Firm and Labor Adjustments to FDI Liberalization

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Abstract

This paper studies how liberalizing outward foreign direct investments (FDI) affects manufacturers' engagement in global production and their domestic workers' labor market outcomes. Focusing on a liberalization policy in Taiwan that permits 122 electronic products to be produced in China, we estimate its effect on Taiwanese electronic manufacturers and their domestic workers. Employing a matched difference-in-differences strategy, we find that the manufacturers targeted by the policy are on average 15% more likely to invest in China relative to the non-targeted ones. Correspondingly, the domestic workers initially employed by the targeted manufacturers are on average more likely to change their jobs, stay fewer years employed, and have lower wages in subsequent years relative to those employed by the non-targeted ones. The worker-level effects exhibit substantial heterogeneity across the initial wage distribution, with the top-decile workers winning and the other workers losing.

Keywords: Production, Employment, International Investment

JEL Codes: E23, E24, F21

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1   Introduction

Foreign production activities by multinational enterprises (MNEs) play a crucial role in the global economy today. According to the OECD, the gross output of foreign affiliates accounts for about 10-12% of the global output and increases from 7 to 20 trillion USD over 2000-2014 (Cadestin et al., 2018). As the barrier to conduct foreign direct investments (FDI) gets lifted, how do the domestic manufacturers respond, and what happens to their workers in the home country? From a theoretical perspective, it is straightforward that the manufacturers would likely respond to cost reductions by setting up foreign affiliates and utilizing cheaper production factors abroad. However, the prediction regarding domestic workers is unclear: on the one hand, the domestic workers could enjoy higher wages due to their employers' growth; on the other hand, they could be replaced by foreign workers as their employers shift production activities abroad. This paper examines the questions empirically utilizing novel multinational production data and a rare liberalization policy in Taiwan that permits a subset of electronic products to be produced in China.

To study the effect of outward FDI on firm and worker outcomes, two main challenges are present in the literature: data availability and identification. First, it is difficult to capture the extent of foreign production activities. A common approach in the offshoring literature (Hummels, Munch and Xiang, 2018) uses imports of intermediates as the empirical measure. However, following this approach to study the impact of outward FDI would neglect a large chunk of foreign production activities if the major purpose of the FDI is to access the host country market (i.e. horizontal FDI, as in Helpman, Melitz and Yeaple, 2004) or to export to the world market (i.e. export-platform FDI, as in Tintelnot, 2017). These activities cannot be captured by import data but still have an impact on workers in the home country. The ideal solution to this challenge would be to have a comprehensive dataset that tracks production activities for both the parent firms in the home country and their affiliates in the host country.

Even if firm production activities across locations are observed, the effect of FDI cannot be identified due to the endogenous nature of investment decisions. As theoretical papers on

multinational production and FDI (Helpman, Melitz and Yeaple, 2004; Antràs and Yeaple, 2014) already highlighted, firms self-select into FDI activities based on their unobserved productivity in the face of fixed costs. As a result, comparing outcomes of FDI firms versus non-FDI firms reflects not only the causal effect of conducting FDI activities that we seek to capture but also the inherent productivity differences across firms. The ideal solution would be to randomly assign firms to invest abroad, but it is not feasible in real life. A second-best solution then is to find a natural experiment that triggers some firms to conduct FDI but not others.

This paper deals with the challenge of data availability by utilizing novel data sources. At the firm level, we utilize a multinational production dataset that covers all Taiwanese listed firms in the electronic manufacturing sector over 1998-2007. It contains balance-sheet information for both the Taiwanese parent firms and their Chinese affiliates, allowing us to examine the extent of outward FDI activities in the electronic manufacturing sector, where China is their major destination. At the worker level, we bring in administrative matched employer-employee data from the Taiwan Fiscal Information Agency (FIA) to identify the domestic workers that are hired by the parent firms in our firm-level data over the sample period. These sources provide a complete picture of the multinational production activities and associated labor market outcomes for the electronic manufacturing sector in Taiwan.

Furthermore, this paper tackles the identification challenge by studying a rare policy change from the Taiwanese government in 2001 that permitted 122 electronic products to be produced in China. As we argue in detail in Section 2, this policy change is a great natural experiment as its timing and content are exogenous from the perspective of Taiwanese electronic manufacturers. In addition, it significantly reduces the targeted firms' fixed costs to produce their products in China and thus increases their incentives to set up affiliates in China and shift their production there.

To estimate the causal effects of the policy change on firm investment behaviors, we employ a matched difference-in-differences (DID) strategy. We first define the "treatment firms" as the electronic manufacturers who have produced products related to the 122 products over 1998-2000, then match these firms one-to-one with the other electronic manufacturers who

have never produced related products before 2001 but nonetheless exhibit similar characteristics in 1998 (the "control firms"). Then we run a standard DID comparing their investment activities before and after the policy change. The underlying assumption of this strategy is that the treatment firms would follow the same investment trend as the control firms in the absence of the policy change.[1] We find quantitatively sizable and statistically significant response from the electronic manufacturers. At the extensive margin, the treatment firms are on average 15% more likely to start investing in China relative to the control firms. At the intensive margin, the treatment firms tend to hire more (less) workers in China (Taiwan), pay higher (lower) wage bills in China (Taiwan), and enjoy higher sales in two locations relative to their counterparts.

Following the firm-level results, we then shift our attention to the worker-level response. In particular, we examine how home country workers employed by the treatment and control firms in 2001 (i.e. the "treated" and "untreated" workers) differ by their labor market outcomes in subsequent years of the policy change. The treated workers experience significantly higher job transition rates after 2001 relative to the untreated workers. They also tend to stay fewer years employed and accumulate slightly lower wages on average, but these effects are not statistically significant. Nonetheless, we find that treated workers in the top decile of the wage distribution in 2001 enjoy significantly better outcomes, while the negative effects are mainly found on the treated workers around the median of the distribution (25th-75th percentile in 2001). Overall, the worker-level results indicate an imprecise negative effect of the liberalization policy on average, but the distribution implication is clear: the effect of FDI liberalization is positive for the workers in the top wage decile, who are more likely to possess higher education and skill levels, but is negative for the median workers.

Our study contributes to two main strands of research in trade and globalization. The first one is about globalization and firm internal organizations. Many papers have found that global engagements of firms, either through imports, exports, or FDI, lead to more (less) employment of domestic high-skilled (low-skilled) workers (Burstein and Vogel, 2017; Hsieh

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[1]The parallel trends assumption is supported by our event study estimates as no significant pre-trends are detected. We further conduct a sensitivity analysis following Rambachan and Roth (2022) as a robustness check.

and Woo, 2005; Hur, Yoon and Ahn, 2019; Bernard and Jensen, 1997; Menezes-Filho and Muendler, 2011; Tsou et al., 2013; Alviarez et al., 2022) and adoption of new technologies in the home country (Lileeva and Trefler, 2010).[2] However, most of the papers do not actually observe the production activities abroad and could not study the intensive margin of FDI activities. In addition, most of them do not have plausibly exogenous episodes of FDI liberalization to identify the firm responses. One rare exception is Alviarez et al. (2022), which exploits a FDI policy change that affects the set of "encouraged" FDI industries in China and uses Japanese confidential survey data to study firm-level structural transformation. Our paper complements their findings by utilizing a FDI liberalization episode in Taiwan that creates *within-industry* variation in FDI activities and further exploring the extensive margin of firm response as well as the labor market effect for domestic incumbent workers.

We also contribute to a second strand of literature on globalization and domestic labor market outcomes. Consistent results across developing and developed countries have shown that regions (Topalova, 2010; Autor, Dorn and Hanson, 2013; Kovak, 2013; Dix-Carneiro and Kovak, 2017) and individuals (Autor et al., 2014; Dix-Carneiro, 2014; Dix-Carneiro and Kovak, 2019) that are initially more exposed to trade liberalization episodes experience declining employment and lower wages in subsequent years. Most of these liberalization episodes are either due to productivity growth from foreign exporters, as the so-called "China shock" in the context of the United States, or policies that reduce import tariffs across sectors, as in the context of India and Brazil. Despite the extensive studies on trade liberalization, the liberalization of outward FDI is less covered in the literature. Given the major role of multinational firms in international trade, policies that remove outward investment barriers can affect multinational firms' investment responses and have a crucial impact on the local labor market at home. This paper fills in the gap by studying a FDI liberalization episode and confirms the large redistributive impact of such policy change on domestic workers.

The rest of the paper is organized as follows. Section 2 introduces the background of Taiwanese outward FDI since the 1990s as well as our firm- and worker-level data. Section 3 describes our empirical strategy and summarizes our firm and worker samples. Section 4

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[2]A recent working paper by Branstetter et al. (2021) studies the same policy in Taiwan and finds that outward FDI into China actually decreases the innovation activities by Taiwanese electronic manufacturers.

and Section 5 present the results of firm and worker responses to the liberalization policy respectively. Lastly, Section 6 concludes.

2 Background and Data

2.1 Background of FDI Liberalization in Taiwan

In this section, we discuss the factors behind the pivotal change in official guidelines on Taiwanese firms investing in China. We present the background of the 2001 liberalization policy that marked the end of Taiwanese government's restrictive attitude toward FDI in China. Finally, we provide two reasons to support the exogeneity of our policy of interest.

Due to political tensions and national security concerns, the Taiwanese government was initially skeptical about investment opportunities following the Chinese economic reform in the 1980s. Under strict regulations, it was not until the 1990s that Taiwanese FDI in China really took off. In 1996, Taiwanese President Lee Teng-Hui announced a series of regulations termed "no haste, be patient", which prohibited a total of 316 products from investing in China, imposed an investment cap of $50 million USD for any single investment project in China, and required the total investment amount per firm to be lower than 40 percent of its net worth.

In 2000, Chen Shui-Bian, the leader of the long-time opposition Democratic Progressive Party (DPP), won the presidential election by a small margin. The DPP had been known for its tougher stance toward China. Under the worldwide economic downturn and intensified cross-strait tensions, the new president was faced with an urgent need to calm skeptics from the business and political groups. Lacking a clear mandate and confronted by an opposition-controlled legislature, Chen Shui-Bian moderated DPP's stance on Taiwanese nationalism and took economic liberalization as a friendly gesture to Beijing. Also, Taiwan and China were both about to join the WTO at that time. Under the trend of trade liberalization, critics doubt the competitiveness of Taiwanese firms against other foreign companies that

took advantage of global supply chain management. If Taiwanese firms were prohibited from offshoring to China, the heavy labor cost will harm the competitiveness of Taiwanese firms.

On account of those concerns, Chen adopted a series of trade policies termed "active opening, effective management". Particularly, the 50 million USD investment cap was alleviated, and a list of 122 high-tech products, including laptops, mobile phones, digital optical drives, computer hardware and software, communication products, and consumer electronics, were allowed to be produced in China starting from 2001.[3] In Figure 1, we can see that the outward FDI amount into China substantially increased after 2001, with a major proportion coming from the electronic manufacturing industry.

FDI liberalization in Taiwan was driven by a series of political shocks. In particular, this paper focuses on the 2001 policy change for two reasons. First, it only allowed a fraction of high-tech products to be produced in China, granting us a natural control group. Second, it was adopted soon after the DPP's (who was more skeptical toward China) unexpected win in the presidential election. Based on these two reasons, we believe that this policy change is plausibly exogenous from the view of the electronic manufacturers in Taiwan.

2.2   Firm-level Dataset

To investigate the effect of the 2001 liberalization policy on firm investment decisions across Taiwan and China, we need a firm-level dataset that collects the production activities of Taiwanese manufacturers in those two places over this period. Focusing on Taiwanese electronic manufacturers, we record their production activities over 1998-2007 utilizing two main sources. On the one hand, their production activities in Taiwan are obtained from the Taiwan Economic Journal (TEJ) dataset, which contains detailed firm information for all publicly listed companies in Taiwan; on the other hand, their production activities in China are provided by the Chinese Annual Survey of Industrial Manufacturers (ASIM), which surveys state and non-state firms above 5 million RMB in annual sales (Brandt, Biesebroeck and Zhang, 2014).

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[3]The complete list of products is provided in Appendix A.

The summary of the full firm sample before the policy change in 2001 is provided in column 2 of Table 1. Overall, we have 533 Taiwanese electronic manufacturers in total. On average, each firm has 1.25 affiliates in China, hires 473 workers in Taiwan and 851 workers in China, pays annually 5.2K USD per worker in Taiwan and 1.4K USD per worker in China, and records annual sales of 54K USD in Taiwan and 49K USD in China.[4]

2.3 Worker-level Dataset

The Fiscal Information Agency (FIA) under the Ministry of Finance in Taiwan provides yearly assembled taxation data starting from 2001. Our main data source for the worker-level analysis is the FIA data for Individual Income Tax filing (equivalent to the IRS data in the US). We track the source of all taxable income of individuals in Taiwan and construct a matched employer-employee dataset. With the unique firm identifier, information from the firm-level dataset can be combined with the employer-employee dataset. Since income types are provided by the matched employer-employee dataset, we can restrict our focus on wage incomes and will not mistake employees for shareholders. We also drop self-employed observations. We focus on native workers since foreign workers are subjected to different labor market regulations in Taiwan.

The advantage of the FIA data is that we can combine datasets for different tax categories and demographic data from other administrative databases in Taiwan with the de-identified individual ID number. By accessing the household registration database, basic demographic information of workers is also available, e.g. age, gender, residence (county level), and marriage status of each worker.

The limitation of our data source is that it does not record information unrelated to tax collection. For example, there is no data for the total working years and education level of workers. In addition, for each individual, we have no information about the working status prior to 2001. We also acknowledge the fact that we cannot accurately determine the skill level of workers.

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[4] If a firm has more than one Chinese affiliate, we sum up their statistics to the firm level.

3 Empirical Strategy

As introduced in Section 2, the policy in 2001 opened up the possibility for Taiwanese electronic manufacturers to conduct FDI in China. Our goal is to exploit this liberalization policy that is exogenous from the firms' perspective and study its effect on the firms and their domestic workers. To achieve this goal, we employ a matched difference-in-differences approach for the firm-level analysis and a cross-section regression approach for the worker-level analysis. In the rest of the section, we explain the empirical approach in details and then present the summary statistics of the firm and worker samples respectively.

3.1 Research Design for the Firm-level Analysis

For the firm-level analysis, the main outcomes of interests include measures of outward FDI activities at both the extensive and intensive margins. The extensive margin outcomes include indicators of exiting the market, investing in China, and investing in the same three-digit industry in China. Making a distinction between the last two investment outcomes is to specify whether the outward FDI into China are directly related to the Taiwanese electronic manufacturers' core production activities and not for other purposes, e.g. marketing. The intensive margin outcomes include variables that cover the extent of production activities for the parent firms in Taiwan and the affiliate firms in China, including number of workers, wage bills per worker, total sales, and export sales for both the parents and affiliates respectively.

To study the causal effect of the liberalization policy in 2001, we employ a difference-in-differences design. In particular, we define the Taiwanese electronic manufacturers who had been producing products related to the 122 permitted product categories before the policy change to be the "treatment firms" and the other electronic manufacturers who had never done so to be the "control firms". The key identification assumption here is the parallel trends assumption, and we discuss its validity in Section 4.

The classification procedure for the electronic manufacturers are conducted by utilizing the product-level sales in the TEJ dataset and manually checking whether each firm had

produced any product that has the same keywords as the 122 electronic products in Appendix A. We end up obtaining 190 treatment firms and 343 control firms, with main outcomes over year 1998-2000 summarized in Table 1. Treatment firms are significantly more engaged in FDI activities in China and have higher total and export sales than the control firms before the policy change. The ex-ante difference in firm characteristics poses a threat to the control firms as a proper control group and hence motivates our matching approach to obtain a sample that is balanced in observables across the treatment and control firms. In addition to the binary treatment measure, we also define a continuous treatment measure as the share of related-product sales for each firm.

