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1. Introduction

Although the term has appeared throughout the history of development in the form of various phrases, such as industrial zone/park/cluster, (special) economic zone, export-processing zone and so forth (see Akinci and Crittle, 2008 for the variations in the history), a zone is often considered an area with defined boundaries with specific policies, typically referred to as place-based policies. We focus on zones mainly to attract businesses and firms and refer to enterprise zone (EZ, hereafter). The EZ is designed for specific policy objectives such as free trade, export manufacturing, regional development, and policy experiments.

More specifically, this study examines the effect of Vietnamese EZs on several outcomes, namely household income per capita, household living expenditure per capita, individual labor force participation and school attendance probability by age cohort. In addition, we test the pollution haven hypothesis of whether the establishment of EZs is associated with more health issues and loss proxied by absent days from routine work. Our research is motivated by several important facts and existing literature as follows.

First, whether EZs impact household income is debatable. Papke (1994), Ham et al. (2011), Ali and Peerlings (2012), Busso et al. (2013), Chaurey (2017), and Zheng et al. (2017) reported higher incomes due to clustered firms in both developed and developing countries. However, Neumark and Kolko (2010) documented that the EZ program in California did not reduce unemployment. Meanwhile, Reynolds and Rohlin (2015) found limited evidence to show that the Federal Empowerment Zone program in the United States aided underprivileged individuals. Meanwhile, if agglomeration economies exist along with improved infrastructure as a result of EZs, quality of life could increase. This could lead to a higher cost of living due to the influx demand and labor mobility. Therefore, household income increases, and whether EZs improve the real net household disposable income, is not a direct result.

Second, increased income and the rising demand for labor, if any, would complicate household or individual decisions regarding investment in education. Parents might invest more in their children's education, either in terms of quantity or quality, due to the wealth effect and increased returns to education (Glewwe and Jacoby, 2004; Glewwe and Patrinos, 1999; Edmonds and Pavcnik, 2005). However, since parents can suddenly become full-time employees, there could be in increased need for intra-household work. Therefore, children may have to compensate (Basu and Van, 1998), as a substitution effect. This would affect children's

education (Beegle et al., 2009) in terms of school absenteeism or dropping out of school altogether. Similarly, if job opportunities surge with the possibility of higher incomes, individuals may reconsider their decisions regarding years of education, especially if an additional year is at individual cost (and expensive).

Third, Vietnamese EZs boomed during 2000 and 2007 as illustrated in Graph 1. Newly established EZs during this period are four times more compared to all previous existing EZs combined. The literature for environmental standards for EZs were homogenous nationwide. However, with the intense outbreak of EZs and to compete with other regions, local government possibly relaxed law enforcement and monitoring efforts to attract new firms and investors. For example, during the Formosa incident in Vietnam in 2016, Hoang et al., (2019) revealed that a single firm in the Vung Ang Economic Zone discharged toxic wastewater into the ocean. This resulted in an immediate loss of an estimated 42–46% of revenue suffered by the fishing industry in the affected area (the sector accounted for 3.8% of employment and 7.3% of income in coastal areas).

[Insert Graph 1 here]

We analyzed Vietnamese households and individuals using the Household Living Standard Survey (2002, 2004, 2006, and 2008) and the 2007 Establishment Census (containing a census of EZs). We combined the two main sources through communal identity. We selected districts without any EZs before 2003. We used the "winner and loser" strategy similar to Vu and Yamada (2019), to select communes with EZs as the treatment group, and communes without EZs that are located in the same district, as the control group until 2008. However, districts containing both groups should not have any zones established prior to 2003. We compared households in the two groups using both differences-in-differences (DID) and a panel-event study approach. Our findings indicated that household income per capita were higher in the treatment commune associated with EZs. However, there was no wealth effect on school attendance probability for individuals under the age of 18 years. In the interim, we did not find any substitution effect. The difference between the two groups in terms of working probability in any age cohort was insignificant. Similarly, we found no difference in the frequency of illnesses, the number of times receiving inpatient or outpatient care, as well as the number of days absent due to illness. As over 94% of households owned houses, the increase in property prices and income while maintaining the same living expenditure per capita, implied EZs would positively impact Vietnamese households.

Our study contributes several important facts to the literature. First, to the best of our knowledge, this study is the first to test whether the presence of EZs might result in different health outcomes in Vietnam. Second, our analyses use direct household and individual outcomes and provided direct evidence of any possible impact. Third, our findings add additional insights to the impact of EZs on Vietnamese households and individuals during the 5-year period.

The paper is organized as follows. We report on essential related literature in Section 2. We describe the data used in Section 3, followed by our identification strategy and methods in Section 4. We report and discuss the findings in Section 5, while Section 6 concludes our research.

2. Literature review

The impact of place-based policies on various outcomes, either at household, individual or firm level in developed countries, have been examined extensively. However, conclusions on household and individual outcomes have not always been consistent. For example, Fishback (2017) summarized that during the relief spending of the New Deal during the 1930s, initiated by Roosevelt's administration, at least 26 research papers presented positive impacts, indifferences, or even opposite conclusions. The relief spending possibly decreased property crime rates; however, it had limited or even a negative impact on private employment (Fishback, 2017). Similarly, Neumark and Kolko (2010) showed that California's EZ program did not increase employment. Reynolds and Rohlin (2015) found no evidence that underprivileged households in the United States benefited from the Federal Empowerment Zone (FEZ) program. In contrast, by measuring the impact of State Enterprise Zones, FEZ, and Federal Enterprise Community on local employment, Ham et al. (2011) found significant results such as a higher employment rate, a decline in the poverty rate and a higher proportion of wage and salary income. Even if the place-based policy places more weight on capital than on employment, as per the Indiana enterprise zone (adopted in 1983 during the Regan administration), the zone's impact on local employment is still significant and positive (Papke, 1994).

Similarly, by examining the *Zones Franches Urbaines* (ZFU) in France, Givord et al. (2013) found that the ZFU attracted more business from both new and reallocated companies,

and increased total employment in the area. However, the ZFU only had an impact on local wages in remote areas (Briant et al., 2015). On other aspects, Krupka and Noonan (2009) found the FEZ increased property values (through improved services and infrastructure, a decrease in crime, and more employment opportunities) and changes in the residential location choices.

