High-Speed Rail, Migration, and Regional Adjustment in Japan

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Abstract

This paper studies how Japan's Shinkansen expansion reshapes internal migration and regional adjustment in a context of population decline and rapid aging. Using the staggered rollout of Shinkansen stations, I compile new prefectural and municipal panel datasets and estimate dynamic treatment effects using a group-time difference-in-differences framework.

The results show that the primary responses to Shinkansen access operate through land and housing markets and localized demographic and fiscal adjustment, rather than through broad prefecture-wide migration or income growth. At the prefecture level, Shinkansen entry is associated with increases in commercial land prices, residential construction, and unemployment counts, consistent with capitalization and transitional adjustment. At the municipal level, station-hosting jurisdictions experience sizable medium-run increases in live births, housing construction, and municipal financial revenue, while surrounding municipalities exhibit heterogeneous spillovers that vary systematically with distance from stations.

Overall, the evidence indicates that Shinkansen expansion primarily reallocates population and fiscal capacity within regions through spatial equilibrium channels, capitalization into land values, housing supply response, and demographic sorting, rather than generating uniform regional growth. These findings highlight the importance of evaluating large transport investments in mature economies through their local and fiscal incidence, not solely through aggregate income measures.

Key Words: High-speed rail, Internal migration, Regional adjustment, Housing markets, Japan, Shinkansen

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Introduction

Japan faces sustained population decline, rapid aging, and widening disparities in local fiscal capacity across regions. In this environment, internal migration and spatial reallocation play a central role in determining which regions retain population, housing demand, and public revenue, and which continue to contract. Large-scale transportation investments such as the Shinkansen have the potential to reshape these adjustment margins by altering accessibility between regions and within local commuting zones. Understanding how Shinkansen access affects population allocation, housing markets, and local public finance is therefore central to evaluating its role in Japan's regional economy.

While similar debates surround high-speed rail investments elsewhere, including cost escalation and delays in projects such as HS2 in the United Kingdom and California High-Speed Rail, Japan provides a uniquely informative setting (California High-Speed Rail Authority 2025; Benson 2024). The Shinkansen is the world's first high-speed rail system, has expanded incrementally for more than six decades, and operates in a mature economy characterized by slow aggregate growth and persistent regional depopulation. Unlike rapidly growing economies, Japan's internal migration and housing adjustment margins are largely zero-sum at the national level, making spatial redistribution a first-order channel through which infrastructure investments may operate.

The central question is therefore not whether the Shinkansen "raises growth," but how improved intercity accessibility reshapes the spatial distribution of population, housing supply, and fiscal capacity within and across regions. Large transport investments in this context may generate substantial local effects even when national aggregates move little, reallocating households, economic activity, and tax bases toward some jurisdictions and away from others.

A substantial amount of literature evaluates major transport investments as potential engines of regional growth through productivity, firm entry, and income gains. At the same time, spatial equilibrium models emphasize migration, sorting, and land-market adjustment as dominant margins of response: accessibility shocks can alter residential and firm location choices, capitalizing benefits into land values and generating concentrated local gains alongside displacement effects elsewhere. For policy evaluation in a declining-population setting, the key issue is therefore not only whether high-speed rail "works," but whether it reallocates population, housing construction, and fiscal capacity across space—and whether those adjustments occur at the level of broad regions (prefectures) or within local commuting zones around station nodes.

This paper studies how Shinkansen access affects internal migration and regional adjustment using the staggered expansion of Japan's Shinkansen network. I compile new prefectural and municipal panel datasets and link outcomes to station opening dates to trace dynamic responses

over time. By examining outcomes at multiple geographic scales, the analysis distinguishes prefecture-wide responses from localized adjustment in station-hosting municipalities and nearby jurisdictions.

More broadly, this paper contributes to the literature on the Japanese economy by documenting how large-scale transport investments interact with demographic decline to reshape internal population allocation, housing supply, and municipal fiscal capacity. Rather than focusing primarily on aggregate income growth, the analysis highlights spatial equilibrium channels—capitalization into land values, housing supply response, and fiscal reallocation—that shape regional adjustment in a mature, aging economy.