3.2   Matching Procedure and Summary of the Firm Sample

To ensure that the control firms serve as a suitable counterfactual group for the treatment firms in the absence of the policy, we conduct a one-to-one matching procedure that provides balance along observable characteristics. Specifically, we match on parent firm characteristics over year 1998-2000, including number of workers, average wage bills, total sales, and export sales. We avoid matching on investment outcomes in China intentionally as they are the main outcomes of interests. The propensity scores, i.e. predicted probabilities of being treated, are illustrated in Figure 2. The common support assumption is plausible, as the treatment and control firms share overlapping support and have similar distributions.

The resulting sample statistics over year 1998-2000 are provided in Panel (a) of Table 2, where the one-to-one matched sample consists of 174 treatment and control firms each, and the outcomes are now balanced across two groups. The share of treatment and control firms doing outward FDI into China is plotted in Figure 3a and Figure 3b. A common rising trend of outward FDI into China is featured for both groups, but it is particularly higher for the treatment firms to conduct FDI in the same 3-digit industry in China after the policy change in 2001. Our matching procedure seems to achieve a well-balanced sample and therefore ensure that the parallel trend assumption is plausible under this setup.

3.3 Research Design for the Worker-level Analysis

To understand how the liberalization policy affects the local workers in Taiwan, a natural approach is to follow the same strategy as the firm-level analysis and conduct difference-in-differences for the worker sample. Unfortunately, the FIA matched employer-employee dataset only starts from 2001 (i.e. the year when the policy change happened), so it is not feasible to do so. Instead, we follow a similar approach to Autor et al. (2014) by following workers' cumulative outcomes by their treatment status from 2001 onward.

Specifically, the Taiwanese workers employed by the treatment firms in 2001 are defined as the "treated workers", and the others employed by the control firms in 2001 are defined as the "untreated workers". We then compare their cumulative outcomes over 2001-2007 between the two groups controlling for individual observable characteristics in 2001, including their age, gender, and marital status. To investigate the heterogeneous treatment effect by initial wage levels, five wage groups are defined based on wage percentiles of the workers in 2001 and summarized in Table 5. The key identification assumption here is the conditional independence assumption, which we discuss its meaning and plausibility in Section 5.

For the worker-level analysis, our outcomes of interests are individual outcomes that evaluate their job security and earnings in the labor market, including whether a worker switches their job, whether a worker is employed, and their wages in a given year.

The liberalization policy lowers the cost for treatment firms to invest in China and thus creates an incentive for them to conduct outward FDI. The policy affects the treated workers directly through job loss or wages driven down by a greater labor supply. Both situations can result in fewer years employed and less wage accumulated in the initial firm. Note that the liberalization policy may also have a second-order effect on workers who have experienced job transitions. While the policy causes treatment firms to lay off workers, being laid off may have adverse effects on re-employment probabilities.

In order to distinguish the first-order effect from the second-order effect, we further decompose the employment status into four mutually exclusive outcomes: years outside the initial firm and same industry, years outside the initial firm and different industry, and years

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unemployed. Similarly, cumulative wages are decomposed into wages earned in the initial firm, wages earned in the initial industry, and wages earned in different industries. The first-order effect is best reflected by the working years and wages accumulated in the initial firm. Therefore, we expect a significant negative effect on the year employed and wages earned in the initial firm.

3.4 Summary of the Worker Sample

The main variables of the worker sample are summarized in Table 4. Out of the 348 electronic manufacturers in the one-to-one matched firm sample, we are able to identify 324 of them in the FIA dataset (168 treatment firms and 156 control firms) and collect 111,426 workers who worked full time in those firms in 2001 and were within age range 22-65 over 2001-2007. The number of total employers hiring the treated workers in 2007 becomes a staggering 7,176 in total, indicating a large transition out of the original firms in subsequent years. In fact, 61% of the workers left their original firms by 2007, and the numbers for the treated and untreated workers are 68% and 54% respectively. The mean yearly wage of the treated workers is similar to that of the untreated workers at around 17K USD in 2001, but then it becomes significantly lower by 1,410 USD in 2007. The policy induced high leaving ratio and negative wage effect observed in the summary statistics is consistent with our regression results which will be elaborated in Section 5

4 Firm-level Response to the Liberalization Policy

With the firm sample obtained via the matching procedure outlined in Section 3.2, we first study how Taiwanese electronic manufacturers respond to the liberalization policy in 2001. In the following, we first lay out the empirical specifications and identification assumption, then present results for extensive and intensive outcomes.

4.1 Empirical Specification

To estimate the effect of the liberalization policy on firm investment behavior, we compare firms who had produced related products before the policy change (i.e. the "treatment firms") versus those who had not (i.e. the "control firms"). This motivates the difference-in-differences specifications for the firm sample as follows:

$$Y_{jkt} = \alpha_0 + \alpha_1 Post_t \times Treatment_j + Year_t + Firm_j + \epsilon_{jkt} \tag{1}$$

$$Y_{jkt} = \alpha_0 + \sum_{t'=1998}^{2007} \alpha_{t'} Year_{t'} \times Treatment_j + Year_t + Firm_j + \epsilon_{jkt} \tag{2}$$

where j indexes firm, k indexes industry, and t indexes year. Y_{jkt} indicates the yearly firm outcome, $Post_t$ is an indicator of year t after 2001 ($t \in [1998, 2007]$). $Treatment_j$ equals one for the treatment firms and zero for the control firms. $Year_t$ and $Firm_j$ are the year and firm fixed effects. Error terms ϵ_{jkt} are clustered at the three-digit industry level of the parent firms.

4.2 Identification Assumption

We claim that the estimates of coefficients α_1 in Equation (1) and $\{\alpha_{t'}\}$ in Equation (2) measure the causal effects of the liberalization policy. The key identification assumption for the coefficients is the standard parallel trends assumption; in other words, the treatment firms would follow the same time trend as the control firms in the absence of the policy. Under

this assumption, α_1 and $\{\alpha_{t'}\}$ can be interpreted as the overall and period-specific average treatment effects on the treated (ATT) for the liberalization policy.[5] Because there are still some treatment firms who decide not to invest in China (the non-compliance problem), we cannot interpret the estimates as the causal effect of outward FDI on workers

The parallel trends assumption is valid for the following reasons. First, the matching procedure outlined in Section 3 ensures similarity across observable characteristics between the treatment and control firms before the policy change. As the firms are similar ex-ante, it is plausible that the treatment firms would exhibit the same time trend as the control firms if the policy change had not happened. Second, our focus on the electronic manufacturers and distinction by the products produced warrant that other major events during this time (e.g. Taiwan's accession to the WTO in 2001) would not affect the treatment and control firms differently.

With a recent method developed by Rambachan and Roth (2022), we can also allow for linear and non-linear time trends and examine to what extent our results would be affected. This sensitivity analysis is included as a robustness check following the firm-level results.

4.3 Extensive Margin Outcomes

We first look at the extensive margin outcomes, including whether firms exiting the market, conducting FDI in China, and conducting FDI in the same 3-digit industry in China. The corresponding DID estimates for Eq (1) are presented in Table 6. The treatment firms do not seem to be different in terms of the exit margin relative to the control firms. However, we do see that the treatment firms are on average 7.8% more likely to invest in China. In particular, the treatment firms are on average 15.2% more likely to invest in the *same* three-digit industry; this magnitude is more than six times as big as the mean for the control firms before 2001. This result is consistent with the argument that the liberalization policy allows the firms who had produced related products to start investing in China and producing those

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[5]In the event-study graphs below, the coefficients $\{\alpha_{t'}\}$ are adjusted with respect to the one before the policy, i.e. α_{2000}.

related products after the policy change. The event study graphs following Eq (2) in Figure 4 also convey a similar message, where higher propensities to invest in China and particularly in the same industry after 2001 are observed for the treatment firms.

We also run the same specifications using a continuous treatment measure (defined as the share of sales that is related to the 122 products before 2001) and present the DID estimates in column (2), (4), and (6) of Table 6. Again the estimate for the exit margin is not statistically different from zero, but the two investment outcomes are significant: on average, raising the share of policy-related sales before the policy change by one standard deviation (0.373) would lead to an increase of investing into China by 4.5% and investing in the same three-digit industry by 7.2%. The estimates using the continuous measure are consistent with the previous estimates using the discrete treatment measure.

4.4 Intensive Margin Outcomes

To understand how firms respond to the policy at the intensive margin, we restrict our sample to the firms that have investments in China over the whole sample period (1998-2007) and study their outcomes including number of workers, wage bills per worker, total sales, and export sales for both the parent firms in Taiwan and their affiliates in China. The DID estimates for all outcomes in log terms are presented in Table 7. Despite low statistical power due to losing observations, the DID estimates for the parent firms show that on average, the treatment firms in Taiwan decrease their hiring and wage bills per worker by 34% and 24% relative to the control firms, while their affiliates in China hire 40% more workers and also raise the wage bills by 57% relative to the counterparts. For the production outcomes, the treatment firms seem to have a positive increase in sales for both the parent and affiliate branches; in particular, export sales of the affiliates increase by 85%, echoing the export-oriented feature of the new outward FDI induced by the policy.

We also use the share of related product sales over 1998-2000 as a continuous treatment measure and report their DID estimates in Column (2), (4), (6), and (8) of Table 7. The standard deviation of the continuous treatment is about 0.373, so the DID estimates for the

parent outcomes indicate that an increase of one standard deviation in the share of related product sales before 2001 would result in a 32% decrease in their number of workers hired in Taiwan and a 26% decrease in their wage bills paid per worker (both statistically significant at 99% level). On the other hand, the estimates for the affiliate outcomes suggest that when the share of related product sales increases by a standard deviation, the number of workers hired in China would raise by 21%, and their wage bills per worker would increase by 19%. Overall, the results are consistent with the binary treatment measure and indicate a strong resource reallocation effect of the FDI liberalization policy.

4.5 Robustness of Firm-level Response

4.5.1 Robustness to Different Firm Samples

To test if our estimates of the firm-level response to the liberalization policy are robust to different samples, we run the same set of specifications with the full firm sample (without doing the one-to-one matching) as well as another matched sample using the kernel matching method. The basic summaries of the two samples are in Table 1 and Panel (b) of Table 2.

The analogous results using the full firm sample are listed in Table 8 and 9, and those using the kernel matching sample are provided in Table 10 and 11. The estimates for the extensive margin outcomes align pretty well; in particular, the DID estimates for investing in the same three-digit industry in China are all around 14-15%. For the intensive margin outcomes, the estimates from the full sample and the kernel matching sample reflect smaller effects in magnitude, but the signs indicate a consistent story: the treatment firms tend to reduce their employment and pay less wage bills in Taiwan while boosting their hiring and wage bills in China. Overall, our estimates are robust to different sample selections.

4.5.2 Robustness to Relaxing Parallel Trends Assumption

The key identifying assumption of the DID and event-study estimates is the parallel trends assumption, i.e. the treatment firms would follow the same time trend as the control firms

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if the policy change in 2001 had not happened. Although we could never directly test this assumption, it is less likely to hold if there is a significant pre-trend before the policy change takes place. For example, if we saw that the treatment firms already have a higher tendency to invest in China relative to the control firms before 2001, then it is hardly believable that the two groups would behave the same in the absence of the policy. As shown in Figure 4, there are no significant pre-trends associated with the two investment outcomes.

To provide a stricter examination, we conduct a sensitivity analysis using the *HonestDiD* package developed by Rambachan and Roth (2022). The main idea of this method is to relax the parallel trends assumption and allow for post-treatment difference in trends that are "close" to the estimated pre-trend, in linear or non-linear fashions. We apply the method to examine each event-study estimates after 2001 in Equation (2), i.e. $\{\alpha_t\}$. The results are shown in Figure 5. The coefficients in blue are the original estimates, and those in red are the estimated confidence sets allowing for trends, with M indicating the degree of non-linearity of the trends. It can be seen that all event-study estimates are robust to allowing for linear trends (i.e. the confidence sets when $M = 0$) but become less so as the trends get more and more non-linear. Nonetheless, the non-linear confidence sets do not change signs and are consistent with our main results. Overall, we are confident to conclude that our firm-level results are robust.

5 Worker-level Response to the Liberalization Policy

After examining the firm-level response to the liberalization policy in Section 4, we now move on to the worker sample to study the policy effect on the domestic incumbent workers, i.e. the Taiwanese workers employed by the electronic manufacturers in our firm sample at the onset of the policy in 2001. We first introduce the empirical specification, then explain the identification assumptions needed to establish causal claims for the regression parameters, and finally present the results as well as the robustness checks.

5.1 Empirical Specification

As discussed in Section 3, the FIA matched employer-employee data starts from year 2001 (i.e. the year when the policy change takes place), so our empirical strategy is to compare the cumulative outcomes over 2001-2007 for the treated and untreated workers conditional on their demographic characteristics. This implies the following regression specification:

$$Y_{ijkt} = \alpha_t \, Treated_j + Industry_k + X_{ijk2001} + \zeta_{ijkt} \tag{3}$$

where i indexes incumbent workers, j indexes worker i's initial employer in 2001, k indexes worker i's initial industry in 2001, and t indexes years following the policy change ($t \in [2002 - 2007]$). Y_{ijkt} are the cumulative outcomes up to year t for worker i originally employed by firm j of industry k in 2001. $Treated_j$ indicates whether firm j is a treatment firm, $Industry_k$ is the four-digit industry fixed effect, and $X_{ijk2001}$ is a set of individual demographic characteristics in 2001, including their age, age squared, gender, and marital status. The statistical error ζ_{ijkt} is clustered at the level of three-digit industries. Following a similar approach by Dix-Carneiro and Kovak (2019), we estimate Equation (3) for each year t to obtain the coefficients of interests $\{\alpha_t\}$, which reveals the effect of the liberalization policy on the treated workers relative to the untreated workers up to year $t \in [2002, 2007]$.

To investigate the heterogeneous treatment effects of the policy by initial wage level and

gender, we further run the following specifications:

$$Y_{ijk2007} = \alpha\, Treated_j + \beta\, Treated_j \times G_{i2001} + \gamma\, G_{i2001} + Industry_k + X_{ijk2001} + \zeta_{ijk} \quad (4)$$

$$Y_{ijk2007} = \alpha\, Treated_j + \beta\, Treated_j \times Male_i + \gamma\, Male_i + Industry_k + X_{ijk2001} + \zeta_{ijk} \quad (5)$$

where $Y_{ijk2007}$ is the cumulative outcomes over 2001-2007, G_{i2001} indicates worker i's wage percentile group in 2001,[6] and $Male_i$ is an indicator of whether worker i is male. The parameters of interests are α and β. The first parameter reflects the average effect of the policy for a reference group (defined as the workers with wages in the top decile in 2001), and the second parameter demonstrates the policy effect for group G_{i2001} relative to the reference group.

5.2 Identification Assumption

To identify the causal parameters $\{\alpha_t\}$ in Equation (3) as well as α and β in Equation (4), the conditional independence assumption is needed. It requires that a worker's treatment status is independent of his or her potential outcomes conditional on the observable characteristics. In other words, whether a worker is employed by a treatment or control firm at the onset of the policy is "as if" random conditional on their individual characteristics and industry fixed effects. Given this assumption, $\{\alpha_t\}$ and β are identified and can be interpreted as the per-period average treatment effects (ATE) and the conditional average treatment effects (CATE) of the liberalization policy respectively.

