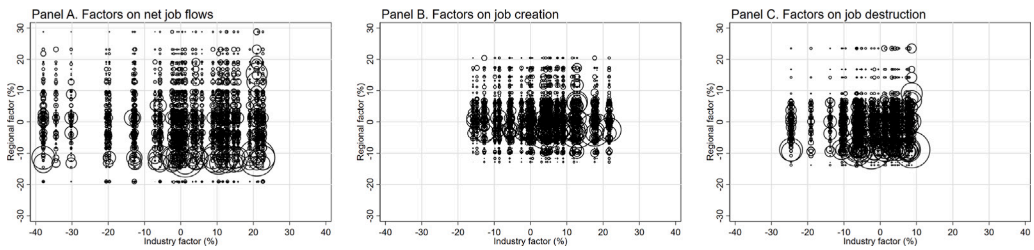

Fig. 6. Industry and regional factors for job flows: 1996–2006.

1996 to 2006 into three factors by using Eqs. (9) and (10). The horizontal line represents the industry factors ($\dot{a}_{i,t}$) of 34 large industries, the vertical line represents the regional factors ($\dot{b}_{r,t}$) of 107 metropolitan employment areas, and the sizes of the symbols represent the number of jobs in each industry–region group ($E_{i,r,t}$).[35] Industry and regional factors have a similar range of distribution in Panel A, implying that both industry and regional factors are potentially similarly influential on job flows. Panels B and C are the results of the decomposition of two subcategories of net job flows: job creation ($DE^+_{i,t}$ and $DE^+_{r,t}$) and job destruction ($DE^-_{i,t}$ and $DE^-_{r,t}$). These two panels also share the same characteristics as those of Panel A.[36]

5.2. Regression results

In this study, the change ratios of job creation and destruction in small and large establishments are chosen, the subject of the analyses in Table 4, to apply the AW decomposition. After decomposing each job flow into three factors, its industry and regional factors are regressed in the same way as in Table 4. The regression results of industry factors and regional factors are summarized in Panels A and B of Table 9. By definition, the estimate for the dependent variable in Table 4 is equal to the sum of the estimates for its industry factor and its regional factor. For example, the estimate of industry-level direct import for job creation of small establishments, −0.251 in Column (1) in Panel A of Table 4, is the sum of its estimate for industry and regional factors, −0.255 in Column (1) and 0.004 in Column (5) in Panel A of Table 9.

There is a conspicuous feature in the results of the industry-level analysis in Panel A that estimates for industry factors in Columns (1)–(4) dominate those for regional factors in Columns (5)–(8), implying that regional factors affect little on industry-level analysis. On the contrary, the results of the region-level analysis in Panel B show that the relative size of estimates for regional factors are larger than those for industry factors. That is, regional factors are the major forces determining how import shocks affect regional job flows and that industry factors play the minor role in it. This represents the fact that the reallocation and aggregate demand effects, two additional local employment effects induced by import shocks, are not observed in each industry proportionally to its labor share across regions but determined by regional characteristics. Regional factors obtained from AW decomposition method succeed in grasping the variation of employment effects through reallocation and aggregate demand effects idiosyncratic to regions. Via the pathway of two regional effects represented in regional factors, direct import additionally decreases employment in both small and large establishments by activating their job destruction (Panel B, Columns (6) and (8)), downstream import additionally reduces small establishments' job reallocation by impeding both job creation and destruction (Panel B, Columns (5) and (6)), and the total job effect of reducing their job reallocation is positive.

The evidence presented by Kainuma and Saito (2022) is useful to understand the last-mentioned positive effect on small establishments. They show in their study that co-location of industries directly affected by imports and their downstream industries in the same region alleviate the negative import effect on employment. Based on their finding, the effect of rising downstream import on deterring job destruction in small establishments can be interpreted as follows: regions with this type of agglomeration have large regional factors which positively correlate with downstream import index in this type of job flow. These arguments demonstrate the benefit of applying AW decomposition to this study as it enables to observe what part of job changes is proportional to industry factors and what part is specific to some particular regions.