This paper makes three contributions. First, it documents where adjustment occurs following Shinkansen access, distinguishing between prefecture-wide outcomes and localized responses in station-hosting municipalities and nearby jurisdictions. Second, it identifies the margins through which adjustment operates, particularly housing construction, demographic change, and municipal fiscal capacity, rather than focusing solely on aggregate income measures. Third, it shows which outcomes do not respond robustly, including prefecture-wide migration and GDP, underscoring that the primary effects of Shinkansen access in Japan operate through spatial reallocation within regions rather than uniform regional growth.

Background and Related Literature

2.1 Institutional background: Shinkansen expansion and regional policy stakes

Japan inaugurated the Shinkansen in 1964 with the opening of the Tokaido Shinkansen between Tokyo and Osaka. The network has expanded incrementally for six decades across Honshu, Kyushu, and Hokkaido, generating substantial variation in the timing and geography of high-speed rail access. Expansion remains active; for example, JR West began service on the Hokuriku Shinkansen extension to Tsuruga in March 2024 (International High Speed Rail Association 2024).

Shinkansen projects have also become increasingly salient in contemporary infrastructure debates as costs, engineering constraints, and timelines have become more visible. In Hokkaido, the extension toward Sapporo has faced major schedule delays tied to construction and geological challenges, shifting the expected opening to early 2039 (Japan Railway Construction, Transport and Technology Agency n.d. “Hokkaido Shinkansen”).

This institutional history motivates the empirical strategy in this paper. Because prefectures and municipalities receive Shinkansen access at different points in time, and because later openings can overlap with the event window around initial access, the analysis focuses on first network

entry and uses sample restrictions to prevent subsequent openings from confounding the ±10-year dynamic profile.

2.2 Financing, Ownership, and the Role of Prefectures and Municipalities

Post-privatization Shinkansen expansion is implemented under a centralized planning framework with shared financing and complementary local investments. Under the National Shinkansen Railway Development Act, MLIT (Ministry of Land, Infrastructure, Transport, and Tourism) plays the central role in authorizing construction and, when JRTT (Japan Railway Construction, Transport and Technology Agency) is the constructor, formally seeks the opinions of prefectures that are also responsible for construction costs. The Act assigns construction cost responsibility to the national government and the relevant prefectures, net of rental income from railway facilities, and allows prefectures to charge beneficiary municipalities for a portion of the prefectural contribution (MLIT 1970).

For many "new" (post-1990s) Shinkansen projects, infrastructure development follows a vertical-separation model in which JRTT constructs the line, retains ownership of the infrastructure after completion, and leases it to the JR passenger company that operates and manages train service (JRTT n.d. "Railway Construction"). Construction costs are shared between the national government, prefectures, and operators under a centralized planning framework, while station-area development and associated public investments are often undertaken by local governments.

Local governments also play a distinct role in "hosting" stations and enabling station-area development. In the post-privatization environment, station construction and station-area environmental improvements, including station plazas, are commonly undertaken by local governments, and station openings are frequently bundled with local access works and redevelopment intended to capture regional development benefits (Ando n.d.). In addition, Shinkansen openings can trigger changes to parallel conventional lines, including cases where local communities establish operators to take over facilities and maintain service, which can shift responsibilities and fiscal burdens toward local actors along the corridor (Saito n.d.). Taken together, this institutional structure implies that station placement and timing reflect negotiated local participation, and that observed fiscal effects are most plausibly mediated through tax-base changes, transfers, and complementary local investment rather than through direct municipal capture of rail operating profits (JRTT n.d. "Railway Construction").

These institutional features motivate the empirical exposure definitions below: I treat first network entry at the prefecture level and separate municipal effects at station-hosting nodes from proximity-based spillovers that operate through migratory, local housing, labor, and fiscal channels.

2.3 Transportation Infrastructure, Migration, and Spatial Reallocation

A central insight of spatial economics is that transportation investments can alter market access and commuting costs, shifting household and firm location choices and capitalizing benefits into land values. As a result, place-based infrastructure can generate large local changes in population, housing supply, and public finance even when aggregate output effects are modest (Redding and Turner 2015; Donaldson and Hornbeck 2016). Spatial equilibrium logic further implies that measured "growth" in connected places may partly reflect redistribution across locations through migration and sorting rather than uniform productivity gains (Hornbeck and Moretti 2019).