We argue that the conditional independence assumption is plausible for the following reasons. First, as we explained in Section 2, the policy change can be viewed as an exogenous event from the perspective of the electronic manufacturers. With the same reasoning, the workers employed by those firms in 2001 also cannot anticipate the policy change beforehand. The matching procedure further strengthens the exogeneity of the policy, as the treatment and control firms are ex-ante similar from the perspective of the workers. In addition, the

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[6]We define five groups based on workers' wage percentiles in 2001: $< p25$, $p25 - p50$, $p50 - p75$, $p75 - p90$, and $> p90$. The top-decile group serves as the reference group in the regressions.

control variables including the four-digit industry fixed effect and the worker characteristics account for the potential threat of selection on observables.

Nevertheless, it is a valid concern that workers might still self-select into the treatment and control firms based on some unobserved characteristics. For example, there may be systematic differences in their education levels or family resources, which are unobserved from the matched employer-employee data but could still affect their employment decisions. We deal with this concern by conducting two robustness checks. The first check is to use different worker samples, including a sample of incumbent workers of all listed electronic firms ("the full worker sample") and another of incumbent workers of the kernel-matching firm sample ("the kernel matching worker sample"). Furthermore, we control for worker parents' financial assets taking advantage of the kinship information provided by the FIA. This control variable serves as a proxy of the workers' education levels and family resources; however, it would be a bad proxy for older workers whose parents already passed away by the time of year 2001. As a result, this specification is provided as a robustness check section in comparison with our main results.

5.3 Main Outcomes

The average effect of the liberalization policy on the worker cumulative outcomes over 2001-2007 are presented in Table 12. First of all, the estimate for job transitions is large and statistically significant. Specifically, the cumulative job transition rates of the treated workers are on average 24% higher than the untreated workers conditional on the industry fixed effect and individual characteristics. The estimate for total years of employment is small and insignificant. However, years employed in the initial firm for the treated workers is 10% lower than the untreated ones. This indicates that the treated workers are more likely to leave their initial employers. The estimated effect on cumulative wages is negative on average but not statistically significant; nonetheless, wages earned in the initial firm is 12% lower for the treated workers relative to the untreated.

Following Equation (3), we then run the specification for each cumulative outcome from

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2001 up to year $t \in [2002, 2007]$ and record the coefficients $\{\alpha_t\}$. The results for job transitions are presented in Figure 6. Consistent with the estimated average policy effect in Table 12, the dynamic estimates indicate that the treated workers experience higher job transition rates. In Figure 7 and Figure 8, we examine the employment and wage outcomes by destinations. As the two figures reveal, the treated workers are more likely to leave their initial employers and accumulate less wages from them over time relative to the untreated workers; they also tend to stay in the same industry instead of moving to other industries or becoming unemployed.

5.4 Heterogeneity

After examining the main results, we now look into the heterogeneous treatment effects for the incumbent workers. We first investigate the heterogeneity by workers' initial wage level, separated into five wage percentile groups. The regression estimates of treatment-wage interaction terms following Equation (4) are presented in Table 13, with the treated workers in the top wage decile as the baseline group. Panel (a) of Table 13 shows that the treated workers in the 1st to 3rd wage quartiles experience higher job transition rates and stay fewer years employed relative to the untreated workers. The effects are particularly large for the treated workers in the 2nd and 3rd wage quartiles: they each experience 37% and 29% higher job transition rates than the untreated workers; furthermore, they each stay 18% and 12% fewer employment years in the initial firm relative to the untreated workers. Consistent with the main results, the negative effect on employment status is most evident in years employed in the initial firm. Contrarily, the effects on job transition and years employed in the initial firm are not significant for treated workers in the top decile.

The substantial heterogeneity across initial wage levels is also observed for workers' cumulative wages, demonstrated in Panel (b) of Table 13. For the treated workers in the 25th-50th, 50th-75th, and 75th-90th percentile groups, their cumulative wages over 2001-2007 are 4%, 6%, and 4% lower than the untreated workers, respectively. On the contrary, the treated workers initially in the top wage decile experience a positive wage increase by

10% relative to the untreated workers.

Apart from initial wage levels, we also explore the heterogeneity by worker gender following Equation (5). Table 14 shows that female workers in the treatment group are subjected to a more serious negative influence compared to male workers. While the treated male workers experience 14% higher job transition rate, stay 5% fewer years, and earn 7% less in the initial firm, treated female workers experience 34% higher job transition rate, 16% fewer years employed in the initial firm, and 17% lower wage earned in the initial firm compared to untreated workers.

Two other approaches are adopted to address worker heterogeneity. First, we present the wage effect for workers who stayed in the initial firm throughout our sample period (i.e. the "stayers") and workers who left the initial firm (i.e. the "leavers") separately in Table 15. Among the stayers, treated workers in the 50th-90th initial wage percentiles earn less compared to the untreated workers. In stark contrast, treated workers in the top decile earn 10% higher than the control group. For the leavers, we can observe a similar negative wage effect concentrated among workers in the 50th-90th initial wage percentiles. Second, we utilize the causal forests method (Wager and Athey, 2018) to estimate the conditional average treatment effect (CATE) of the policy. Similarly, the estimates suggest large heterogeneity along worker initial wage and gender. The description of the method and related results are provided in Appendix B.

The results presented above convey stark difference of the policy effect on incumbent workers. On the one hand, the treated workers from the top decile benefited from the liberalization policy in terms of job security and earnings. These workers are likely well-educated, high-skilled, and in occupations that are less subjected to the competition from workers in the Chinese affiliates (e.g. R&D, managers, headquarter services). On the other hand, the liberalization policy leads to higher job transitions, lower years employed, and lower cumulative wages for the treated workers in the medium income percentiles. The workers in the bottom wage decile also face more job transitions and stay fewer years employed in the initial firm. However, there is no significant negative wage effect.

5.5 Robustness of Worker-level Response

5.5.1 Robustness to Different Worker Samples

To ensure the robustness of our worker-level estimates, we run the same regressions in Equation (3) and Equation (4) using two other worker samples: one sample with all workers employed by the full firm sample ("the full worker sample") and another sample with workers employed by the kernel-matching firm sample ("the kernel matching worker sample"). The results are presented in Tables 18, 19, 20, 21, 22, and 23.

Robustness checks conducted with the full sample and the kernel-matching sample generate similar results. Treated workers experienced more job transitions and stayed less year employed on average and in the initial firm. The negative wage effects are concentrated among workers with initial wage ranked in the 25th-90th percentiles, while the treated workers from the top decile are better off.

5.5.2 Robustness to Additional Controls

To better control workers' characteristics unrelated to the liberalization policy, we control for the workers' parents' wealth. Parents' wealth can represent the resource from a worker's family and positively correlate with the worker's education level. We do not add this control variable to our main regression since we require both parents to be alive to measure their wealth, and it will cause us to lose 48,457 observations. The results with parents' wealth controlled are presented in Table 16 and 19.

Overall, our results are consistent with the story that FDI liberalization would trigger manufacturing firms to move their production to low-cost countries and reduce their employment in the home country, in particular for the workers by lower initial wage percentiles, who are likely lower-skilled or workers with lower education level. The workers in the top wage decile who are mostly in charge of management and R&D activities would benefit, because their employers now enjoy higher profits from cost reductions and increasing sales; thus, they have larger demand for headquarter services in the home country.

6   Conclusion

FDI activities are a crucial component of global trade. However, episodes of FDI liberalization are much less studied comparing to other trade liberalization episodes such as import competitions. The theoretical prediction for the causal effect of such liberalization policies on worker outcomes is unclear due to competing forces of firm growth and worker replacement. Taking advantage of novel data sources that cover Taiwanese electronic manufacturers and their affiliates in China as well as their workers in Taiwan, our paper studies a policy change in 2001 by the Taiwanese government that provides a subset of Taiwanese electronic manufacturers extra incentives to conduct FDI in China.

The DID estimates at the firm level confirm a large treatment effect for the treatment firms which see them reallocate their production resources to China both at the extensive and intensive margins. Moreover, the worker-level analysis indicates substantial heterogeneous effects of the policy, where the incumbent workers in the top decile of initial wages benefit and the other workers lose out following the implementation of the policy. This result echo the theoretical predictions from classic trade models that trade liberalizations create winners and losers. From an aggregate perspective, a large-scale FDI liberalization episode such as the one experienced in Taiwan since the 1990s could substantially affect the overall income distribution and inequality of the society as a whole.

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Tables

Table 1: Summary statistics of the full firm sample over 1998-2000

	All	Treatment firm	Control firm	Difference
CN FDI	0.33	0.39	0.29	-0.10**
CN FDI SIC3	0.06	0.09	0.04	-0.06***
# affiliates	1.25	1.28	1.23	-0.05
Parent # workers	472.64	474.15	471.78	-2.37
Parent average wage bills	5.22	5.61	5.01	-0.59
Parent total sales	53.67	71.89	43.30	-28.58*
Parent export sales	39.47	58.44	28.68	-29.76*
Affiliate # workers	851.17	866.23	837.98	-28.25
Affiliate average wage bills	1.43	1.53	1.35	-0.17
Affiliate total sales	49.29	67.94	32.97	-34.97
Affiliate export sales	34.41	43.65	26.32	-17.33
Observations	533	190	343	533

NOTE: "CN FDI" is an indicator of whether a Taiwanese electronic manufacturer conducts FDI in China, and "CN FDI SIC3" is an indicator of whether a Taiwanese electronic manufacturer conducts FDI in China in the same 3-digit industry. "Parent" indicates the parent branch in Taiwan, and "Affiliate" indicates the affiliate branch in China. The unit of sales and wages is 1,000 USD. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Summary statistics of the matched firm samples over 1998-2000

(a) One-to-one matching

	All	Treatment firm	Control firm	Difference
CN FDI	0.33	0.35	0.31	-0.04
CN FDI SIC3	0.03	0.04	0.02	-0.02
# affiliates	1.22	1.28	1.14	-0.14
Parent # workers	394.73	440.70	348.76	-91.94
Parent average wage bills	4.68	5.19	4.17	-1.02
Parent total sales	51.82	64.14	39.49	-24.65
Parent export sales	39.96	51.51	28.41	-23.10
Affiliate # workers	770.16	764.50	779.16	14.66
Affiliate average wage bills	1.36	1.35	1.38	0.03
Affiliate total sales	51.99	53.08	50.25	-2.83
Affiliate export sales	32.61	28.94	38.44	9.50
Observations	348	174	174	348

(b) Kernel matching

	All	Treatment firm	Control firm	Difference
CNFDI	0.30	0.35	0.28	-0.07
CNFDI SIC3	0.03	0.04	0.02	-0.02
# affiliates	1.22	1.28	1.19	-0.09
Parent # workers	462.38	440.70	474.10	33.40
Parent average wage bills	5.04	5.17	4.97	-0.20
Parent total sales	47.31	63.89	38.43	-25.46*
Parent export sales	33.68	51.26	24.27	-26.99*
Affiliate # workers	698.66	764.50	647.46	-117.04
Affiliate average wage bills	1.23	1.35	1.13	-0.21
Affiliate total sales	40.88	53.08	31.38	-21.70
Affiliate export sales	26.34	28.94	24.31	-4.64
Observations	511	175	336	511

NOTE: "CN FDI" is an indicator of whether a Taiwanese electronic manufacturer conducts FDI in China, and "CN FDI SIC3" is an indicator of whether a Taiwanese electronic manufacturer conducts FDI in China in the same 3-digit industry. "Parent" indicates the parent branch in Taiwan, and "Affiliate" indicates the affiliate branch in China. The unit of sales and wages is 1,000 USD. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Summary statistics of the worker sample

	Treated worker	Untreated worker
N	61,468	49,958
Male (%)	54.2	52.7
Age in 2001	32.7	32.0
Wage in 2001 (1,000 USD)	17.1	17.0
Wage in 2007 (1,000 USD)	19.7	21.1
Leave initial firm by 2007 (%)	67.7	53.7

Table 5: Summary statistics of mean wages by worker group

Wage percentile in 2001	Number of workers	Wage mean in 2001	Wage mean in 2007
<p25	27,857	7.781	10.028
p25-p50	27,856	11.068	12.370
p50-p75	27,857	15.112	18.736
p75-p90	16,714	22.618	29.572
>p90	11,142	51.435	56.059

NOTE: The unit of wages is 1,000 USD.

Table 6: Effect of the liberalization policy on firm extensive margin outcomes

	(1) Exit	(2) Exit	(3) CN FDI	(4) CN FDI	(5) CN FDI SIC3	(6) CN FDI SIC3
Disc. treatment*Post	0.009 (0.016)		0.078* (0.044)		0.152* (0.078)	
Cont. treatment*Post		0.027 (0.046)		0.121** (0.055)		0.192* (0.106)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Pre-policy control mean	0	0	0.308	0.308	0.023	0.023
Observations	3480	3480	3480	3480	3480	3480
Adjusted R^2	0.341	0.342	0.651	0.651	0.610	0.609

NOTE: Standard errors are clustered at the 3-digit industry level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Effect of the liberalization policy on firm intensive margin outcomes

(a) Parent firms in Taiwan

Parent firms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	# workers		Wage bills per worker		Total sales		Export sales	
Disc. treatment	-0.340*		-0.240		0.317		-0.274	
*Post	(0.185)		(0.164)		(0.207)		(0.546)	
Cont. treatment		-0.846***		-0.688***		0.189		-0.352
*Post		(0.214)		(0.203)		(0.262)		(0.629)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	300	300	250	250	150	150	150	150
Adjusted R^2	0.871	0.883	0.905	0.914	0.952	0.949	0.824	0.824

(b) Affiliate firms in China

Affiliate firms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	# workers		Wage bills per worker		Total sales		Export sales	
Disc. treatment	0.403		0.574**		0.420		0.846**	
*Post	(0.274)		(0.241)		(0.281)		(0.331)	
Cont. treatment		0.574*		0.511*		0.155		0.661
*Post		(0.266)		(0.263)		(0.488)		(0.481)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	280	280	300	300	290	290	230	230
Adjusted R^2	0.788	0.790	0.818	0.814	0.817	0.814	0.838	0.829

NOTE: All outcomes are in log. The sample is restricted to firms who have investments in China throughout the sample period (1998-2007). Firms that report zero or missing values in the outcome of interests are also excluded. Standard errors are clustered at the 3-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Robustness check: Effect of the liberalization policy on firm extensive margin outcomes using the full firm sample)

	(1) Exit	(2) Exit	(3) CN FDI	(4) CN FDI	(5) CN FDI SIC3	(6) CN FDI SIC3
Disc. treatment*Post	0.003 (0.016)		0.034 (0.032)		0.144* (0.082)	
Cont. treatment*Post		0.018 (0.046)		0.070 (0.051)		0.188* (0.108)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Pre-policy control mean	0	0	0.292	0.292	0.036	0.036
Observations	5330	5330	5330	5330	5330	5330
Adjusted R^2	0.328	0.328	0.654	0.654	0.648	0.647

NOTE: Standard errors are clustered at the 3-digit industry level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Robustness check: Effect of the liberalization policy on firm intensive margin outcomes using the full firm sample

(a) Parent firms in Taiwan

Parent firms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	# workers		Wage bills per worker		Total sales		Export sales	
Disc. treatment	-0.141		-0.207		0.100		-0.296	
*Post	(0.146)		(0.144)		(0.204)		(0.366)	
Cont. treatment		-0.524***		-0.565***		-0.039		-0.420
*Post		(0.084)		(0.117)		(0.180)		(0.401)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	510	510	430	430	260	260	260	260
Adjusted R^2	0.883	0.888	0.900	0.906	0.948	0.948	0.869	0.870