These varying conclusions may be the result of using different comparison groups (Vu and Yamada, 2019). Finding an appropriate comparison (control) group is crucial but challenging. The reason for this, is that the decision for selecting an area for the EZ is not exogenous. For example, Felix and Hines (2013) showed that American communities offer special treatment for firms with low revenues, that are located close to a state border, or that are faced with issues in terms of political cultures. In addition, political decision makers are likely to select the location with the highest possibility for obtaining designed policy goals. The timing in passing a policy could also not be exogenous. For example, states often increase minimum wages while the economy is healthy (Card and Krueger, 1995). Vu and Yamada (2019) summarized several practical measures in the literature to construct counterfactuals such as propensity score matching, comparison between zones with candidates in a "loser-winner" effect, and the geographical boundary discontinuity combined with DID.

However, to the best of our knowledge, more researchers use data from developed countries than from developing countries. Abeberese and Chaurey (2019) found that the New Industrial Policy for Uttarakhand and Himachal Pradesh (India) resulted in a decrease in informal businesses, while maintaining a high number of formal firms. Chaurey (2017) also established that the place-based policy increased employment, output, fixed capital, and the number of firms. Similarly, using night light data as the outcome and analyzing the same place-based policy for Uttarakhand, Shenoy (2018) found the treatment region's economic activities rose sharply compared to a region located on the state border. In addition, Chaurey (2017) indicated an increase in wage workers, but not in property rental or migration in treatment areas. Meanwhile, Ali and Peerlings (2012) revealed that industrial clusters promote structural changes: in rural Ethiopia, farm households created non-farm businesses that resulted in a higher household income. From the perspective of a different type of place-based policy, such as a poverty eradication program, Jalan and Ravallion (1998) discovered increased consumption. In addition, Wang (2013) illustrated that special economic zones in China promoted wages to increase more rapidly than living costs. Growth in local employment and wages, due to industrial parks, attracted housing construction and consumption in China (Zheng et al. 2017).

In Vietnam, the initial private EZ was established as early as 1991 (Vu and Yamada, 2019). In early times, Vietnamese EZs were controlled directly by the prime minister. From 2008 onwards, control was assigned to provincial government. Two typical policies included tax incentives and motivations for land rent (see Vu and Yamada, 2019 for specific policy descriptions). The two correspond with industrial zones (IZ, hereafter) and industrial clusters (IC, hereafter)[1]. Vu and Yamada (2019) found that IZs and ICs resulted in a higher concentration of firms with nine or more workers in the commune, since the zone was established. They found an incrementing number of firms and employment within the treatment commune. This impacted not only firms located within the zone, but also businesses located within the commune, but outside the zone border (Vu and Yamada, 2019). However, whether IZs or ICs impacted local households and individuals, remains to be investigated. For example, it was not clear whether the source of labor from the increment came from local households or internal migration. Moreover, the Formosa incident (see Hoang et al., 2019) in 2016 raised an interesting research question regarding the pollution haven hypothesis. Specifically, whether EZs create more health and environmental issues than possible income advantages.

3. Data

Our analysis relied on a combination of commune[2] identities between two important sources of data. The first one refers to the 2007 Establishment Census (ES), conducted by the General Statistics Office of Vietnam (GSO). Following Vu and Yamada (2019), we extracted information from a census of enterprise zones from the ES. The information includes location (detailed at commune level), year of establishment, and type of zone. We mirrored Vu and Yamada's approach (2019) precisely to classify zones into either industrial zone or industrial cluster. IZs were established and directly controlled by the prime minister (central government), while ICs were managed by the provincial government. Vu and Yamada (2019) noted that

[1] In Vietnamese, IZ consists of "khu công nghiệp/nghệ" (industrial/manufacturing zone), "khu chế xuất" (export processing zone), "khu kinh tế" (economic zone), and "khu công nghệ cao" (high-technology zone) while IC includes "cụm công nghiệp" (industrial cluster), and "làng nghề" (industrial village/community).

[2] Commune is the 3rd level of the national administration division in Vietnam. There were about over 10,000 communes. The 2nd level is district which consists of about 700 districts in total. The 1st level is province (61–63 during 2002–2008).

Vietnam lacked legislation to regulate IC establishment by 2008. The detailed distribution of the establishment and nature of zones can be found in Table 1 and Graph 1.

[Insert Table 1 here]

The second one is the Vietnam Household Living Standard Survey (VHLSS) from 2002, 2004, 2006, and 2008. The VHLSS has been conducted by the GSO once every two years since 2002. Based on the renowned Living Standard Measurement Survey (LSMS) by the World Bank, the VHLSSs are country specific and were sampled using a two-stage stratified approach. The VHLSSs between 2002 and 2008 used the same sampling units from the 1999 Vietnamese Population and Housing Census. We noted that the majority (97.95%, 98.21%, and 98.57% in 2004, 2006, and 2008, respectively[3]) of individuals in the VHLSS had families registered within the commune. Therefore, households in VHLSSs most likely originated from and had been living in the commune for a long time.

From each wave, we gathered several outcomes at household level for households residing in the selected communes (to be explained in more detail subsequently) from the main questionnaires: general information, education, employment (working), income, expenditure, health and housing[4]. Outcomes included the logarithm of household income per capita ($Ln\ (Income\ p.c)$), average household working hours (for the main occupation[5]) among members of 18+ years for 12 months prior the survey ($Working\ hours\ p.a$), household living expenditure per capita ($Ln\ (living\ expenditure\ p.c)$), and property price[6] per square meter ($Ln\ (housing\ price\ p.m2)$). In addition, we included indicators for the frequency of illnesses developed (counted in last 4 week, ($Freq.4w$) and 12 months, ($Freq.12m$) prior to the survey), inpatient ($Inpatient$) or outpatient ($Outpatient$) care per capita, and the average number of absent days (per capita) from routine activities ($Absent\ days$) due to the illness within 12 months prior to the survey.

Also, we added important outcomes at individual level for the corresponding households. We used the information regarding whether an individual attends school

[3] VHLSS 2002 did not enquire such information.

[4] GSO used each questionnaire for country representative samples for their intended purposes. Every household in VHLSS was asked for several or (not compulsory) all questionnaires.

[5] VHLSS defined the main job as the job that individuals undertook for most of the working time.

[6] Land is state property in Vietnam. However, Vietnamese laws allowed the right to use land to be transferred and traded. We used the expected property price. In general, the price for the house included the land usage right.