To observe whether the three largest regions, Tokyo, Osaka, and Nagoya, influence the results in Panels A and B, the regression is run by using the dataset excluding observations in these three regions. The results are summarized in Panel C for industry-level and Panel D for region-level analysis. Estimates in Panels C and D are similar to those in Panels A and B, respectively, implying that all regions share the same pattern of job reallocation regardless of their size.

6. Conclusion

This study delineated the overview of job reallocation induced by the China shock in Japanese regions. Both industry- and region-level data of detailed manufacturing job flows were constructed, and the regression results were compared to clarify the characteristics of local job reallocation. Three import shocks were considered: direct shock, upstream shock from downstream industries, and downstream shock from upstream industries. To obtain a clearer picture, each job flow was decomposed into industry, regional, and common factors, and then, industry and regional factors were regressed on import shocks to discern what factor affects the job flow and how.

The present study found six sets of salient features regarding Japanese manufacturing job reallocation from regression results. First, the rising direct import from China decreases total jobs. The size of implied job loss is similar in small establishments and large establishments. Second, the rising downstream import increases total jobs. The main route of the positive result in region-level analyses is subsided job destruction in small establishments. Third, in region-level analysis, the total effect of three import shocks decreases employment in large establishments, while it increases employment in small establishments, thanks to the positive downstream effect. The total job effect is negative in all four cases examined. Fourth, job changes are mainly induced by establishments' entry and exit. Surviving establishments' job changes are relatively small. Fifth, implied total job changes are substantially larger in region-level analysis than those in industry-level analysis. The difference between estimated job changes obtained from industry-level analysis and those from region-level analysis is that the former covers

[35] A common factor $\dot{c}_t$ is not shown, because it is common to all industries and regions and therefore does not vary by nature.

[36] Each industry and regional factor in Fig. 6 is expressed as a relative value, being the difference from a median value of 108 industries or 228 regions, respectively. This study employs the distribution of factors, rather than their values, to explain their relative importance to job flows, because a common factor, the sum of medium regional and industry factors, affects all industry–region pairs identically.

Table 9
Second-stage IV estimates for industry and regional factors.

	Industry factors				Regional factors			
	Small establishments		Large establishments		Small establishments		Large establishments	
	Creation	Destruction	Creation	Destruction	Creation	Destruction	Creation	Destruction
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Industry-level analysis, import penetration ratio								
$\Delta T_{i,t}^{ip,di}$	−0.255***	−0.523**	−0.381***	0.013	0.004	−0.021***	−0.011	0.009
	(0.070)	(0.215)	(0.096)	(0.157)	(0.005)	(0.007)	(0.008)	(0.008)
$\Delta T_{i,t}^{ip,us}$	−0.241	−0.097	0.294	−0.442**	0.013	0.007	−0.025	0.075**
	(0.261)	(0.289)	(0.320)	(0.217)	(0.015)	(0.014)	(0.016)	(0.029)
$\Delta T_{i,t}^{ip,ds}$	0.633	1.141	0.579	−1.294	−0.100**	0.098*	0.057	−0.283***
	(0.722)	(1.378)	(1.263)	(0.871)	(0.042)	(0.055)	(0.068)	(0.094)
Panel B. Region-level analysis, per-worker import								
$\Delta T_{r,t}^{pw,di}$	0.007*	−0.004	−0.004	−0.009*	0.004	−0.046***	−0.003	−0.048**
	(0.004)	(0.005)	(0.004)	(0.004)	(0.009)	(0.015)	(0.021)	(0.022)
$\Delta T_{r,t}^{pw,us}$	0.003	0.001	0.030***	−0.042***	0.010	−0.025	−0.060**	0.046*
	(0.005)	(0.006)	(0.006)	(0.006)	(0.012)	(0.017)	(0.030)	(0.024)
$\Delta T_{r,t}^{pw,ds}$	−0.033**	0.050***	−0.032*	0.061***	−0.128***	0.267***	0.129	−0.114
	(0.016)	(0.019)	(0.019)	(0.019)	(0.042)	(0.063)	(0.095)	(0.088)
Panel C. Industry-level analysis, import penetration ratio, excluding Tokyo, Osaka, and Nagoya								
$\Delta T_{i,t}^{ip,di}$	−0.296***	−0.608***	−0.521***	0.109	0.007	−0.021*	−0.006	0.016
	(0.082)	(0.226)	(0.108)	(0.145)	(0.010)	(0.011)	(0.012)	(0.012)
$\Delta T_{i,t}^{ip,us}$	−0.303	−0.065	0.409	−0.467**	0.026	−0.008	−0.050***	0.130***
	(0.293)	(0.346)	(0.412)	(0.227)	(0.023)	(0.025)	(0.019)	(0.034)
$\Delta T_{i,t}^{ip,ds}$	0.633	2.380*	2.030	−2.457***	−0.157**	0.194**	0.100	−0.394***
	(0.779)	(1.240)	(1.305)	(0.928)	(0.072)	(0.084)	(0.093)	(0.143)
Panel D. Region-level analysis, per-worker import, excluding Tokyo, Osaka, and Nagoya								
$\Delta T_{r,t}^{pw,di}$	0.004	−0.001	−0.009**	−0.005	0.006	−0.037***	−0.013	−0.028
	(0.004)	(0.005)	(0.004)	(0.005)	(0.010)	(0.014)	(0.023)	(0.019)
$\Delta T_{r,t}^{pw,us}$	−0.004	0.003	0.035***	−0.043***	0.015	−0.028*	−0.065**	0.061***
	(0.005)	(0.006)	(0.005)	(0.007)	(0.013)	(0.016)	(0.031)	(0.023)
$\Delta T_{r,t}^{pw,ds}$	−0.023	0.073***	0.002	0.016	−0.143***	0.241***	0.185**	−0.119
	(0.018)	(0.021)	(0.022)	(0.023)	(0.045)	(0.053)	(0.085)	(0.090)