(b) Affiliate firms in China

Affiliate firms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	# workers		Wage bills per worker		Total sales		Export sales	
Disc. treatment	0.319*		0.442**		0.168		0.499**	
*Post	(0.145)		(0.165)		(0.178)		(0.198)	
Cont. treatment		0.591***		0.501**		0.209		0.517
*Post		(0.125)		(0.204)		(0.314)		(0.394)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	500	500	510	510	510	510	430	430
Adjusted R^2	0.822	0.825	0.835	0.834	0.831	0.831	0.838	0.836

NOTE: All outcomes are in log. The sample is restricted to firms who have investments in China throughout the sample period (1998-2007). Firms that report zero or missing values in the outcome of interests are also excluded. Standard errors are clustered at the 3-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Robustness check: Effect of the liberalization policy on firm extensive margin outcomes using the kernel-matching firm sample)

	(1) Exit	(2) Exit	(3) CN FDI	(4) CN FDI	(5) CN FDI SIC3	(6) CN FDI SIC3
Disc. treatment*Post	0.007 (0.015)		0.054 (0.038)		0.150* (0.086)	
Cont. treatment*Post		0.022 (0.043)		0.098* (0.052)		0.200 (0.116)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Pre-policy control mean	0	0	0.279	0.279	0.022	0.022
Observations	5110	5110	5110	5110	5110	5110
Adjusted R^2	0.334	0.334	0.656	0.656	0.610	0.609

NOTE: Standard errors are clustered at the 3-digit industry level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Robustness check: Effect of the liberalization policy on firm intensive margin outcomes using the kernel-matching firm sample)

(a) Parent firms in Taiwan

Parent firms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	# workers		Wage bills per worker		Total sales		Export sales	
Disc. treatment	-0.082		-0.153		0.194		-0.176	
*Post	(0.183)		(0.176)		(0.177)		(0.363)	
Cont. treatment		-0.557***		-0.571***		0.104		-0.257
*Post		(0.093)		(0.152)		(0.186)		(0.463)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	450	450	370	370	230	230	230	230
Adjusted R^2	0.875	0.881	0.889	0.895	0.921	0.920	0.795	0.795

(b) Affiliate firms in China

Affiliate firms	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	# workers		Wage bills per worker		Total sales		Export sales	
Disc. treatment	0.417*		0.491**		0.199		0.517**	
*Post	(0.192)		(0.206)		(0.199)		(0.186)	
Cont. treatment		0.628***		0.531**		0.048		0.534
*Post		(0.188)		(0.175)		(0.431)		(0.386)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	440	440	450	450	450	450	370	370
Adjusted R^2	0.774	0.775	0.807	0.805	0.789	0.788	0.790	0.788

NOTE: All outcomes are in log. The sample is restricted to firms who have investments in China throughout the sample period (1998-2007). Firms that report zero or missing values in the outcome of interests are also excluded. Standard errors are clustered at the 3-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: Effect of the liberalization policy on worker cumulative outcomes

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated	0.225**	-0.094	-0.482*	0.254*	0.134	0.094
	(0.080)	(0.052)	(0.179)	(0.118)	(0.126)	(0.052)
Control mean in 2007	0.950	6.385	4.755	0.474	1.157	0.615
Observations	111,426	111,426	111,426	111,426	111,426	111,426

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated	-0.161	-0.618*	0.354	0.104
	(0.223)	(0.251)	(0.200)	(0.208)
Control mean in 2007	7.136	5.304	0.583	1.249
Observations	111,426	111,426	111,426	111,426

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: Effect of the liberalization policy on worker cumulative outcomes by initial wage

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*<p25	0.251**	-0.098	-0.687**	0.182*	0.408*	0.098
	(0.079)	(0.059)	(0.224)	(0.072)	(0.182)	(0.059)
Treated*p25-p50	0.305***	-0.226***	-0.802***	0.198*	0.379*	0.226***
	(0.073)	(0.061)	(0.172)	(0.091)	(0.144)	(0.061)
Treated*p50-p75	0.229***	-0.250***	-0.544***	0.053	0.241**	0.250***
	(0.053)	(0.070)	(0.125)	(0.062)	(0.082)	(0.070)
Treated*p75-p90	0.000	-0.069	0.046	-0.106	-0.010	0.069
	(0.074)	(0.043)	(0.151)	(0.071)	(0.100)	(0.043)
Treated	0.051	0.019	-0.040	0.154*	-0.096	-0.019
	(0.072)	(0.046)	(0.182)	(0.062)	(0.193)	(0.046)
Control mean in 2007	0.950	6.385	4.755	0.474	1.157	0.615
Observations	111,426	111,426	111,426	111,426	111,426	111,426

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*<p25	-0.692*	-1.317***	0.106	0.519**
	(0.276)	(0.260)	(0.165)	(0.188)
Treated*p25-p50	-0.974***	-1.463***	0.148	0.341*
	(0.240)	(0.273)	(0.145)	(0.141)
Treated*p50-p75	-1.138***	-1.248***	-0.054	0.164
	(0.235)	(0.253)	(0.101)	(0.098)
Treated*p75-p90	-0.986***	-0.656*	-0.226	-0.104
	(0.213)	(0.255)	(0.141)	(0.108)
Treated	0.707*	0.455	0.341**	-0.089
	(0.314)	(0.250)	(0.107)	(0.280)
Control mean in 2007	7.136	5.304	0.583	1.249
Observations	111,426	111,426	111,426	111,426

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: Effect of the liberalization policy on worker cumulative outcomes by gender

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*Male	-0.186***	0.182***	0.547***	-0.190*	-0.175*	-0.182***
	(0.037)	(0.045)	(0.091)	(0.081)	(0.076)	(0.045)
Treated	0.320***	-0.187	-0.763***	0.352**	0.224*	0.187*
	(0.084)	(0.072)	(0.197)	(0.129)	(0.110)	(0.072)
Control mean in 2007	0.950	6.385	4.755	0.474	1.157	0.615
Observations	111,426	111,426	111,426	111,426	111,426	111,426

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*Male	0.259*	0.523***	-0.205	-0.058
	(0.120)	(0.138)	(0.110)	(0.103)
Treated	-0.294	-0.887**	0.459*	0.134
	(0.247)	(0.255)	(0.210)	(0.168)
Control mean in 2007	7.136	5.304	0.583	1.249
Observations	111,426	111,426	111,426	111,426

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. We set gender = 1 for male and gender = 0 for female. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: Effect of the liberalization policy on worker cumulative outcomes for stayers and leavers

(a) Main results

	Wage for stayers	Wage for leavers			
	Overall	Overall	Initial firm	Initial industry	Other industries
Treated	0.022	0.169	0.026	0.260	-0.117
	(0.193)	(0.282)	(0.081)	(0.173)	(0.270)
Control mean in 2007	8.168	6.332	3.072	1.037	2.223
Observations	40,303	71,123	71,123	71,123	71,123

(b) Heterogeneity by initial wage

	Wage for stayers	Wage for leavers			
	Overall	Overall	Initial firm	Initial industry	Other industries
Treated*<p25	-0.149	-0.279	-0.471***	0.011	0.182
	(0.350)	(0.270)	(0.101)	(0.168)	(0.226)
Treated*p25-p50	-0.509	-0.557*	-0.571***	0.014	0.001
	(0.272)	(0.215)	(0.144)	(0.148)	(0.140)
Treated*p50-p75	-0.816***	-0.901**	-0.434***	-0.316*	-0.150
	(0.191)	(0.259)	(0.113)	(0.125)	(0.109)
Treated*p75-p90	-1.135***	-0.845**	-0.227**	-0.420	-0.198*
	(0.172)	(0.259)	(0.082)	(0.211)	(0.084)
Treated	0.786**	0.726	0.433**	0.376***	-0.083
	(0.289)	(0.418)	(0.137)	(0.083)	(0.371)
Control mean in 2007	8.168	6.332	3.072	1.037	2.223
Observations	40,303	71,123	71,123	71,123	71,123

NOTE: The cumulative wage is normalized by wage in 2001. Workers that stayed working in the initial firm from 2001-2007 are defined as "stayers". Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: Robustness check: Effect of the liberalization policy on worker cumulative outcomes with parents' wealth controlled

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated	0.220*	-0.060	-0.461*	0.304*	0.097	0.060
	(0.091)	(0.030)	(0.203)	(0.141)	(0.127)	(0.030)
Control mean in 2007	0.950	6.488	4.716	0.548	1.224	0.512
Observations	62,969	62,969	62,969	62,969	62,969	62,969

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated	-0.086	-0.601*	0.440	0.075
	(0.199)	(0.273)	(0.250)	(0.206)
Control mean in 2007	7.475	5.394	0.699	1.382
Observations	62,969	62,969	62,969	62,969

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, marital status in 2001 and parents' wealth in 2003 (which is the earliest wealth data we have access to). The sample is restricted to individuals with both parents alive in 2008, which is the earliest household registration data we have access to. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: Robustness check: Effect of the liberalization policy on worker cumulative outcomes by initial wage with parents' wealth controlled

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*<p25	0.217**	-0.079	-0.638**	0.131	0.428**	0.079
	(0.074)	(0.066)	(0.205)	(0.081)	(0.135)	(0.066)
Treated*p25-p50	0.292***	-0.174***	-0.733***	0.162	0.397**	0.174***
	(0.080)	(0.048)	(0.194)	(0.100)	(0.141)	(0.048)
Treated*p50-p75	0.197**	-0.191***	-0.459***	0.033	0.235*	0.191***
	(0.056)	(0.042)	(0.124)	(0.076)	(0.092)	(0.042)
Treated*p75-p90	-0.010	-0.057	0.042	-0.135	0.034	0.057
	(0.073)	(0.030)	(0.157)	(0.095)	(0.114)	(0.030)
Treated	0.063	0.028	-0.058	0.235**	-0.150	-0.028
	(0.072)	(0.027)	(0.183)	(0.069)	(0.156)	(0.027)
Control mean in 2007	0.950	6.488	4.716	0.548	1.224	0.512
Observations	62,969	62,969	62,969	62,969	62,969	62,969

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*<p25	-0.856**	-1.395***	0.013	0.526***
	(0.290)	(0.280)	(0.213)	(0.136)
Treated*p25-p50	-1.169***	-1.562***	0.069	0.323*
	(0.222)	(0.299)	(0.170)	(0.153)
Treated*p50-p75	-1.332***	-1.327***	-0.125	0.121
	(0.190)	(0.249)	(0.131)	(0.127)
Treated*p75-p90	-1.192***	-0.788**	-0.323	-0.081
	(0.189)	(0.276)	(0.176)	(0.138)
Treated	0.994***	0.589*	0.508***	-0.104
	(0.276)	(0.238)	(0.142)	(0.236)
Control mean in 2007	7.475	5.394	0.699	1.382
Observations	62,969	62,969	62,969	62,969

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: Robustness check: Effect of the liberalization policy on worker cumulative outcomes by initial wage using the full worker sample

(a) Job transitions and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated	0.195**	-0.079	-0.371*	0.188*	0.103	0.079
	(0.064)	(0.056)	(0.158)	(0.077)	(0.105)	(0.056)
Control mean in 2007	0.908	6.385	4.755	0.474	1.157	0.615
Observations	206,794	206,794	206,794	206,794	206,794	206,794

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated	-0.262	-0.501	0.242	-0.003
	(0.214)	(0.261)	(0.133)	(0.161)
Control mean in 2007	7.257	5.438	0.639	1.181
Observations	206,794	206,794	206,794	206,794

NOTE: The cumulative wage is normalized by wage in 2001. Standard errors are clustered at the 3-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: Robustness check: Effect of the liberalization policy on worker cumulative outcomes using the full worker sample

(a) Job transitions and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*<p25	0.237***	-0.144*	-0.581***	0.016	0.421**	0.144*
	(0.052)	(0.059)	(0.150)	(0.079)	(0.132)	(0.059)
Treated*p25-p50	0.295***	-0.306***	-0.720***	0.066	0.348**	0.306***
	(0.058)	(0.062)	(0.129)	(0.075)	(0.117)	(0.062)
Treated*p50-p75	0.232***	-0.298***	-0.549***	0.011	0.240**	0.298***
	(0.037)	(0.062)	(0.097)	(0.042)	(0.079)	(0.062)
Treated*p75-p90	0.054	-0.105**	-0.070	-0.105*	0.070	0.105**
	(0.068)	(0.035)	(0.139)	(0.042)	(0.096)	(0.035)
Treated	0.028	0.075	0.015	0.186***	-0.125	-0.075
	(0.075)	(0.065)	(0.194)	(0.048)	(0.174)	(0.065)
Control mean in 2007	0.908	6.393	4.826	0.505	1.062	0.607
Observations	206,794	206,794	206,794	206,794	206,794	206,794

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*<p25	-0.837	-1.204***	-0.158	0.526***
	(0.452)	(0.333)	(0.210)	(0.126)
Treated*p25-p50	-1.120***	-1.392***	-0.056	0.329**
	(0.289)	(0.264)	(0.133)	(0.099)
Treated*p50-p75	-1.126***	-1.195***	-0.122	0.191*
	(0.227)	(0.237)	(0.085)	(0.083)
Treated*p75-p90	-0.862***	-0.660**	-0.236**	0.035
	(0.132)	(0.191)	(0.084)	(0.100)
Treated	0.673	0.493	0.387**	-0.208
	(0.353)	(0.382)	(0.122)	(0.225)
Control mean in 2007	7.257	5.438	0.639	1.181
Observations	206,794	206,794	206,794	206,794

NOTE: The cumulative wage is normalized by wage in 2001. Standard errors are clustered at the 3-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 20: Robustness check: Gender Effect of the liberalization policy on worker cumulative outcomes using the full worker sample

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*Male	-0.192***	0.165***	0.535***	-0.200*	-0.169*	-0.165***
	(0.030)	(0.041)	(0.085)	(0.089)	(0.067)	(0.041)
Treated	0.297***	-0.166	-0.653**	0.294**	0.193*	0.166*
	(0.074)	(0.072)	(0.188)	(0.092)	(0.095)	(0.072)
Control mean in 2007	0.908	6.393	4.826	0.505	1.062	0.607
Observations	206,794	206,794	206,794	206,794	206,794	206,794

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*Male	0.154	0.490***	-0.269	-0.066
	(0.119)	(0.080)	(0.145)	(0.085)
Treated	-0.343	-0.760**	0.385*	0.032
	(0.218)	(0.266)	(0.147)	(0.146)
Control mean in 2007	7.257	5.438	0.639	1.181
Observations	206,794	206,794	206,794	206,794

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. We set gender = 1 for male and gender = 0 for female. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 21: Robustness check: Effect of the liberalization policy on worker cumulative outcomes by initial wage using the kernel worker sample

(a) Job transitions and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated	0.223***	-0.091	-0.450**	0.205*	0.154	0.091
	(0.060)	(0.052)	(0.139)	(0.089)	(0.093)	(0.052)
Control mean in 2007	0.907	6.391	4.825	0.507	1.059	0.609
Observations	195,302	195,302	195,302	195,302	195,302	195,302

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated	-0.264	-0.579**	0.262	0.052
	(0.169)	(0.200)	(0.155)	(0.148)
Control mean in 2007	7.246	5.425	0.642	1.179
Observations	195,302	195,302	195,302	195,302

NOTE: The cumulative wage is normalized by wage in 2001. Standard errors are clustered at the 3-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 22: Robustness check: Effect of the liberalization policy on worker cumulative outcomes using the kernel worker sample