($School\ attendance$) for each of the three main age cohorts (7–10[7], 11–14, and 15–17 years) corresponding to the Vietnamese school system (compulsory primary school with 5 grades, secondary school with 4 grades, and high school with 3 grades, respectively). In addition, we also use the information on working activity status to ascertain whether an individual is employed ($Working$). The 2004–2008 VHLSS enquired from respondents aged 6 and above (the 2002 VHLSS questioned only those aged 10 and above) whether they have ever been employed in work that generated income in the 12 months prior to the survey. Additionally, we specified the work category for members aged 18 and above (hereafter, 18+) in three cases across the corresponding age cohorts with salaried work ($Salaried\ work$), self-employed work related to agriculture, aquaculture and forestry ($Self-employed\ type\ A$), and other self-employed work ($Self-employed\ type\ B$). Finally, we also repeatedly calculated the outcomes related to health similar to those at household level ($Freq.4w$, $Freq.12m$, $Inpatient$, $Outpatient$, and $Absent\ days$). The descriptive statistics of the outcomes are presented in Appendices 1–3.

4. Methods

4.1 Identification strategy and sample selection

Vu and Yamada (2019) noted how an area was selected by candidates to build a zone, and though endogenous, no transparency was shared with citizens, especially local communities in Vietnam. Vu and Yamada (2019) revealed that by 2008 the prime minister of Vietnam was the only eligible individual to establish IZs, while the Provincial People's Committee president could establish ICs. As noted in Graph 1, enterprise zones were not popular during the early 2000s. However, the period between 2003 and 2007 observed the highest growth in the number of new zones, equal to the total of all existing zones. Therefore, zone establishment could act as an exogenous shock to commune households and common citizens.

[7] We chose 7 instead of 6 because Vietnamese regulations on education allows all children born in the same year to go to school for the same grade, rather than by age. Therefore, 7 secured all children under compulsory education.

Similar to Vu and Yamada (2019), our identification strategy relies on the "winner-loser" approach. The approach assumption is that a losing area constitutes a valid counterfactual for the concurrent winning area, conditional on the control of pre-existing trends and various fixed effects (Greenstone et al., 2010). Greenstone et al. (2010) suggested that the winning area should show a similar trend in most economic variables compared to the losing area. We also assumed that other communes in the same district (the potential losers) of the winner, were considered potential candidates by policy makers. The distance to harbors and airports were similar for the losers and the winner (Vu and Yamada, 2019).

Therefore, we followed Vu and Yamada's (2019) identification strategy on selecting communes with EZs. We elected districts that did not have any EZs from 2000–2002, but accommodated EZs by 2008. We inherited the data on EZs for a country representative of 1,971 communes in 124 districts from Vu and Yamada (2019), in the same selection categories.

However, since the VHLSSs cover more than 2,901–3,961 communes out of the total of approximately 10,000–11,000 communes in Vietnam, when layering the VHLSS communes on the commune data of Vu and Yamada (2019) for each corresponding year, we roughly obtained that 30% of communes (583–772 communes in 112–113 districts) matched. Then, we ensured that each district had at least one control and one treatment commune. The treatment commune refers to one in which an EZ was established by July 2007. Meanwhile, the control commune is within the same district as the treatment commune, but without an EZ prior to 2007. The selection secures the validity of commune fixed effects explained in the next section. However, this resulted in a selection between 283–287 communes (in each wave[8]) in 52 identical districts and/or 8,726 households over four respective years (see Appendix 2).

However, we acknowledged that the commune's decision to build a zone might be based on households' existing characteristics, although this decision was more likely exogenous to their knowledge. For example, the objectives of policy makers could be either to eradicate poverty or to attract firms by targeting a higher productive local labor force (proxied by the average educational level of communes with a population of 18+ years). In our selection, policy makers could have selected the latter since the number of schooling years among

[8] There were 291 identical communes for the whole period 2002–2008; however, there was also attrition. In addition, each commune with a zone, hosted either IZs or ICs.

individuals of 18+ years was roughly 0.616 years more in the treatment commune in 2002, as observed in Appendix 1.

Also, we acknowledged the endogenous timing for zone establishment. For example, Graph 1 showed the Vietnamese government seemed to establish numerous zones (as many as all the previous years combined) during 2003 and 2006, before gaining access to the World Trade Organization in 2007. However, in the interim, there was a variation in the timing within the short period between 2003 and 2007. Therefore, we can exploit this variation by examining the length of zone establishment and by using a panel-event study.

4.2 Methods

We applied differences-in-differences (DID) and a panel event-study to identify the effect of enterprise zones on household and/or individual outcomes.

For DID, we selected only the VHLSSs for 2002 and 2008. We started with the following reduced form equation for each household/individual i for a set of s outcomes ($Outcome_{ijs}$) defined in Section 3, using commune fixed effects (FE) and clustered standard errors at household-level:

(1) $Outcome_{is} = \alpha_1\ zone \times t + \alpha_2\ t + \alpha_3\ commune + \ \alpha_4 X_i + \varepsilon_i$,

where t=1 if it was year 2008, and $zone_j$ equal to 1 if the $commune$ accommodated the EZ by 2008 (otherwise a value of zero was attributed). α_1 acts as the DID estimator. Where X_i appears, we used the most significant characteristics as control variables. As long as $zone$ is uncorrelated with any household/individual characteristics lying in ε_i, the equation (1) identifies the effect of the enterprise zone on household/individual outcomes. More specifically, at household level, we used the average schooling years ($Household\ education$) among members aged 18+ years in our estimations where outcomes were related to income and school attendance. Additionally, we also used four dummies (simplified as $Type\ of\ property$) for five types of properties (villas; concrete houses with; or without a shared kitchen, toilet and bathroom; semi-concrete houses; and temporary houses) when analyzing the property price. Similarly, at individual level, we used years of schooling where outcomes were related to the employment of members aged 18+ years. Meanwhile, we used $Household\ education$ for outcomes of children under 18 years. We also considered gender differences (Sex equals 1 if female, 0 otherwise).

However, since the year of zone establishment varied per commune, we took advantage of this useful variation information corresponding with IZs and ICs, and modified (1) to:

(2) $$Outcome_i = \beta_1\, IZ \times\ zone\ experience + \beta_2 IC \times\ zone\ experience\ + \beta_5 t + \beta_6 commune + \beta_7 X_i + \varepsilon_i,$$

where $zone\ experience = 0$ if the zone had not yet been established at the time *t* (i.e. 2008). In other cases, $zone\ experience$ equals to the year interval between time *t* (i.e. 2008) and the year of establishment of the initial zone in the $commune$.