Note: The number of observations, the structure of the sample, controls for industry- and region-level regressions, weights in regressions, and Kleibergen–Paap F statistics are the same as the corresponding ones for Tables 2 and 6. Robust standard errors in parentheses are clustered by industries for the industry-level analysis and by regions for the region-level analysis. $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$.

Table A.1
Top 20 and bottom 5 regions of manufacturing jobs in 1996.

Region	1996	2016
Tokyo	2,959,654	1,831,288
Osaka	1,335,984	806,594
Nagoya-Komaki	726,850	546,308
Kyoto	284,644	200,504
Kobe	251,945	193,102
Hamamatsu	210,494	172,241
Maebashi-Takasaki-Isesaki	195,655	148,150
Toyama-Takaoka	166,036	130,782
Okayama	161,579	119,076
Utsunomiya	138,174	112,156
Shizuoka	132,878	85,371
Kitakyushu	128,376	101,809
Toyota	119,495	144,100
Fukuyama	114,232	85,330
Ota-Oizumi	114,138	87,835
Hiroshima	110,792	90,072
Himeji	108,262	81,378
Toyohashi	104,557	91,446
Fukui	101,988	75,810
Tsukuba-Tsuchiura	100,909	85,318
Miyakojima	1,073	1,090
Furano	951	627
Yomitan	903	1,810
Atami	772	351
Kutchan	476	334

Table A.2
108 industries and their number of jobs in 1996 and 2016.