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*<p25	0.218***	-0.151**	-0.572***	0.006	0.415**	0.151**
	(0.055)	(0.052)	(0.140)	(0.085)	(0.120)	(0.052)
	0.289***	-0.329***	-0.729***	0.056	0.345**	0.329***
	(0.067)	(0.065)	(0.146)	(0.081)	(0.121)	(0.065)
Treated*p50-p75	0.232***	-0.317***	-0.547***	-0.001	0.231**	0.317***
	(0.042)	(0.066)	(0.096)	(0.043)	(0.075)	(0.066)
Treated*p75-p90	0.044	-0.117***	-0.047	-0.121*	0.052	0.117***
	(0.069)	(0.030)	(0.133)	(0.046)	(0.096)	(0.030)
Treated	0.066	0.073	-0.076	0.213***	-0.064	-0.073
	(0.068)	(0.063)	(0.165)	(0.056)	(0.160)	(0.063)
Control mean in 2007	0.907	6.391	4.825	0.507	1.059	0.609
Observations	195,302	195,302	195,302	195,302	195,302	195,302

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*<p25	-0.885*	-1.243***	-0.179	0.537***
	(0.401)	(0.279)	(0.217)	(0.117)
Treated*p25-p50	-1.227***	-1.454***	-0.078	0.305**
	(0.255)	(0.250)	(0.137)	(0.109)
Treated*p50-p75	-1.243***	-1.256***	-0.148	0.161*
	(0.197)	(0.209)	(0.085)	(0.080)
Treated*p75-p90	-0.964***	-0.694***	-0.254**	-0.015
	(0.105)	(0.177)	(0.091)	(0.109)
Treated	0.766**	0.463	0.430**	-0.127
	(0.284)	(0.285)	(0.132)	(0.217)
Control mean in 2007	7.246	5.425	0.642	1.179
Observations	195,302	195,302	195,302	195,302

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 23: Robustness check: Gender Effect of the liberalization policy on worker cumulative outcomes using the kernel worker sample

(a) Job transition and years employed by destination

	Job transition	Years employed				Years unemployed
		Overall	Initial firm	Initial industry	Other industries	
Treated*Male	-0.193***	0.162***	0.553***	-0.209*	-0.182**	-0.162***
	(0.035)	(0.043)	(0.084)	(0.090)	(0.061)	(0.043)
Treated	0.324***	-0.176*	-0.740***	0.315**	0.250**	0.176*
	(0.070)	(0.070)	(0.170)	(0.101)	(0.080)	(0.070)
Control mean in 2007	0.907	6.391	4.825	0.507	1.059	0.609
Observations	195,302	195,302	195,302	195,302	195,302	195,302

(b) Normalized wage by destination

	Wage earned			
	Overall	Initial firm	Initial industry	Other industries
Treated*Male	0.109	0.483***	-0.270	-0.104
	(0.134)	(0.087)	(0.147)	(0.075)
Treated	-0.322	-0.832	0.404*	0.107
	(0.203)	(0.217)	(0.163)	(0.131)
Control mean in 2007	7.246	5.425	0.642	1.179
Observations	195,302	195,302	195,302	195,302

NOTE: The cumulative wage is normalized by wage in 2001. Control variables include the four-digit industry fixed effect, worker age, age squared, gender, and marital status. We set gender $= 1$ for male and gender $= 0$ for female. Standard errors are clustered at the three-digit industry level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figures

Figure 1: Taiwanese yearly outward FDI (Billion USD)
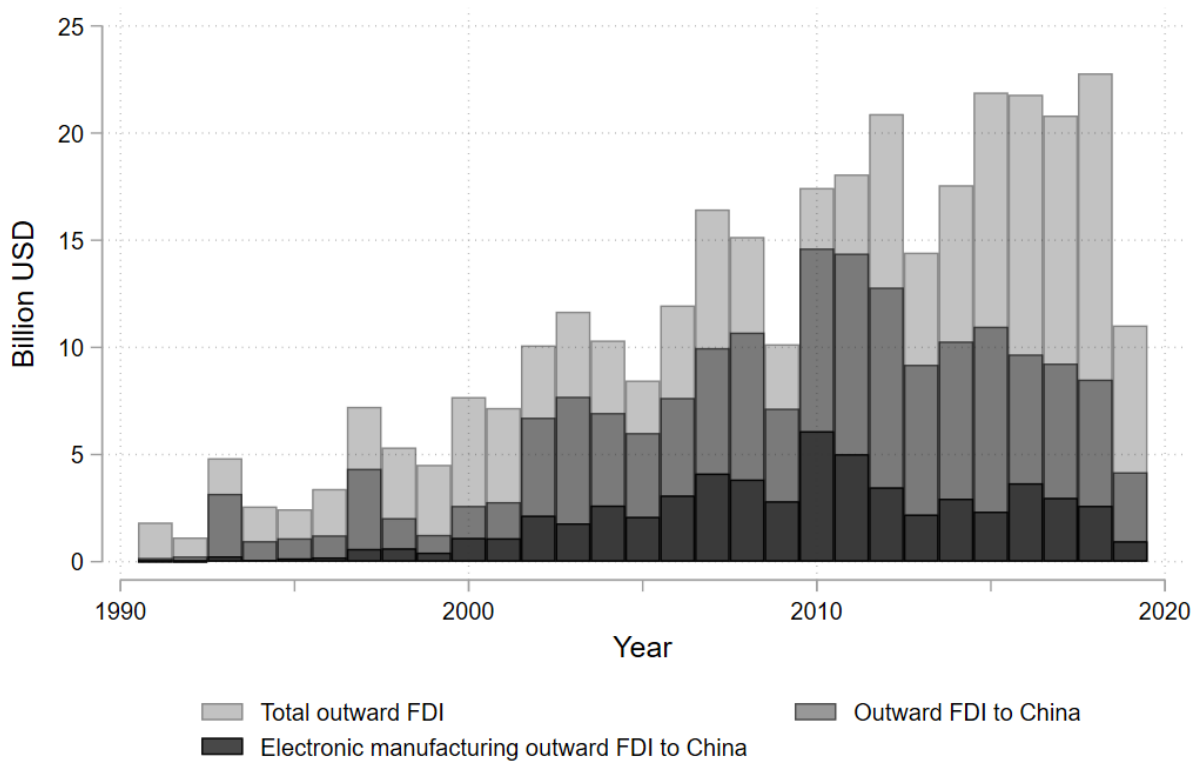
Source: The Investment Commission, Ministry of Economic Affairs (MOEAIC), Taiwan.

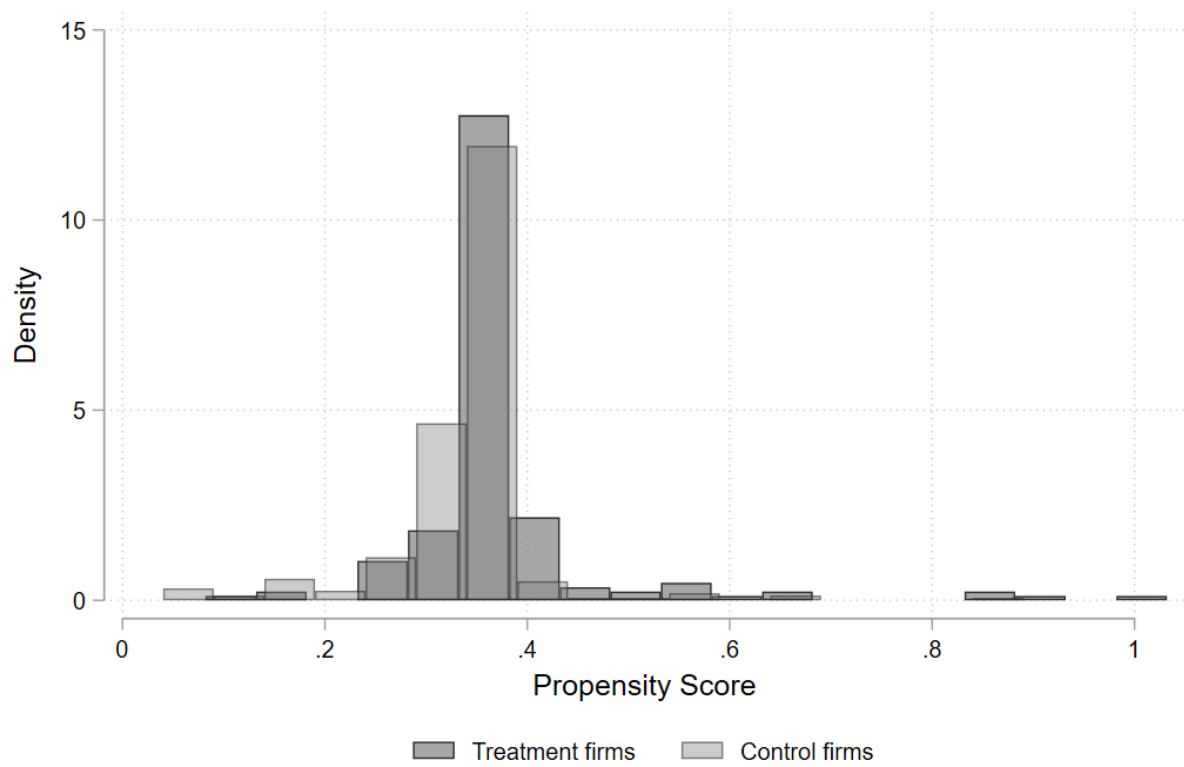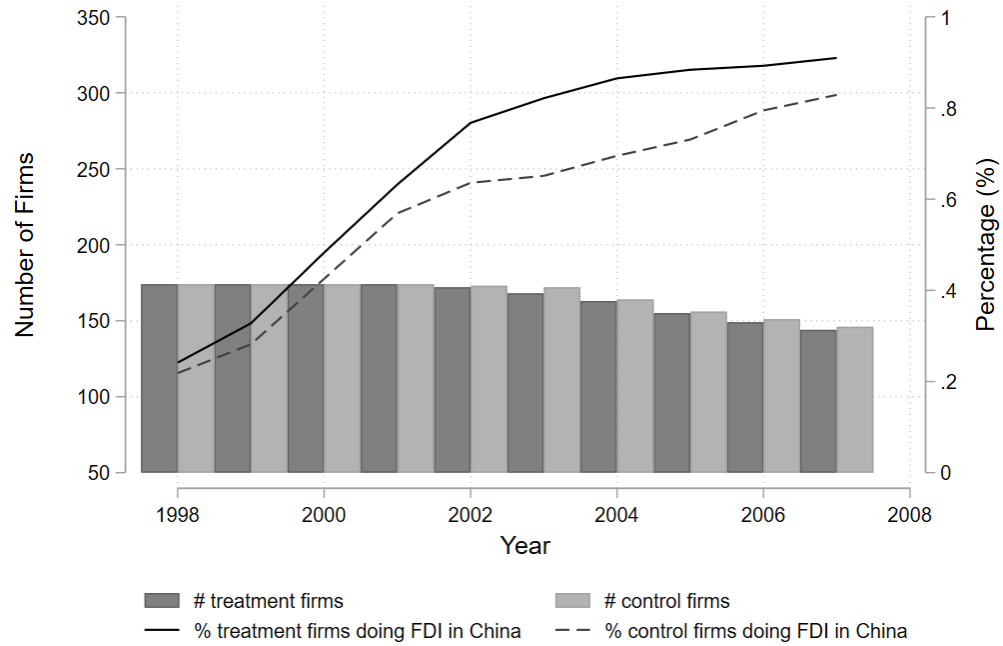**Figure 2:** Propensity scores for the treatment and control firms

Figure 3: Number of treatment and control firms

(a) Conduct FDI in China

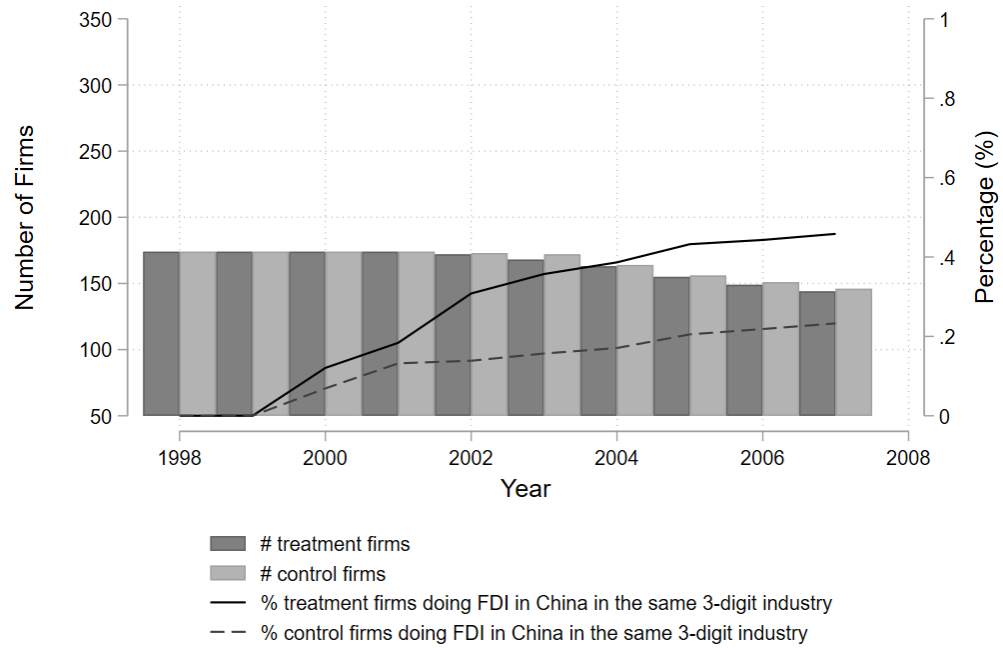

(b) Conduct FDI in the same industry in China

Figure 4: Event study graph for firm extensive margin outcomes
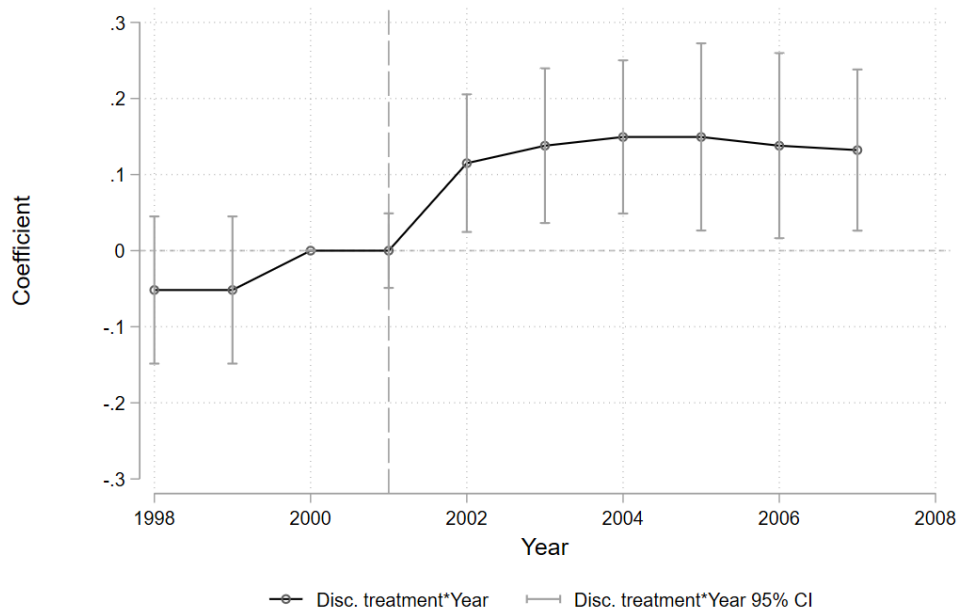
(a) Conduct FDI in China
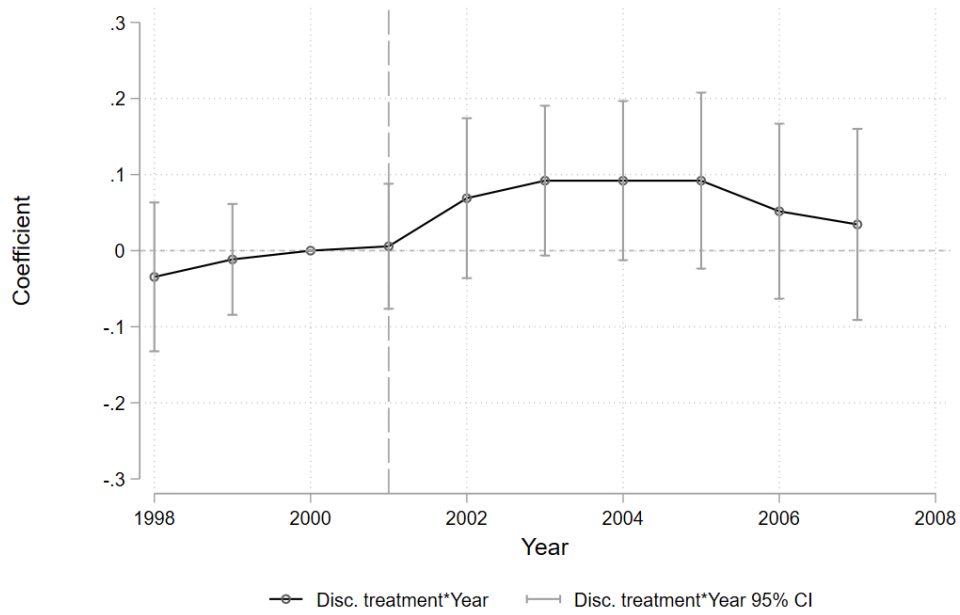
(b) Conduct FDI in the same industry in China