Similar to $zone\ experience$, we deployed a panel-event study by using a set of dummies indicating the point of the year *t* relative to the year of establishment of the first zone in the $commune_j$. The base line is the year of the original zone establishment. More specifically, $before_7 = 1$ if the $commune$ was 7 years before the initial zone was established. Similarly, $after_1 = 1$, …, $after_4 = 1$ when it was one to four years after the establishment of the zone, correspondingly. The set of dummies equal zero otherwise.

We shifted our analysis to a panel-event study, since we were unable to test for the DID important assumption on the parallel trend with only two waves of data. We added the VHLSS from 2004 and 2006 to the current sample for the following equation:

(3) $$Outcome_i = \gamma_1\, before_m + \gamma_2\, after_n + \gamma_3\, commune + \ \gamma_4 X_i + \gamma_{5k} baseline_k\ \times t + \gamma_6\, district\ \times t + \varphi_i.$$

$Baseline_{jk}$ refers to four commune characteristics (k = [1, 4]) measured in 2000 including the distances from the commune to the nearest harbor and international airport, and two aggregated business indicators, namely the logarithm of total capital and sales per workers among firms (with more than 9 employees) located in the commune in 2000. We obtained the characteristics from Vu and Yamada (2019), in which business indicators originated from the Vietnam Enterprise Survey, 2000 (see Vu and Yamada, 2019 for the detailed description of the data and the four commune characteristics). γ_{5k} captures the effect of commune endowments with possible nonlinear effects by the time the zone was established. Meanwhile, γ_{6l} captures the average time trend of each district.

Finally, we constructed two dummies similar to $zone \times t$ in equation (1): *IZ started* and *IC started*. IZ refers to the approximate impact of industrial zones, while IC references industrial clusters. This method decomposed the average difference between the two types of EZs. We used the following equation for our final estimation:

(4) $Outcome_i = \gamma_{1m}\, before_m + \gamma_{2n}\, after_n + \gamma_3\, commune + \gamma_4 X_i + \gamma_{5k}\, baseline_k \times t + \gamma_6\, district \times t + \gamma_7\, IZ\ started + \gamma_8\, IC\ started + \varphi_i.$

This method enabled us to test the parallel trend assumption. The test hypothesis is that all γ_{1m} (m = [–7, –1]) equally.

5. Results

5.1 Income, working hours, living expenditure, and property price

We found that EZs were associated with higher household income per capita. As per Table 2, the logarithm of household income per capita increased by 3.24 percentage points compared to each year since the IZ was established in the household's commune. However, we noted that the baseline comparison in Appendix 1 showed a significant difference in household income per capita. Therefore, we employed a panel-event study to cross-check and confirm the robustness of the results.

[Insert Table 2 and 3 here]

Our corresponding analysis using the panel-event study as per Table 3, confirmed the validity of previous results from using the DID approach. In column (1) of Table 3, the parallel trend is valid as H0: all "before" equal coefficients were not rejected. Meanwhile, H0 for the difference between IZ and IC (IZ started = IC started = 0) was rejected. Furthermore, we noted that we cannot derive a conclusion from the estimation using a panel-event study where the parallel trend assumption is violated.

We did not find any evidence indicating an increase in household living expenditure per capita (negative signs of zone coefficients appeared instead) as presented in Table 2. Combined with an increase in household income, our results are in line with those from Wang (2013) based on China.

Additionally, the estimations in columns (7) and (8) from Table 2 showed an increase in property prices. More specifically, there was an increase of 8.54 percentage points per year in the logarithm of property price per square meter in IZ communes. We did not find the same increment among households in IC communes. In addition, the comparison in Appendix 1 showed that property prices would have been equal in the baseline. Therefore, we can respond to DID results without referring to the panel-event study results, and conclude that the zone

could have induced an increase in property prices in the local commune. We noted that the majority (94.1%, 94.7%, 95.8%, 95.8% in 2002, 2004, 2006, 2008, correspondingly) of Vietnamese households in the VHLSS owned houses. Therefore, the increased cost of housing could benefit households in the treatment communes.

We further examined the reasons for an increase in household income per capita in the treatment group. First, we tested whether the working probability for specific job types could have been adjusted at individual level. We found that individuals aged 18+ years in treatment communes are more likely to have salaried work, especially in IC communes as shown in columns (1) and (2) of Table 4. The results suggest that local employment would have increased, which are consistent with and contribute to Vu and Yamada' findings (2019). Meanwhile, EZs could have scaled down the participation rate in self-employed jobs for both type A and type B. We further divided the sample into male and female groups as per Appendix 4, in which the results are consistent with those found in the combination. We noted there could have been an increment in salaried work for females in association with IZs. However, there is no statistically significant difference observed from the corresponding male group. The results agree with Vu and Yamada (2018, and 2020) in that there are more opportunities for women to acquire paid jobs, specifically those associated with foreign investment firms, to decrease the gender wage gap.

[Insert Table 4 here]

However, we acknowledged that the results from the DID approach in Table 4 should be interpreted using caution. The reason being, that corresponding estimations in the panel-event study showed no statistically significant EZ effect on salaried work and self-employed type A.

Second, we investigated the average working hours of households within 12 months prior to the survey, for the main occupation of members aged 18+ years. The results, evident in columns (5) and (6) of Table 2, indicated the EZ increased working hours by approximately 42.74 hours per year, due to zone experience in the treatment group. The numbers are 51.5 and 36 hours for IZ and ICs, respectively. Unfortunately, the VHLSS did not specify the job type of individuals' main occupation. Therefore, we were unable to explore the purposes behind this more thoroughly.

5.2 Health issues

Given that households would have maximized their available HI whenever household members were ill, we examined the probability and consequences of illnesses, namely the

number of absent days (per capita within 12 months prior to the survey) from routine work. We acknowledged that our analysis was limited to a short period of time (<5 years) in experiencing an EZ. We noted that we cannot apply DID for outcomes related to the average number of times inpatient/outpatient care is received, the average number of times an illness occurs (4 weeks/12 months prior the survey), and absent days from routine work as a result. The reason for this being that the information was not requested in the 2002 VHLSS (the baseline). However, given that the zone experience time varied across communes, we can duplicate the estimations in equation (4) without using the 2002 wave data as per Table 5.