Industry	1996	2016	Industry	1996	2016
Livestock products	162,975	160,245	Glass and its products	81,926	51,181
Seafood products	235,008	158,196	Cement and its products	199,232	90,264
Fruit and vegetable products	73,101	57,694	Structural clay products	14,467	4,638
Seasonings	63,676	58,053	Pottery and related products	100,930	51,122
Sugar processing	9,853	5,121	Clay refractories	14,713	9,466
Flour and grain mill products	22,030	16,908	Carbon and graphite products	5,602	5,419
Bakery and confectionery products	307,348	289,111	Abrasive products	10,469	9,115
Animal and vegetable oils and fats	14,095	11,047	Aggregate and stone products	46,654	25,204
Misc. food products	434,905	475,852	Misc. ceramic and stone products	29,787	21,301
Soft drinks	36,584	35,839	Iron and steel	334,149	238,132
Alcoholic beverages	58,043	39,435	Rolling of non-ferrous metals	38,855	31,209
Tea and coffee	34,325	28,417	Electric wire and cable	74,231	35,244
Tobacco manufactures	11,031	3,502	Plated sheet products	24,478	12,604
Animal foods and organic fertilizers	20,861	18,666	Tableware, cutlery, and hardware	60,992	44,688
Spinning mills	102,442	33,701	Heating and plumbing supplies	64,547	43,439
Woven fabric mills	180,347	58,508	Architectural metal products	421,866	266,956
Knit fabrics mills	14,049	5,693	Fabricated wire products	32,944	17,873
Misc. textile mill products	30,929	19,003	Bolts, nuts, rivets, and screws	55,418	46,413
Outer garments and shirts	543,706	144,555	Misc. fabricated metal products	365,615	280,869
Underwear	55,812	12,803	Boilers, engines, and turbines	47,512	46,297
Misc. fabricated textile products	164,745	84,252	General industry machinery	326,337	242,022
Lumbering and wood products	105,395	44,946	Misc. machinery and machine parts	293,074	270,645
Prefabricated structural wood products	77,280	44,194	Agricultural machinery	44,840	35,098
Wooden containers	21,094	7,976	Construction machinery	76,749	63,940
Misc. wood products	22,979	10,958	Textile machinery	49,819	23,900
Furniture and fixtures	264,638	141,439	Special industry machinery	141,006	149,538
Pulp	2,611	3,275	Metal working machinery	179,015	161,061
Paper	76,925	35,341	Office and household machines	173,057	112,421
Coated and glazed paper	37,328	25,843	Measuring and analytical instruments	91,753	75,959
Paper products	32,402	23,560	Medical instruments and apparatus	65,540	76,383
Paper containers	130,604	91,140	Optical instruments and lenses	86,857	45,415
Misc. paper products	42,107	40,451	Ordnance	3,282	5,118
Printing and allied industries	612,641	365,123	Electronic parts and devices	759,856	483,217
Chemical fertilizers	9,237	5,884	Industrial electric apparatus	438,717	335,031
Industrial inorganic chemicals	55,979	44,821	Household electric appliances	137,680	65,469
Industrial organic chemicals	123,684	112,045	Electric bulbs and lighting fixtures	59,909	42,536
Detergents and surface-active agents	72,345	52,552	Electronic equipment	80,163	57,723
Drugs and medicines	144,500	153,287	Electric measuring instruments	56,821	35,340
Cosmetics and toilet preparations	38,335	47,682	Misc. electrical machinery	86,250	56,961
Misc. chemical and allied products	62,715	58,323	Communication equipment	259,716	108,739
Paving materials	9,824	7,988	Electronic computer	167,606	73,959
Plastic plates, bars, pipes, and sheets	133,297	110,958	Motor vehicles and parts	939,575	946,130
Plastic products	367,567	320,948	Railroad equipment and parts	28,128	27,896
Tires and inner tubes	32,808	32,143	Shipbuilding and marine engines	116,966	80,418
Rubber and plastic footwear	30,557	9,250	Aircraft and parts	40,548	54,164
Rubber belts and hoses	97,927	84,091	Misc. transportation equipment	45,896	36,140
Misc. rubber products	20,194	13,069	Precious metal products and jewels	26,911	13,406
Leather tanning and finishing	7,577	3,499	Costume accessories	23,491	11,209
Mechanical leather products	618	462	Watches and clocks	34,145	11,868
Leather footwear	34,199	11,604	Musical instruments	19,884	8,828
Leather gloves and mittens	2,277	804	Toys and sporting goods	60,720	36,833
Leather baggage	38,096	17,069	Painting materials and stationery	31,385	19,910
Fur skins	524	169	Sundry goods of daily commodities	37,450	20,060
Misc. leather products	5,181	2,066	Manufacturing industries, n.e.c.	161,065	109,939

the direct impact of import shocks and the indirect impacts arising from input–output linkages, and the latter additionally encompasses the reallocation effect and the aggregate demand effect. Therefore, the result indicates that these two additional local effects are the dominant factors that cause the change in local manufacturing employment. Sixth, in region-level analysis, implied job changes from regional factors are much larger than those from industry factors. This indicates that regional factors, the main forces determining how import shocks affect regional job flows, represent well two local job effects of import shocks. The method of decomposing job changes into detailed job flows and into industry and regional factors, proposed in this study, enabled obtaining a clearer view of job reallocation and how import shocks travel through labor market.