Figure 5: Sensitivity analysis: Relaxing parallel trends assumption

(a) Year 2002

(b) Year 2003

(c) Year 2004

(d) Year 2005

(e) Year 2006

(f) Year 2007
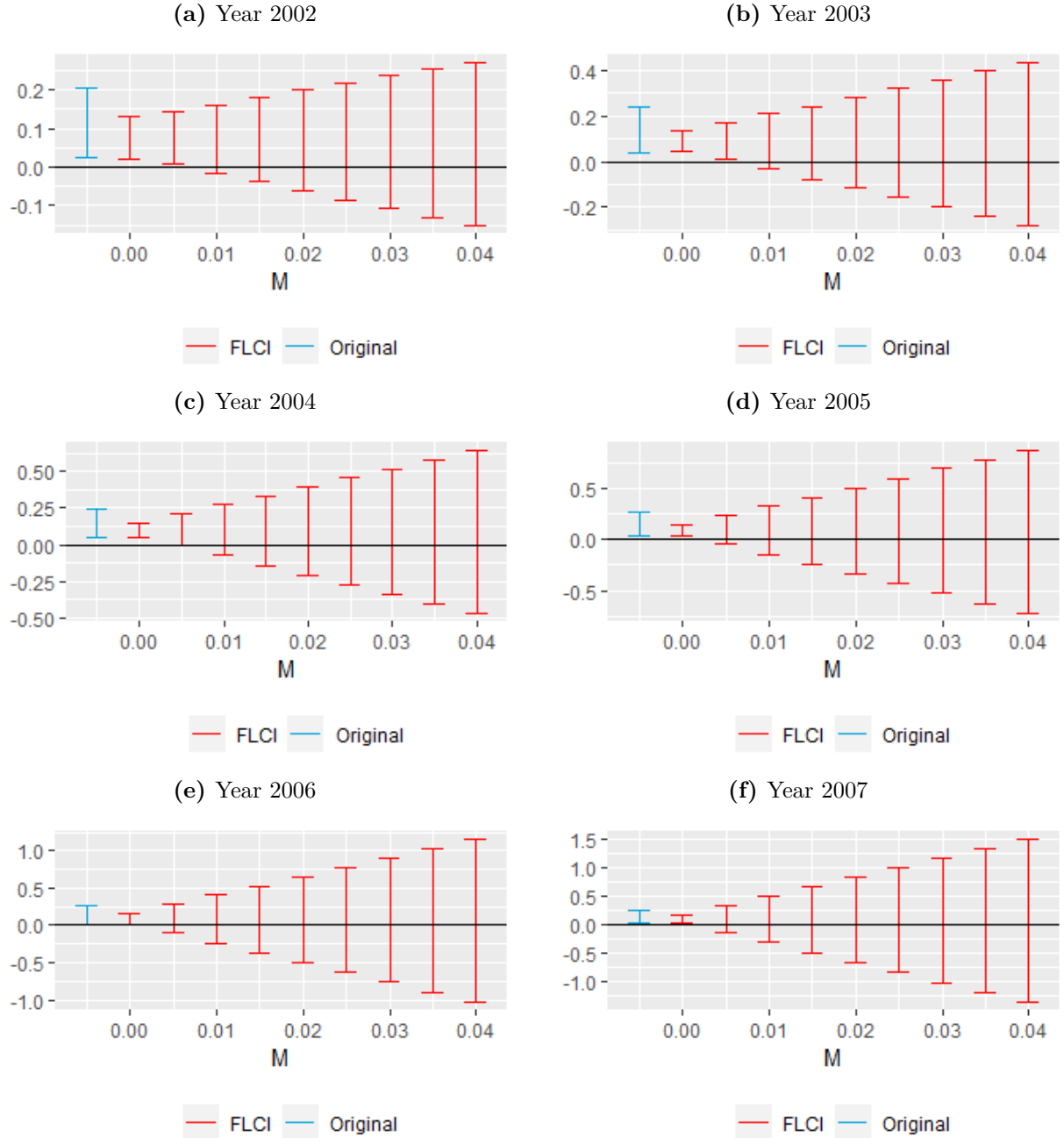
Figure 6: Worker cumulative outcome by year: Cumulative job transitions
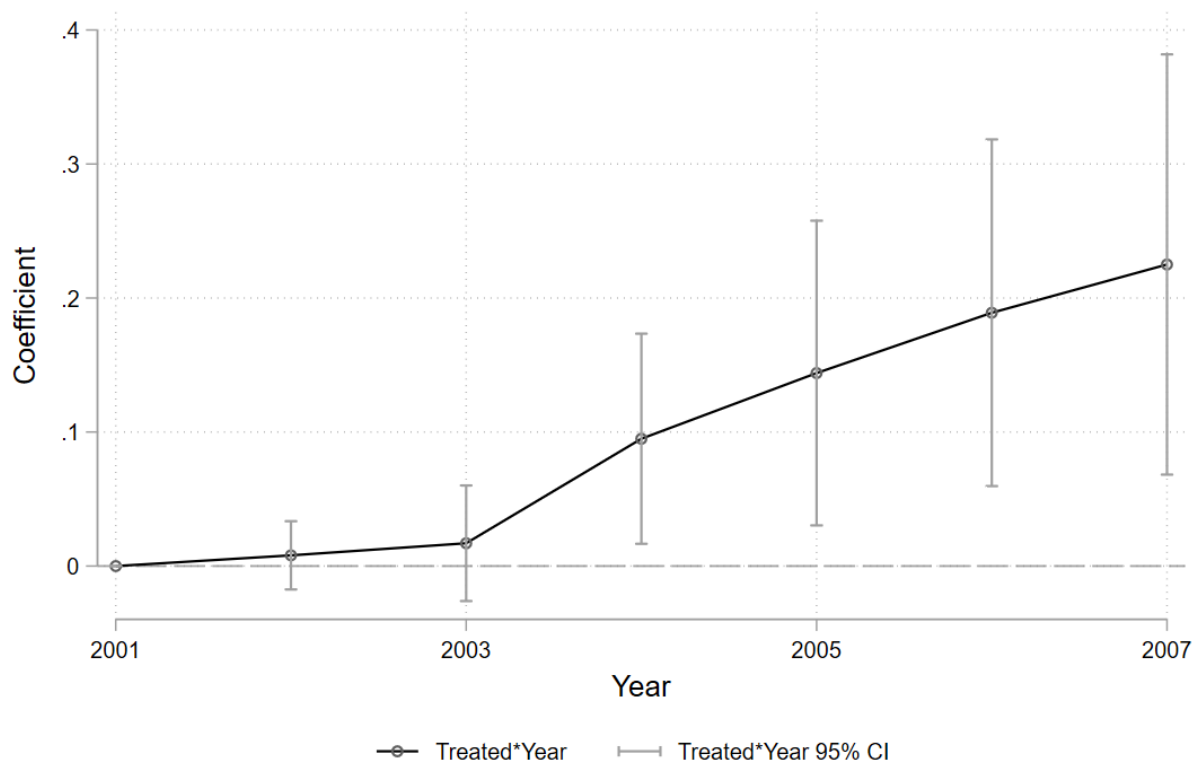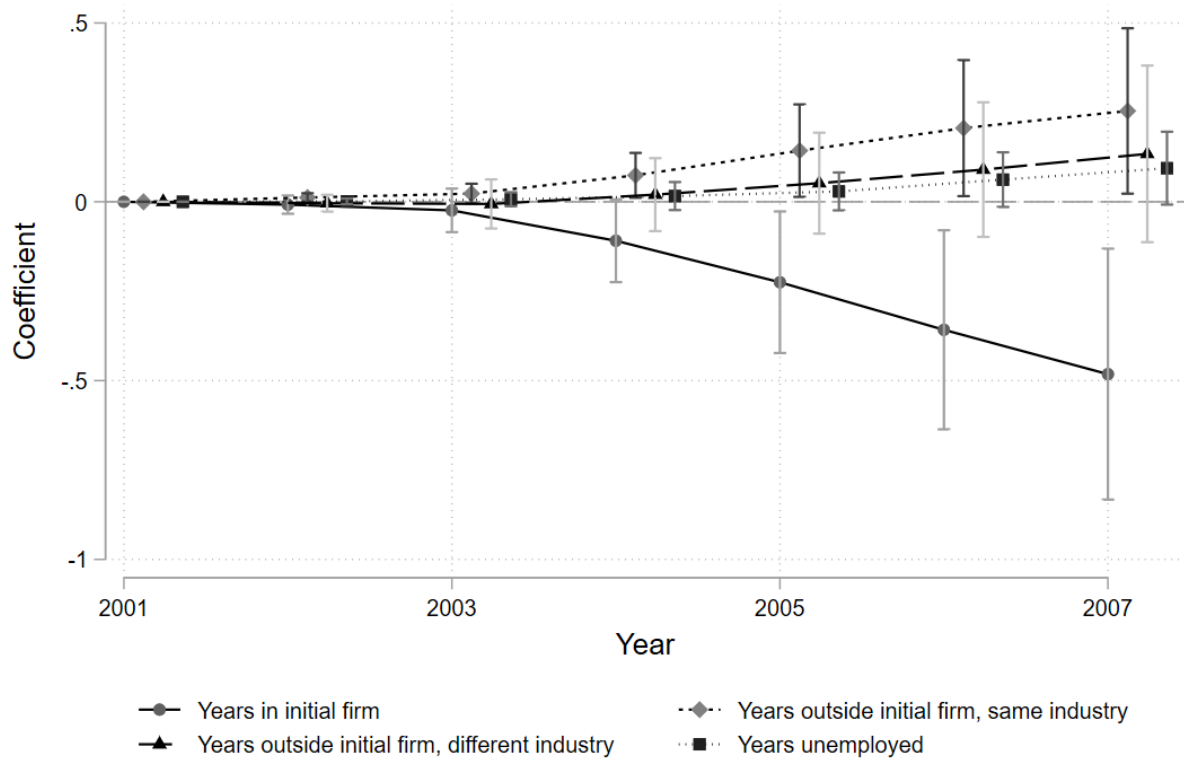
Figure 7: Worker cumulative outcome by year: Employment years by destination
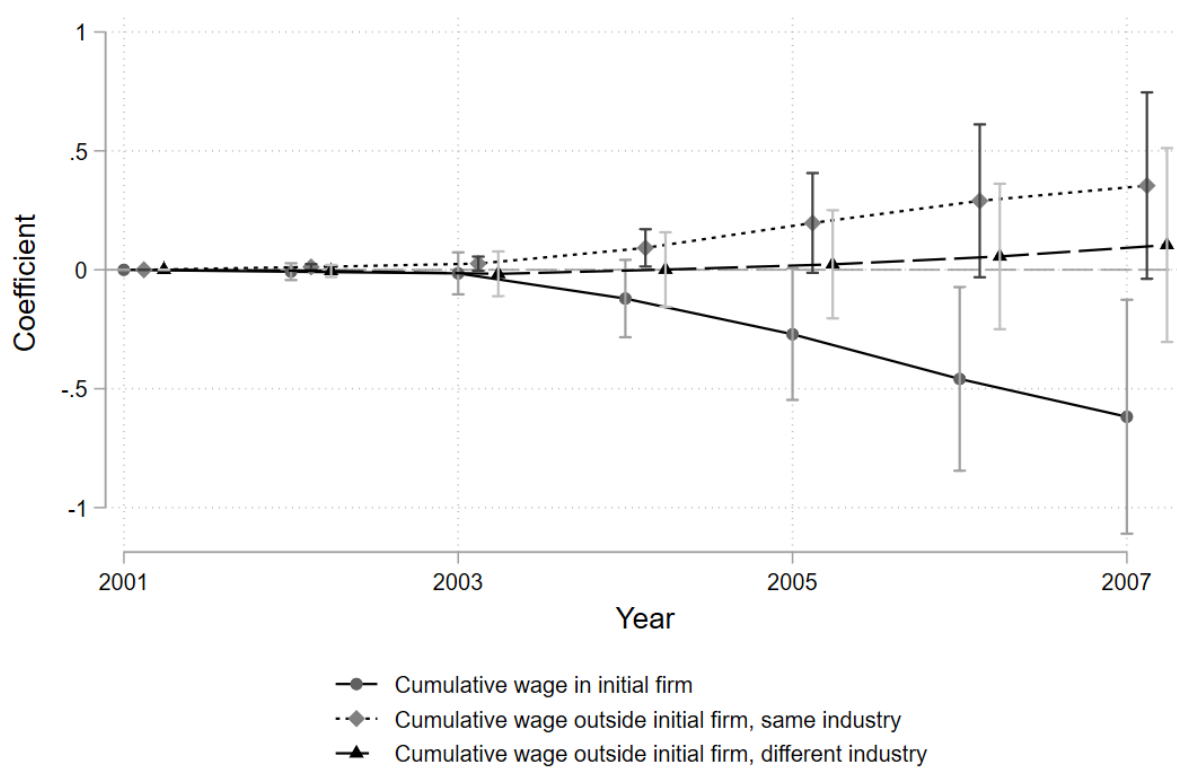
Figure 8: Worker cumulative outcome by year: Cumulative wage by destination