[Insert Table 5 here]

We did not find an increase in the risk of experiencing health issues in either 4 weeks or 12 months prior to the survey, in both household and individual analysis as shown in columns (1), (2), (6), and (7) of Table 5. Since H0: all zone coefficients = 0 was not rejected in all corresponding estimations, while even the coefficients related to zones attained negative signs. In addition, the difference in the number of times outpatient/inpatient care was received, was statistically insignificant. The parallel trend condition was met in all estimations. H0: No zone coefficients = 0 were rejected in columns (3) and (4), while none of the single zone coefficients were statistically significant in column (9) of Table 5.

Further, as seen in column (5) of Table 5, when ICs were established in a commune, local households experienced more absent days from routine work due to illness, which could suggest a possibility of severe consequences in terms of health issues. However, all corresponding hypothesis test results (H0: All zone coefficients=0; H0: IZ started=IC started=0; and H0: All zone coefficients =0) in columns (5) and (10) of Table 5 supported the argument that there is no zone effect[9] at either household or individual level. Therefore, we acknowledged that the interpretation for more severe consequences of health issues should be interpreted with caution.

5.3 School attendance and working probability among members under 18 years

We did not find any statistical increase in school attendance among individuals of eligible age for general education. The sign for corresponding coefficients were all negative as

[9] We further excluded 32 households with more than 99 days absent from routine work due to illness, to eliminate the possibility of outliers. However, the results (available upon request) were consistent with the ones in column (5).

evident in Table 6 for the DID approach. However, while parallel trend assumptions were met, no H0: All zone coefficients = 0 were rejected in columns (7), (8), and (9) of Table 6. The evidence confirms a zero zone effect. However, we also acknowledged three elements pertaining to school attendance that have yet to be discussed. These include the ability of an average child in the household to study, their past school attendance, and the household decision to adjust schooling years conditional on the establishment of enterprise zones (with changes in employment availability and earnings).

[Insert Table 6 and 7 here]

Finally, we did not find any significant zone effect on working probability for the three age cohorts, as observed in Table 7. Hypothesis tests (H0: All zone coefficients =0) also strongly support our argument, while the parallel trend assumptions were all valid.

6. Conclusions

In this study, we examined the impact of EZs on Vietnamese household and individual outcomes from 2000–2007 using DID and the panel-event study approaches. We found EZs are associated with a higher household income per capita and property prices in the zone commune, but not for the household living expenditure per capita. We did not find any statistical significant increases or decreases in school attendance, nor in working probability among members aged between 7 and 17 years. Within 5 years of zone establishment, we did not find a difference in terms of the frequency of illness, inpatient and outpatient care, and number of absent days from routine work due to illness. While we did not find any evidence relating to significant decreases in living expenditure, school attendance, and health outcomes, the increases in income and property prices suggests that EZs have a positive impact on Vietnamese households and individuals overall.

However, we also acknowledged several drawbacks in this study for future research agendas. First, households in the treatment and control groups were not homogenous in terms of the average household education level. Second, our analyses covered a short window of observation limited to 5 years, without the long-term effects of EZs. Third, we were unable to place more control variables at household level due to the limitation of the data. A panel data of the matching households is the ideal scenario replacement. Fourth, income and housing prices might contain measurement errors. Household respondents declared the expected market

price of their house or land, according to his/her best knowledge. Survey timings varied within a wave of VHLSS; therefore, we were unable to exclude the time trend value and fluctuation of the price within a year. Also, the prices did not reflect the ones recorded by real purchases in the market. Fifth, spillover effects could have occurred. Since the treatment and control communes were located in the same district within geographical proximity, individuals from the zone commune could have commuted to work. Therefore, the difference in household income per capita could be under-estimated.

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Appendix 1 Descriptive statistics for DID approach

Variable	2002					2008				
	Control		Treated		Diff.	Control		Treated		Diff.
	Obs.	Mean	Obs.	Mean		Obs.	Mean	Obs.	Mean	
	(1)	(2)	(3)	(4)	(2)–(4)	(6)	(7)	(8)	(9)	(7)–(9)
Household level	2,114		605			3,328		959		
Household size		4.1883		4.3124	–0.1241		3.8675		4.0125	–0.1450**
Household education		5.6803		6.1594	–0.4790***	3,327	7.4893		7.7413	–0.2520**
Ln (Income p.c)		8.0121		8.1211	–0.1090***		9.0196		9.1227	–0.1031***
Ln (Living expenditure p.c)†		7.7645		7.8396	–0.0750***	666	8.7608	192	8.8570	–0.0962**
Ln (housing price p.m2)	2,106	6.2055	602	6.4737	–0.2682	3,322	7.4020	956	7.7229	–0.3210***
Having health insurance		0.3070		0.3074	–0.0004	2,482	0.1821	703	0.1693	0.0128
Among 18+ working member										
Average working hour for 12 months‡	2,026	1598.658	577	1767.916	–169.258***	3,151	1506.925	904	1714.777	–207.852***
Individual level										
Aged 7-10§	805		240			786		233		
Sex		0.4571		0.5458	–0.0887**		0.4898		0.4893	0.0005
Working	205	0.0243	65	0.0461	–0.0218		0.0115		0.0086	0.0029
School attendance		0.9734		0.9917	–0.0153		0.9637		0.9516	0.0121
Aged 11-14	936		292			1,140		329		
Sex		0.4850		0.4383	0.0467		0.5017		0.4802	0.0215
Working		0.1579		0.1027	0.0522**		0.0851		0.0365	0.0486***
School attendance		0.9081		0.9418	–0.0337*		0.9456		0.9422	0.0034
Aged 15-17	657		198			1,044		282		
Sex		0.4734		0.4545	0.0188		0.4962		0.4220	0.0742**
Working		0.4551		0.3687	0.0864**		0.3362		0.2837	0.0525*
School attendance		0.6149		0.6869	–0.0720*		0.6906		0.7553	–0.0647**
Aged 18+	5,570		1,635			10,154		3,033		
Sex		0.5223		0.5309	–0.0086		0.5379		0.5282	0.0097
Years of schooling		6.9957		7.612	–0.6165***		7.5578		7.8432	–0.2854***
Salaried work		0.3199		0.2911	0.0288**		0.3247		0.3343	–0.0096
Self-employed (related to agriculture, aquaculture, and forestry) type A		0.6714		0.5608	0.1106***		0.5805		0.4405	0.1400***
Self-employed (others) type B		0.2068		0.3248	–0.1180***		0.1805		0.2239	–0.0434***

Notes: (†) In the original 2008 VHLSS, only 9,189 out of 45,945 households were questioned about information on household expenditure. (‡) We omitted 422 households (1% of upper bound of its distribution) with the average working hours in 12 months prior to the survey for the main occupation > 3,624 hours (over 9.928 hours per day for each day of the year). (§) The 2002 VHLSS requested information on the working status of those aged 10 years and above.