A natural extension of the study would be to examine the trade impact on a more detailed level considering both demand and supply aspects of labor. On the demand side, firms and establishments are the basic entities of labor demand, and their decisions are affected by both industry- and region-level imports, which are at the core of this study. Examining firm- or establishment-level reaction to import shocks would provide us clarity on how import shocks travel through the labor market. On the supply side, if a large set of Japanese individual-level panel data becomes available, the trade impact on not only worker reallocation but also on their working and welfare status can be observed. The outcome of this future research direction would help us grasp the heterogeneous trade impact on each individual and establish trade policy to make trade more inclusive.

Data availability

The authors do not have permission to share data.

Appendix. Tables

See Tables A.1–A.4.

Table A.3
Top 10 and bottom 5 industries affected negatively by the China shock: 1996–2016.

Industry	Number of implied job	Industry	Implied job ratio to jobs in 1996
Outer garments and shirts	−81,889	Misc. textile mill products	−0.363
Communication equipment	−69,623	Communication equipment	−0.268
Electronic parts and devices	−51,961	Rubber and plastic footwear	−0.248
Industrial electric apparatus	−29,276	Toys and sporting goods	−0.231
Electronic computer	−24,804	Leather baggage	−0.209
Misc. machinery and machine parts	−19,040	Tableware, cutlery, and hardware	−0.180
Household electric appliances	−16,680	Misc. transportation equipment	−0.179
Misc. fabricated textile products	−14,924	Sundry goods of daily commodities	−0.172
Furniture and fixtures	−14,129	Outer garments and shirts	−0.151
Toys and sporting goods	−14,030	Electronic computer	−0.148
Alcoholic beverages	498	Railroad equipment and parts	0.010
Drugs and medicines	647	Tea and coffee	0.010
Bakery and confectionery products	659	Shipbuilding and marine engines	0.010
Office and household machines	966	Soft drinks	0.013
Shipbuilding and marine engines	1,173	Fur skins	0.033

Table A.4
Top 20 and bottom 10 regions affected negatively by the China shock: 1996–2016.

Region	Number of implied job	Region	Implied job ratio to jobs in 1996
Tokyo	−52,993	Yamaga	−0.166
Osaka	−13,299	Ichinoseki	−0.130
Fukushima	−5,309	Fukushima	−0.098
Nagano	−4,085	Honjo	−0.097
Koriyama	−3,889	Shiroishi	−0.096
Kyoto	−3,509	Yasu	−0.091
Kobe	−3,448	Tottori	−0.078
Matsumoto	−3,413	Nasushiobara-Otawara	−0.078
Nasushiobara-Otawara	−2,749	Yonezawa	−0.074
Yamagata	−2,682	Nagano	−0.065
Ichinoseki	−2,583	Towada	−0.064
Maebashi-Takasaki-Isesaki	−2,390	Goshogawara	−0.064
Kanazawa	−2,374	Oyama	−0.063
Kofu	−2,286	Matsumoto	−0.061
Utsunomiya	−2,218	Kitakami	−0.061
Tottori	−2,202	Koriyama	−0.060
Honjo	−2,180	Sakata	−0.060
Yonezawa	−2,133	Kashiwazaki	−0.059
Oyama	−2,099	Osaki	−0.058
Ueda	−2,063	Yurihonjo	−0.054
Anjo	1,352	Yomitan	0.027
Kariya	1,476	Koka	0.028
Toyama-Takaoka	1,505	Makinohara	0.030
Hiroshima	1,697	Yamaguchi	0.030
Fuji	1,734	Anjo	0.032
Okazaki	1,755	Hekinan	0.032
Hamamatsu	1,960	Okazaki	0.032
Toyohashi	2,708	Tsuruga	0.033
Toyota	4,219	Toyota	0.035
Nagoya-Komaki	6,406	Nishio	0.036

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