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Appendices

A Original List of the 122 products

C.C.C.Code	Category in English	Category in Chinese
95421090	Fiber distributed data interface (FDDI), Synchronous Optical Networking (SONET), ISDN equipment and IC related products	光纖分散數據介面、同步光纖網路系統、整體服務數位網路設備及其相關 IC
85179092108	Thermal printhead (printer component)	熱感應印字頭
85252010102	All types of mobile phones, wireless communication system, digital wireless switches, satellite communications systems	行動電話、數位行動電話、GSM 行動電話機、泛歐無線電話 (DECT)、展頻數位無線電話、第二代數位無線 CT2 基台及手機、無線通信系統、數位式無線交換機與電話機、網際網路電腦通訊器及國際海事衛星通信 M/B 型移動系統
84213910	Filtering or purifying machinery for gase	電動空氣過濾器及電動空氣清潔器
84219910	Cartridges for filter/purifying machines	過濾芯子（供立即使用者）
84709010	Postage machine	郵資機
84709090	Other 8470 machines	其他第 8470 節所屬之機器
84710000	Advanced CAD/CAM system	高級 CAD/CAM 系統
84711000	Analog or hybrid automatic data processing machine	類比或混合自動資料處理機
84713000	Portable automatic data-processing machines, weighing not more than 10 kg, consisting of at least a central processing unit, a keyboard and a display	攜帶式數位自動資料處理機，其重量不超過 10 公斤並至少包含有一中央處理單元，一鍵盤及一顯示器者

C.C.C.Code	Category in English	Category in Chinese
84713000EX	Portable automatic data-processing machines, weighing not more than 10 kg, consisting of at least a central processing unit, a keyboard and a display (for work processing stations and related to: RISC CHIPS, multiprocessor systems, medical optical cards, interface card, medical records system, multimedia systems - hardware, software and applications, back servers, high-performance networks and controllers)	攜帶式數位自動資料處理機，其重量不超過 10 公斤並至少包含有一中央處理單元，一鍵盤及一顯示器者（高級工作站及相關 RICS CHIPS、多處理機系統、醫療光卡、光卡閱讀機個人電腦介面卡及光卡醫療記錄寫作系統、多媒體電腦系統－硬體、軟體及應用系統、後置服務器、高性能跨越網路之控制器）
84714100	Other digital automatic data processing machines comprising at least a central processing unit and an input and output unit	其他數位式自動資料處理機同一機殼內至少包含有一中央處理單元及一輸入、輸出單元，不論是否組合者
84714100EX	Other digital automatic data processing machines :– Comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined (for work processing stations and related to: RISC CHIPS, multiprocessor systems, medical optical cards, interface card, medical records system, multimedia systems - hardware, software and applications, back servers, high-performance networks and controllers)	其他數位式自動資料處理機同一機殼內至少包含有一中央處理單元及一輸入、輸出單元，不論是否組合者（高級工作站及相關 RICS CHIPS、多處理機系統、醫療光卡、光卡閱讀機個人電腦介面卡及光卡醫療記錄寫作系統、多媒體電腦系統－硬體、軟體及應用系統、後置服務器、高性能跨越綯路之控制器）
84714900	Other digital automatic data processing machines :– Other, presented in the form of systems	其他數位式自動資料處理機，具系統形式者

C.C.C.Code	Category in English	Category in Chinese
84714900EX	Other digital automatic data processing machines :– Other, presented in the form of systems	其他數位式自動資料處理機，具系統形式者（高級工作站及相關 RICS CHIPS、多處理機系統、醫療光卡、光卡閱讀機個人電腦介面卡及光卡醫療記錄寫作系統、多媒體電腦系統－硬體、軟體及應用系統、後置服務器、高性能跨越網路之控制器）
84715000EX	Digital processing units other than those of sub-headings 8471.41 and 8471.49, whether or not containing in the same housing one or two of the following types of unit : storage units, input units, output units	第 8471.41 及 8471.49 等目除外之數位式處理單元，在同一機殼內不論其是否含有一個或兩個下列形式之單元: 儲存單元、輸入單元、輸出單元（電子音樂合成系統）
84716020	Printers	列表機
84716020EX	Laser printers, optical printers, high resolution printers	雷射印表機、光電成像印表機、高解析度頁印機
84716090	Input or output units, whether or not containing storage units in the same housing	其他輸入或輸出單元，在同一機殼內不論其是否含有儲存單元者
84716090EX	High performance scanner	高性能文件掃瞄器
84717010EX	Hard disk drives, micro hard drives, micro drives	硬式磁碟機、微小型硬式磁碟機、微小型磁碟機
84717090	Other storage units	其他儲存單元
84717090EX	Solid-state storage, medical optical cards, PC-linked smart card readers, IC cards	固態記憶系統、醫療光卡、光卡閱讀機個人電腦介面卡及光卡醫療記錄寫作系統、IC 記憶卡
84718000	Other automatic data processors - magnetic or optical readers	其他自動資料處理機單元
84719030	Magnetic or optical readers	磁性或光學閱讀機
84719030EX	Barcode readers, catalytic converters, medical optical cards, optical card reader PC interface card and the optical card medical record writing system	條碼閱讀機、觸媒轉化器、醫療光卡、光卡閱讀機個人電腦介面卡及光卡醫療記錄寫作系統

C.C.C.Code	Category in English	Category in Chinese
84719090	Other automatic data processing machines under the heading 8471	其他第 8471 節所屬之自動資料處理機（其中電子音樂合成系統及固態記憶系統為禁止類）
84719090EX	Electronic music synthesis system and a solid-state memory system	電子音樂合成系統及固態記憶系統
84731000	Parts and accessories of the machines of heading 84.69	第 8469 節機器之零件及附件
84732900	Other parts and accessories of the machines of heading 84.70	其他第 8470 節所屬機器之零件及附件
84733010	Other parts and accessories of the machines of subheading8471.10, 8471.30, 8471.41, 8471.49, 8471.50, 8471.60 and 8471.70	第 8471.10、8471.30、8471.41、8471.49、8471.50、8471.60、8471.70 目下機械之零件及附件
84733010EX	Photocopying machine toners, heat sensitive printing head servo writer, fiber-optic network with a waveguide coupler, high-resolution laser printer engine, drives head	影印機用墨粉、熱感應印字頭伺服寫入器、光纖網路用波導藕合器、高解析度雷射印表引擎、磁碟機讀寫頭
84733021	Parts and accessories of the machines of division 8471.90.10	第 847190.10 款下機械之零件及附件
84733029	Parts and accessories of the machines of subheading 8471.80 and 8471.90	第 8471.80、第 8471.90 目下機械之零件及附件
84734010	Parts and accessories of perforating (punching), stapling, and pencil-sharpening machines	打孔機、裝訂機及削鉛筆機之零件及附件
84735010	Parts and accessories equally suitable for use with machinesofsubheading 8471.80 and 8471.90	同時適用於第 8471.80、8471.90 目下機械之零件及附件
84735020	Parts and accessories equally suitable for use with machinesofsubheading 8471.10, 8471.30, 8471.41, 8471.49,8471.50, 8471.60 and 8471.70	同時適用於第 8471.10、8471.30、8471.41、8471.49、8471.50、8471.60、8471.70 目下機械之零件及附件

C.C.C.Code	Category in English	Category in Chinese
84735020EX	photocopying machine toners, heat sensitive printing head servo writer, fiber-optic network with a waveguide coupler, high-resolution laser printer engine	影印機用墨粉、熱感應印字頭伺服寫入器、光纖網路用波導耦合器、高解析度雷射印表引擎
85011090EX	Precision small motors	精密微小馬達
85041100	Widescreen Desktop CRT	大尺寸／寬螢幕映像管 (16：9 CRT)
85044011EX	Switched mode power supplies	交換式電源供應器（高功率密度、高頻電源供應器）
85044012EX	UPS power supplies (high power density, high-frequency power supply)	不斷電式電源供應器（高功率密度、高頻電源供應器）
85044019EX	Other power supplies (high power density, high frequency power supply)	其他電源供應器（高功率密度、高頻電源供應器）
85044090EX	Other electrostatic converters	其他靜電式變流器（微電腦控制交流感應馬達變頻器等相關變頻器）
85171 lOOEX	Wireless and wired phones	附無線手機之有線電話機（整體服務數位網路用戶端設備）
85171910	Video phone	影像電話機
85171990EX	Other phones (ISDN CPE)	其他電話機（整體服務數位網路用戶端設備）
85172100EX	fax machine, ISDN	G4 傳真機、整體服務數位網路用戶端設備
85173011	Central office telephone exchange	局用電話交換機
85173011EX	Central office telephone exchange (Integrated services digital network CPE)	局用電話交換機（整體服務數網路用戶端設備）
8517301990	Other telephone exchange	其他電話交換機
85173019EX	Other telephone exchange (Integrated Services Digital network CPE)	其他電話交換機（整體服務數網路用戶端設備）
85175010EX	Modem (Integrated Services Digital network CPE)	數據機（整體服務數網路用戶端設備）＋ E5878
85175090	Other carrier or digital line systems with appliances	其他載波電流線路系統用或數位線路系統用器具

C.C.C.Code	Category in English	Category in Chinese
85175090EX	ADM150 synchronous optical network systems, optical digital subscriber loop carrier equipment, network take equipment, fiber distributed data interface, Integrated Services Digital network CPE, multimedia, multi-protocol network hub, Ethernet to ATM Smart Hub, High Speed digital subscriber loop equipment, ISDN router, high-speed Ethernet LAN chipset (speed of 100Mbps and above), regional control network products, high-capacity fiber-optic subscriber loop systems, digital wireless subscriber loop transmission equipment, FAST ETHERNET-speed B set line too network (speed of 100Mbps and above), the full range of network technology	同步光纖網路 ADM150 系統、光纖迴路數位用戶載波機、網路存取設備、光纖分散式數據界面、整體服務數位網路用戶端設備、多媒體、多重協定網路中樞、Ethernet to ATM Smart Hub、高速數位用戶迴路設備、ISDN 路由器、高速乙太區域網路晶片組（速率 100Mbps 以上）、區域性控制網路系列產品、大容量光纖用戶迴路系統、數位式無線用戶迴路傳輸設備、Fast Ethernet 高速乙太網路（速率 100Mbps 及以上）、全方位網路技術之集線路
85203210	Digital tape recorders or digital casette tape players	數位錄放音帶機或數位卡帶錄放音機
85203290	Other digital sound recording apparatus	其他數位錄放音器具
85209000EX	Other sound recording apparatus (digital tape players)	其他錄放音器具（數位錄放音機）
85211019EX	Other tape-VCR (Digital Video Recorder)	其他磁帶式錄放影機（數位錄放影機）
85219010	Laser optical system disc video player	雷射光學系統碟式放影機
85219010EX	Laser video disk players	雷射影音碟機
85219010EX	Digital DVD player	數位影音光碟機
85219090	Other VCRs	其他錄放影機
85219090EX	Digital VCR	數位錄放影機
85229020EX	Parts and accessories of tape players (digital tape players)	錄放音機之零件及附件（數位錄放音機機構體）

C.C.C.Code	Category in English	Category in Chinese
85232010	Blank audio CDs	空白音碟
85232020	Blank DVDs	空白影碟
85232030	Blank disc automatic data processing systems	自動資料處理系統之空白磁碟
85232030EX	CD and floppy drives	硬碟機薄膜磁片
85232090	Multimedia systems	多媒體系統
85232090	Multimedia computer system - hardware, software, applications	多媒體電腦系統－硬體、軟體、及應用系統
85232090	Multimedia computer systems and software	多媒體電腦系統及其軟體
85232090	Systems and Instrumental software	系統及工具性軟體
85232090	Multimedia database management system	多媒體資料庫管理系統
85232090	System software	系統軟體
85232090	Family information systems	家庭資訊系統
85232090	High-tech application software systems	高科技應用軟體系統
85232090	Electrical systems auxiliary systems engineering tools	電統輔助系統工程工具
85232090	Other blank discs	其他空白磁碟
85232090	Rewritable CDs/DVDs	可重複讀寫光碟片 (DVD-RAM, PD)
85232090EX	Floppy disks	磁片碟片
85233000EX	Equipped with a card magnetic strip (multimedia computer systems and software, multimedia computer systems - hardware, software and applications, systems and tools of software, multimedia systems)	裝有磁條之卡片（多媒體電腦系統及其軟體、多媒體電腦系統－硬體、軟體及應用系統、系統及工具性軟體、多媒體系統）
85239090EX	Other recording media, blank or recorded (multimedia computer systems and software, multimedia computer systems - hardware, software and applications, systems and tools of software, multimedia systems)	其他錄音或錄製其他類似現象用之空白媒體（多媒體電腦系統及其軟體、多媒體電腦系統－硬體、軟體及應用系統、系統及工具性軟體、多媒體系統）
85241010	Language teaching records	語言教學唱片

C.C.C.Code	Category in English	Category in Chinese
85241020	Recorded music	音樂唱片
85241090	Other records	其他唱片
85243100	Recorded discs for reproducing phenomena other than sound or image	已錄製供重放聲音或影像以外現象之碟片
85243211	Educational, news, and audio CDs	教育性、新聞性音碟
85243219	Other recorded audio CDs	其他已錄製音碟
85243910	Educational and news DVDs	教育性、新聞性影碟
85243990	Discs for laser reading systems :– Other	其他已錄製供雷射閱讀系統用碟片
85244030	Recorded tapes for reproducing phenomena other than sound or image - of a width exceeding 6.5mm	已錄製供重放聲音或影像以外現象之磁帶，寬度超過 6.5 毫米者
85245111	Educational and news audio tapes, width no more than 4mm	教育性、新聞性錄音帶，寬度未超過 4 毫米者
85245121	Educational and news videos, width no more than 4mm	教育性、新聞胜錄影帶，寬度未超過 4 毫米者
85245211	Educational and news audio tapes, width between 4 and 6.5mm	教育性、新聞性錄音帶，寬度超過 4 毫米，但未超過 6.5 毫米者
85245221	Educational and news videos, width between 4 and 6.5mm	教育性、新聞性錄影帶，寬度超過 4 毫米，但未超過 6.5 毫米者
85245311	Educational and news audio tapes, width over 6.5mm	教育性、新聞性錄音帶，寬度超過 6.5 毫米者
85245321	Educational and news videos, width over 6.5mm	教育性、新聞性錄影帶，寬度超過 6.5 毫米者
85245329	Other recorded videos, width over 6.5mm	其他已錄製錄影帶，寬度超過 6.5 毫米者
85245390	Other recorded tapes, width over 6.5mm	其他已錄製磁帶，寬度超過 6.5 毫米者
85246000	Recorded cards with a magnetic strip	裝有已錄製磁條之卡片
85249100	Recorded media for reproducing phenomena other than sound or image	已錄製供重放聲音或影像以外現象之媒體
85249300	Medical optical cards, optical card reader PC interface, and optical card medical record	醫療光卡、光卡閱讀機個人電腦介面及光卡醫療記錄寫作系統

C.C.C.Code	Category in English	Category in Chinese
85249900	Other music recordings or other similar media recordings	其他已錄音或已錄製其他類似現象之媒體
85251020	Radio transmission apparatus	無線電廣播傳輸器具
85251030	TV transmission apparatus	電視傳輸器具
85251090	Other radio transmission machines	其他無線電傳輸機器
85252010	Radio phone	無線電話機
85252090	Other radio transmission receivers	其他具有接收器具之無線電傳輸器具
85254010	Static camcorder	靜相攝影機
85254010EX	Static photography	電子靜相照像機
85279000EX	Other wireless telephone or wireless telegraphy receivers	其他無線電話或無線電報接收機（全球定位系統接收器、全球定位系統接收器及引擎、國際海事衛星通信 M/B 型移動系統及網際網路口袋型電腦通訊器）
85281200EX	Color TV reception apparatus, whether or not incorporating radio broadcast receivers or sound, video recording or reproducing apparatus by TV (resolution of more than 1000)	彩色電視接收器具，不論是否裝有無線電廣播接收機或音、影錄或放器具者［高級數位電視機、高畫質電視機（水平解析度在 1000 條以上）］
85282110	Color CCTV System A	彩色閉路電視系統
85282190EX	17-inch or more color video monitors	17 吋以上彩色影像監視器
85283010	Color projector	彩色影像投射機
85283010EX	Color projector (tv projector, LCD projector)	彩色影像投射機（投影式電視機、液晶投影電視機）
85283020EX	Black and white monochrome video projectors (digital type)	黑白或其他單色影像投射機（數位式）
85371010EX	Computer numerical control (CNC)	電腦數值控制器，PC 級電腦數值控制器
90065900EX	Static camera	電子靜相照像機
90079100EX	Digital camcorders	數位攝錄放影機
90139000	HS Code 9013, parts and accessories	第 9013 節所屬物品之零件及附件

B   Estimate CATE using Causal Forests

In this section, we apply the causal forests method (or the generalized random forests, GRF) developed by Wager and Athey (2018); Athey, Tibshirani and Wager (2019) to our incumbent worker sample and estimate the conditional average treatment effect (CATE) of the 2001 liberalization policy. The method is briefly explained first, and the empirical results follow. Readers who are interested in the details of the method should read the original papers and check out the package codebook online.[7]

B.1   Outline of the Method

The causal forests method utilizes the algorithm of random forests to estimate the CATE. Similar to random forests, subsamples are randomly drawn from the main sample to train decision trees. However, rather than splitting the tree to minimize the sum of squared residuals in the outcome within each node, the splits are chosen so as to maximize the differences of treatment effects between nodes. Once the training is done, the prediction of CATE for a test example can be made by "pushing down" the test example from top to bottom for each tree and calculating the weighted treatment effects with weights given by the share of times that the test example falls into the same leaf as the training samples.