Appendix 2 Descriptive statistics for panel-event study approach at household level

	Obs.	Mean	Std. Dev.	Min	Max
Household level	8,726				
Household size		4.0333	1.6203	1	13
Residing in a zone commune		0.2226	0.4160	0	1
Year 2002		0.3116	0.4632	0	1
Year 2004		0.0986	0.2981	0	1
Year 2006		0.0986	0.2981	0	1
Year 2008		0.4913	0.5000	0	1
IZ started		0.0456	0.2087	0	1
IC started		0.0925	0.2897	0	1
Ln (Income p.c)		8.6325	0.7692	4.9416	12.0717
Ln (Living expenditure p.c) †	5,297	8.0841	0.6148	6.4345	10.3498
Ln (Housing price p. m2)	8,702	7.0042	1.0594	–0.5108	10.7609
Among 18+ working member	8,304				
Working hour p.a‡		1576.097	678.911	0	3,624
Average per household member *	6,007				
Illness - Freq. 4w		0.4242	0.6522	0	2
Illness - Freq. 12m		0.5288	0.5401	0	2
Absent days due to illness		6.6385	17.1453	0	365
Inpatient (times)	3,803	0.1428	0.3954	0	8
Outpatient (times)	3,803	1.9424	3.0238	0	42
Number of identical districts	52				
Number of identical communes	291				
Number of IZ by 2008	21				
Number of IC by 2008	43				

Notes:

(†) and (‡) are the same as in Appendix 1.

*** The 2002 VHLSS did not contain information on health at individual level as well as these categories.

Appendix 3 Descriptive statistics for panel-event study approach at individual level

	Obs.	Mean	Std. Dev.	Min	Max
All	37,656				
Sex		0.5148	0.4998	0	1
Year 2002		0.3044	0.4602	0	1
Year 2004		0.1024	0.3032	0	1
Year 2006		0.0999	0.2999	0	1
Year 2008		0.4933	0.5000	0	1
Frequency of illness					
Freq. 4w	26,193	0.4386	0.7066	0	2
Freq. 12m	21,331	0.6525	0.6542	0	2
Absent days due to illness	14,484	12.3732	30.3799	0	365
Times in 12 months prior the survey					
Outpatient	11,146	2.6036	3.6994	0	70
Inpatient	11,146	0.1936	0.5668	0	12
Household having health insurance	28,744	0.2374	0.4255	0	1
Aged 7-10	2,613				
Sex		0.4768	0.4996	0	1
Working	1,838	0.0163	0.1267	0	1
School attendance		0.9782	0.1461	0	1
Aged 11-14	3,414				
Sex		0.4918	0.5000	0	1
Working		0.1163	0.3206	0	1
School attendance		0.9335	0.2492	0	1
Aged 15-17	2,783				
Sex		0.4650	0.4989	0	1
Working		0.3705	0.4830	0	1
School attendance		0.6813	0.4661	0	1
Aged 18+	25,521				
Sex		0.5318	0.4990	0	1
Years of schooling		7.4367	3.8733	0	21
Working		0.8107	0.3918	0	1
Salaried work		0.3213	0.4670	0	1
Self-employed (related to agriculture, aquaculture, and forestry) type A		0.2102	0.4074	0	1
Self-employed (others) type B		0.5914	0.4916	0	1

Note:

The 2002 VHLSS did not contain information on health at individual level.

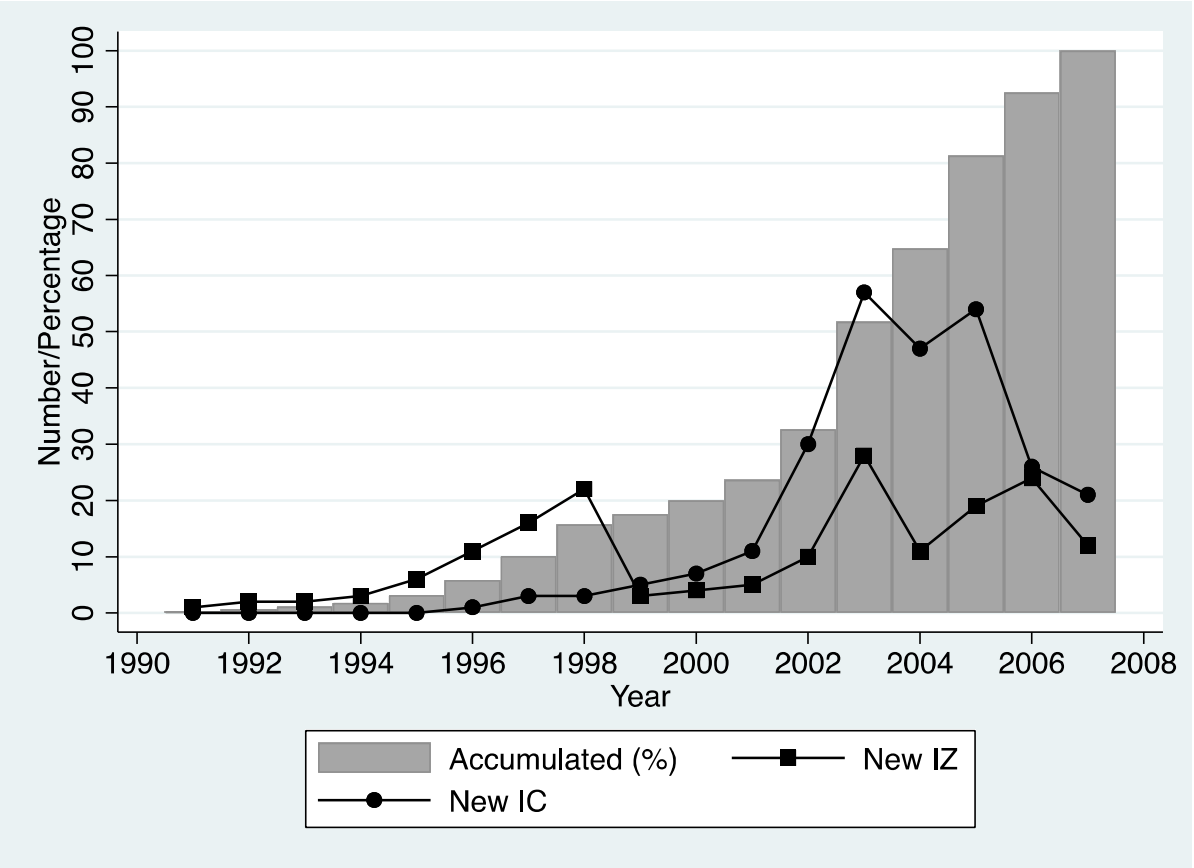
Appendix 4 Labor force participation among individuals aged 18+ years by gender using DID approach

VARIABLES	Salaried work	Salaried work	Self-employed Type A	Self-employed Type A	Self-employed Type B	Self-employed Type B
Female	(1)	(2)	(3)	(4)	(5)	(6)
Zone experience	0.0129**		–0.0210***		–0.0156**	
	(0.0062)		(0.0069)		(0.0068)	
IZ experience		0.0163*		–0.0461***		0.0075
		(0.0089)		(0.0097)		(0.0093)
IC experience		0.0101		–0.0009		–0.0340***
		(0.0079)		(0.0086)		(0.0088)
N (households)	10,841	10,841	10,841	10,841	10,841	10,841
R-squared	0.123	0.123	0.244	0.245	0.147	0.148
Male	(7)	(8)	(9)	(10)	(11)	(12)
Zone experience	0.0038		–0.0104		–0.0235***	
	(0.0079)		(0.0074)		(0.0072)	
IZ experience		–0.0172		–0.0381***		–0.0052
		(0.0110)		(0.0104)		(0.0102)
IC experience		0.0198**		0.0106		–0.0375***
		(0.0100)		(0.0094)		(0.0093)
N (households)	9,551	9,551	9,551	9,551	9,551	9,551
R-squared	0.078	0.079	0.229	0.231	0.104	0.105

Note:

Sex, years of schooling, year 2008 dummy and commune FE were included in all estimations.

Graph 1 Development of enterprise zones during 1990–2007



Notes:

Accumulated number of zones compared to that of 2007 in percentage. New IZ = number of newly established industrial zone. New IC = number of newly established industrial cluster.

Table 1 Enterprise zones as of July 2007

	IZ			IC		
	Mean	Min	Max	Mean	Min	Max
Year of establishment	2001.40	1991	2007	2003.69	1996	2007
Year started/expected in operation	2002.68	1992	2013	2005.56	1997	2012
Area in the masterplan (ha)	336.29	3.82	10,000	69.43	1.1	2,111.29
Area for lease (ha)	194.34	0	2,816.26	33.40	0	2,111.29
	IZ			IC		
Status						
In operation	144			189		
Under construction	35			76		
Classification						
Industrial (manufacturing) zone	173			17		
Export processing zone	4			2		
High-technology zone	0			1		
Economic zone	2			3		
Industrial cluster/industrial village	0			242		
Total	179			265		

Note: The table is from Vu and Yamada (2019). IZ = industrial zone; IC = industrial cluster.

Table 2 Effects of zones on household outcomes using DID approach

VARIABLES	Ln (Income p. c)		Working hours p.a		Ln (Living expenditure p.c)		Ln (housing price p. m2)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Zone experience	0.0080		42.7497***		–0.0073		0.0324**	
	(0.0095)		(11.6462)		(0.0132)		(0.0132)	
IZ experience		0.0324**		51.5071***		–0.0047		0.0854***
		(0.0129)		(18.0739)		(0.0226)		(0.0199)
IC experience		–0.0112		36.0414***		–0.0091		–0.0085
		(0.0124)		(13.9740)		(0.0146)		(0.0161)
Types of properties							Yes	Yes
N (households)	7,005	7,005	6,658	6,658	3,577	3,577	6,986	6,986
R-squared	0.580	0.581	0.246	0.246	0.617	0.617	0.618	0.619

Notes:

In (1)–(6), household education was included while year 2008 dummy and commune FE were included in all estimations.

Working hours p.a. is the average household working hours for the main occupation in 12 months prior to the survey among members aged 18+ years.

Table 3 Effects of zones on household outcomes using panel-event study approach

VARIABLES	Ln (income p. c)	Working hours p. a	Ln (living expenditure p.c)	Ln (housing price p. m2)
	(1)	(2)	(3)	(4)
Before (–7)	0.3063	–685.9603**	0.5557**	0.1591
	(0.2502)	(304.7126)	(0.2222)	(0.2595)
Before (–6)	0.1896**	–323.1814***	–0.0018	–0.3632***
	(0.0962)	(121.3817)	(0.0974)	(0.1383)
Before (–5)	0.3633**	–201.7042	0.2854*	–0.2000
	(0.1648)	(217.8439)	(0.1716)	(0.2137)
Before (–4)	0.2982***	–56.9145	0.1535**	0.1389
	(0.0744)	(101.7294)	(0.0681)	(0.1158)
Before (–3)	0.3782**	–447.4872**	0.2327	–0.2092
	(0.1502)	(207.8200)	(0.1599)	(0.1997)
Before (–2)	0.2033***	–46.1908	0.0648	–0.1346
	(0.0660)	(79.0569)	(0.0690)	(0.0984)
Before (–1)	0.2486*	–168.7361	0.2614*	–0.1463
	(0.1277)	(179.7468)	(0.1395)	(0.1699)
After (1)	0.3156***	–149.6944	0.2722*	0.0770
	(0.1206)	(171.7450)	(0.1408)	(0.1604)
After (2)	–0.0091	4.3398	–0.0768	–0.1178
	(0.0680)	(84.3380)	(0.0795)	(0.0978)
After (3)	0.2419*	–238.2500	0.1767	0.3037*
	(0.1268)	(177.2051)	(0.1418)	(0.1710)
After (4)	0.0169	67.3241	0.0849	0.2311*
	(0.0946)	(114.0157)	(0.1370)	(0.1317)
IZ started	0.2155***	–106.2521	0.0758	–0.1259
	(0.0739)	(92.9460)	(0.0717)	(0.1050)
IC started	0.0900	–93.9193	–0.0024	–0.1489
	(0.0691)	(89.7368)	(0.0627)	(0.0992)
Household education	Yes	Yes		
Types of properties				Yes
Prob>F				
H0: All "Before" are equal	0.4135	0.0129	0.0637	0.0009
H0: All "After" = 0	0.1309	0.6511	0.2194	0.0076
H0: IZ started=IC started=0	0.0131	0.8889	0.5008	0.2921
H0: All zone coefficients=0	0.0018	0.0962	0.0437	0.0000
N (households)	8,725	8,304	5,297	8,702
R-squared	0.569	0.270	0.583	0.629

Notes:

Commune FE, baseline-year FE, and district-year FE were included in all estimations.