B.2   Results

We implement the GRF package in R using our incumbent worker sample. Three cumulative outcomes over 2001-2007 are of our focus: job transitions, employment years, and normalized wages. Worker characteristics of interests include their initial wages in 2001, gender, marital status, and age. Four-digit industry dummies (for their initial employers in 2001) are also added into the model to control for industry fixed effects.

The individual CATE estimates for each outcome are predicted and summarized in quintiles from the smallest to the largest in Figure 9, 10, and 11. Large heterogeneity is spotted in panel A for all three outcomes, as the estimates goes from significantly negative to significantly positive. The average worker characteristics for each CATE quintile are presented in panel B. Echoing our regression-based heterogeneity analysis in Section 5, male workers and

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[7]Codebook link of the R package: https://grf-labs.github.io/grf/REFERENCE.html#general-algorithm.

workers with higher initial wages tend to have the less job transitions, more employment years, and higher cumulative wage.

Figure 9: CATE estimates using causal forests: Cumulative job transitions
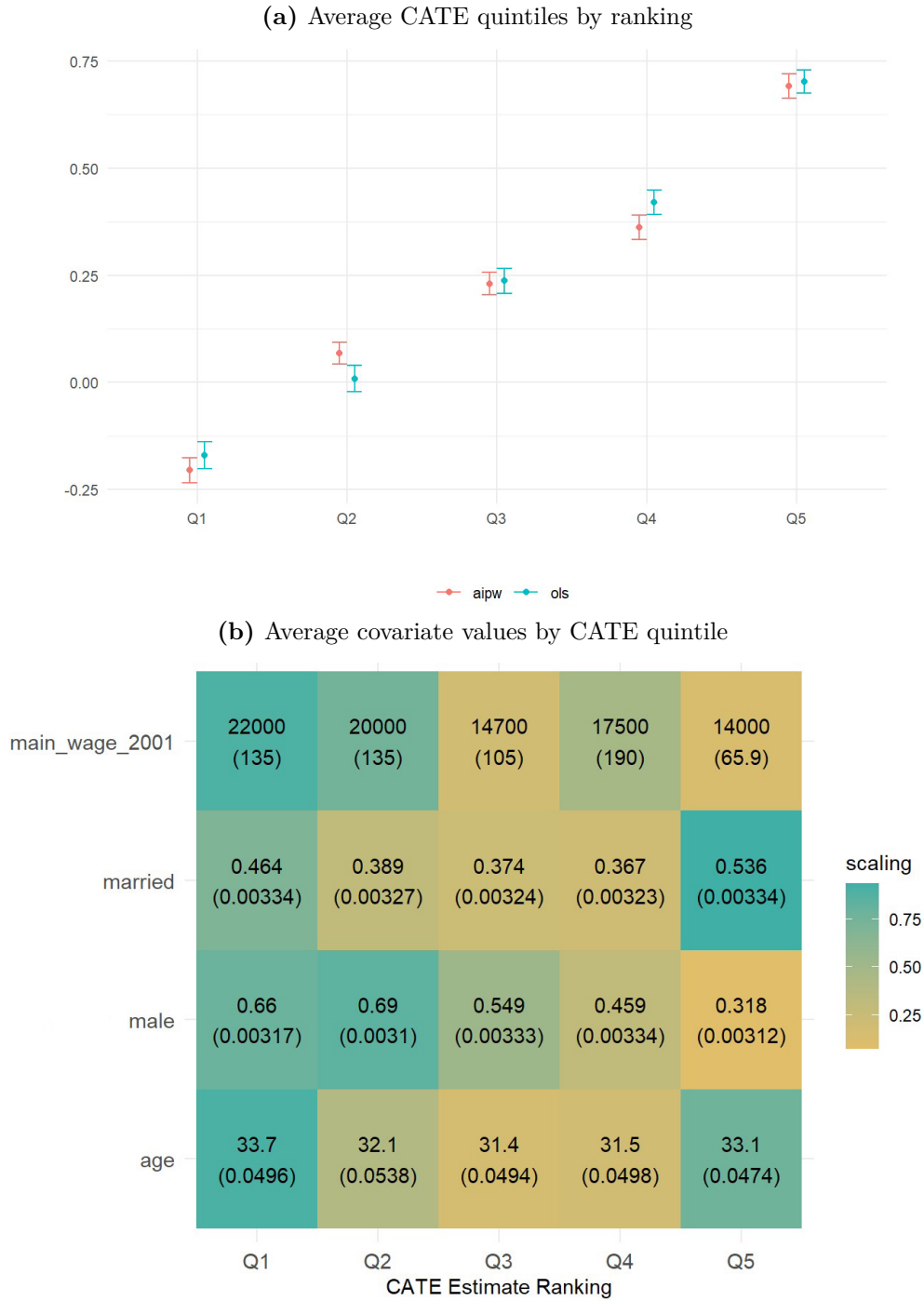
(a) Average CATE quintiles by ranking

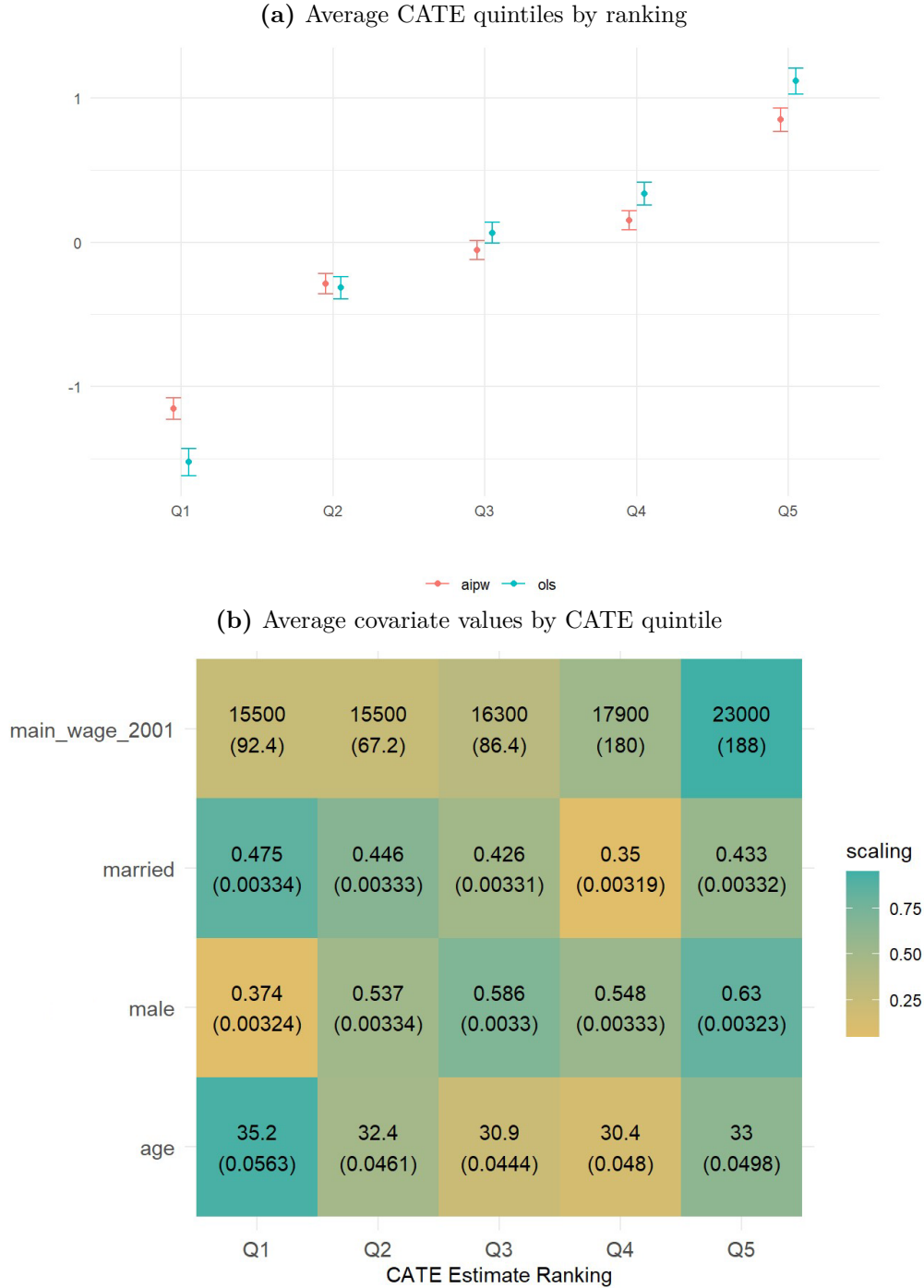**(b)** Average covariate values by CATE quintile

NOTE: The individual CATE estimates are summarized in quintiles and ranked from the smallest to the largest. Two methods to predict CATE are presented in panel A: the out-of-bag predictions following the procedure of Chernozhukov et al. (2016) and the predictions using augmented inverse-propensity weighting (AIPW) following Athey, Tibshirani and Wager (2019). In panel B, the average worker characteristics are shown in number and their standard deviations in parenthesis. The unit of worker initial wage is USD.

Figure 10: CATE estimates using causal forests: Employment years
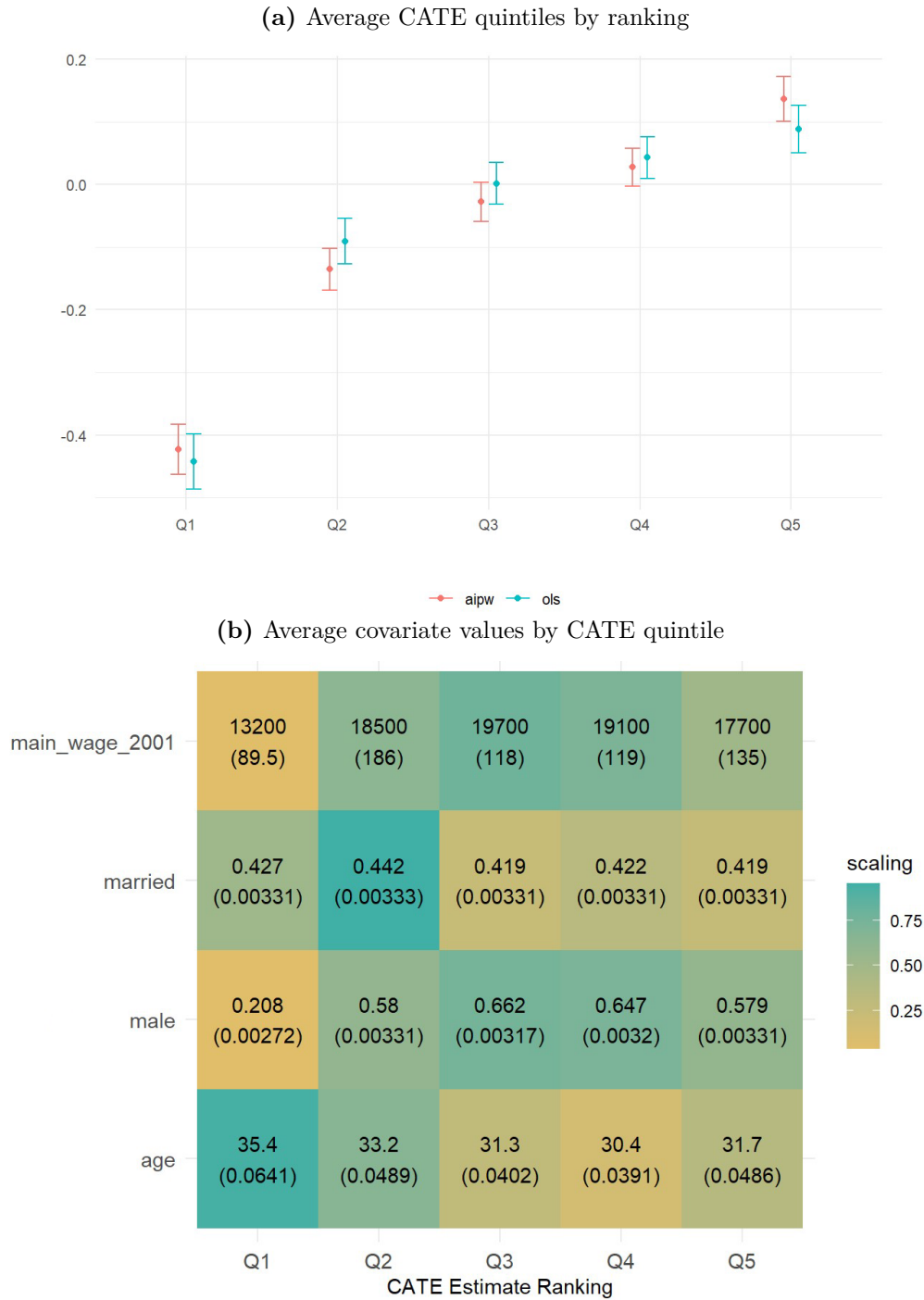
(a) Average CATE quintiles by ranking

(b) Average covariate values by CATE quintile

NOTE: The individual CATE estimates are summarized in quintiles and ranked from the smallest to the largest. Two methods to predict CATE are presented in panel A: the out-of-bag predictions following the procedure of Chernozhukov et al. (2016) and the predictions using augmented inverse-propensity weighting (AIPW) following Athey, Tibshirani and Wager (2019). In panel B, the average worker characteristics are shown in number and their standard deviations in parenthesis. The unit of worker initial wage is USD.

Figure 11: CATE estimates using causal forests: Normalized wage

(a) Average CATE quintiles by ranking

(b) Average covariate values by CATE quintile

NOTE: The individual CATE estimates are summarized in quintiles and ranked from the smallest to the largest. Two methods to predict CATE are presented in panel A: the out-of-bag predictions following the procedure of Chernozhukov et al. (2016) and the predictions using augmented inverse-propensity weighting (AIPW) following Athey, Tibshirani and Wager (2019). In panel B, the average worker characteristics are shown in number and their standard deviations in parenthesis. The unit of worker initial wage is USD.