Working hours p.a. refer to the household average among members aged 18+ years for the main occupation in 12 months prior to the survey.

Table 4 Labor force participation among members aged 18+ years

VARIABLES	Salaried work		Self-employed Type A		Self-employed Type B	
DID	(1)	(2)	(3)	(4)	(5)	(6)
Zone experience	0.0095*		–0.0162***		–0.0195***	
	(0.0055)		(0.0057)		(0.0058)	
IZ experience		0.0011		–0.0429***		0.0012
		(0.0076)		(0.0080)		(0.0079)
IC experience		0.0161**		0.0045		–0.0356***
		(0.0071)		(0.0071)		(0.0078)
N (Individuals)	20,392	20,392	20,392	20,392	20,392	20,392
R-squared	0.112	0.112	0.216	0.217	0.113	0.114
Panel-event study	(7)		(8)		(9)	
Prob>F						
H0: All "Before" are equal	0.5414		0.8944		0.0005	
H0: All "After" = 0	0.6213		0.4053		0.0651	
H0: IZ started=IC started=0	0.4152		0.2299		0.1812	
H0: All zone coefficients=0	0.2542		0.4731		0.0002	
N (Individuals)	25,521		25,521		25,521	
R-squared	0.123		0.222		0.125	

Notes:

In (1)–(6), sex, years of schooling, year 2008 dummy and commune FE were included.

In (7)–(9), IZ/IC started, "Before"/ "After", years of schooling, commune FE, baseline-year FE, and district-year FE were included.

Table 5 Frequency of illness and its severe consequences using panel-event study

VARIABLES	Freq. 4w	Freq. 12m	Inpatient	Outpatient	Absent days
Household level	(1)	(2)	(3)	(4)	(5)
IZ started	–0.1153	–0.0058	0.0245	0.1548	–3.5959
	(0.1342)	(0.1513)	(0.0822)	(0.7273)	(5.0291)
IC started	–0.0298	–0.0270	0.0244	0.8412	7.0271*
	(0.1220)	(0.1207)	(0.0730)	(1.0328)	(4.2120)
Prob>F					
H0: All "Before" are equal	0.5375	0.4939	0.5096	0.3695	0.5741
H0: All "After" = 0	0.6004	0.7260	0.9728	0.3823	0.4329
H0: IZ started=IC started=0	0.6912	0.9749	0.9292	0.7131	0.1144
H0: All zone coefficients=0	0.9039	0.8234	0.8848	0.2642	0.4311
N (Households)	3,803	3,803	3,803	3,803	3,803
R-squared	0.223	0.255	0.276	0.309	0.139
Individual level	(6)	(7)	(8)	(9)	(10)
Prob>F					
H0: All "Before" are equal	0.1566	0.0193	0.2863	0.5692	0.4690
H0: All "After" = 0	0.2354	0.0589	0.5005	0.0412	0.5798
H0: IZ started=IC started=0	0.5607	0.6607	0.1667	0.5568	0.1908
H0: All zone coefficients=0	0.5309	0.1444	0.0869	0.0990	0.3966
N (Individuals)	17,281	13,224	9,589	9,589	11,440
R-squared	0.116	0.230	0.186	0.151	0.103

Notes:

All outcomes were not requested in the 2002 VHLSS at individual level.

"Before"/ "After," HI, commune FE, commune-endowment-characteristic-year FE, district-year FE were included in all estimations. In (6)–(10), gender dummy was included.

Table 6 School attendance among individuals from 7–17 years of age

	Aged 7-10		Aged 11-14		Aged 15-17	
DID	(1)	(2)	(3)	(4)	(5)	(6)
Zone experience	–0.0009		–0.0101		–0.0053	
	(0.0039)		(0.0070)		(0.0148)	
IZ experience		0.0012		–0.0083		–0.0001
		(0.0024)		(0.0099)		(0.0176)
IC experience		–0.0025		–0.0115		–0.0095
		(0.0060)		(0.0086)		(0.0212)
N (Individuals)	2,064	2,064	2,696	2,696	2,179	2,179
R-squared	0.245	0.245	0.190	0.190	0.305	0.305
Panel-event study	(7)		(8)		(9)	
Prob>F						
H0: All "Before" are equal	0.3705		0.1858		0.7949	
H0: All "After" = 0	0.6120		0.9460		0.5254	
H0: IZ started=IC started=0	0.9677		0.5134		0.5264	
H0: All zone coefficients=0	0.4102		0.5411		0.5789	
N (Individuals)	2,613		3,413		2,781	
R-squared	0.275		0.246		0.342	

Notes:

In (1)–(6), sex, household education, year 2008 dummy and commune FE were included.

In (7)–(9), sex, IZ/IC started, "Before"/ "After", household education, commune FE, commune-endowment-characteristic-year FE, district-year FE were included.

Table 7 Labor force participation among household members from 7–17 years of age

	Aged 7-10		Aged 11-14		Aged 15-17	
VARIABLES	Working	Working	Working	Working	Working	Working
DID	(1)	(2)	(3)	(4)	(5)	(6)
Zone experience	–0.0076		–0.0034		0.0013	
	(0.0089)		(0.0077)		(0.0148)	
IZ experience		–0.0171		–0.0091		–0.0143
		(0.0128)		(0.0103)		(0.0173)
IC experience		0.0001		0.0008		0.0138
		(0.0115)		(0.0096)		(0.0211)
N (Individuals)	1,289	1,289	2,696	2,696	2,179	2,179
R-squared	0.2221	0.2238	0.247	0.247	0.3314	0.3318
Panel-event study	(7)		(8)		(9)	
Prob>F						
H0: All "Before" are equal	0.1727		0.2794		0.3136	
H0: All "After" = 0	0.3964		0.3350		0.2010	
H0: IZ started=IC started=0	0.1167		0.8498		0.1502	
H0: All zone coefficients=0	0.5121		0.6087		0.4326	
N (Individuals)	1,838		3,413		2,781	
R-squared	0.325		0.330		0.375	

Notes:

In (1)–(6), sex, household education, year 2008 dummy and commune FE were included.

In (7) and (9), IZ/IC started, "Before"/ "After", household education, commune FE, baseline-year FE, and district-year FE were included.