These mechanisms are particularly relevant in mature, aging economies such as Japan, where aggregate growth is slow and regional depopulation is an active policy concern. In such settings, high-speed rail may induce substantial spatial resorting and fiscal reallocation even if regional GDP effects are limited.

2.4 High-Speed Rail Evidence: Japan, Europe, and China

Empirical findings on high-speed rail vary widely across contexts and time horizons. In rapidly industrializing settings, large transport investments have produced sizable gains through market integration and structural reallocation (Faber 2014; Banerjee, Duflo, and Qian 2020). In advanced economies, evidence more often emphasizes heterogeneous, node-centered effects and redistribution, with impacts concentrated near connected cities and stations and limited systematic evidence of broad-based regional growth.

For Japan, existing work points to changes in urban form and population distribution consistent with reallocation toward connected nodes (Nickelsburg, Ahluwalia, and Yang 2018; Komikado et al. 2021). European evidence similarly suggests that effects depend on local conditions and complementary policies, with stronger impacts where high-speed rail meaningfully shifts accessibility in ways that interact with housing supply and local development constraints (Ahlfeldt and Feddersen 2010). These patterns align with broader syntheses emphasizing context dependence and the importance of identifying mechanisms, including migration and land-market adjustment, rather than treating regional GDP growth as the sole metric of success (Blanquart and Koning 2017). Concerning Japan specifically, early work finds that Shinkansen investments can affect regional outcomes but with impacts that vary substantially by place and horizon, underscoring that the main margin may be spatial reallocation rather than broad-based growth (Yoshino 2017).

Data

I construct two panel datasets linking socioeconomic outcomes to the timing and geography of Shinkansen station openings. The prefecture panel covers all 47 prefectures annually from

1950–2024 (series-dependent). The municipal panel covers 1980–2023 and distinguishes (i) municipalities that host a Shinkansen station and (ii) non-host municipalities assigned to mutually exclusive exposure bands based on distance to the nearest station (0–10 km, 10–20 km, 20–30 km). Outcomes span demographics, labor markets, land and housing markets, and public finance.

3.1 Data sources

Most outcomes are obtained via reproducible API pulls from e-Stat, Japan's official government statistics portal, which consolidates series from national ministries and statistical agencies. For earlier years and selected series where e-Stat coverage is incomplete, I supplement with official historical publications (e.g., statistical yearbooks) and standardize definitions and units when necessary. Station opening dates and station-to-municipality assignments come from a compiled station dataset that records opening year and geocoded location, matched to municipality codes.

3.2 Treatment definition and exposure groups

Prefecture treatment (first network entry). A prefecture is treated in the year its first Shinkansen station opens within its borders; let g_i denote that first opening year and $g_i = 0$ for never-treated prefectures. Because later openings can overlap the event window around first access, the main prefecture analysis uses a clean-window-10 sample: I retain prefectures for which any second station opening occurs more than 10 years after the first, so that the $[-10,+10]$ event-study window around initial access is not mechanically confounded by another opening. In the prefecture sample, there are 27 prefectures: 11 treated across five opening cohorts and 16 never-treated prefectures serving as controls.

Municipal treatment (station hosts). A municipality is directly treated in the year a Shinkansen station first opens within its boundaries ("host" municipalities). For host municipalities, g_i is the earliest station opening year in that municipality; $g_i = 0$ for municipalities that never host a station (in the host specification's control set).

Municipal spillovers (distance-based exposure). For municipalities that do not host a station, I define indirect exposure based on proximity to Shinkansen stations. I construct mutually exclusive distance bands (0–10 km, 10–20 km, and 20–30 km), excluding host municipalities from these rings. Within each band, a municipality's exposure year g_i is defined as the earliest station opening year such that at least one station lies within the band's distance threshold of the municipality centroid (based on the station-to-nearby-municipality mapping). The control group consists of municipalities that are neither hosts nor within 30 km of any station ("never exposed within 30 km"). Because exposure definitions differ across rings, I estimate each band in a separate regression design.

Clean-window restriction and sample size. In the ring analyses, I impose a clean-window restriction that retains treated municipalities only if the second exposure event in that band occurs more than 10 years after the first, so the [−10,+10] event-study window around initial exposure is not mechanically confounded by subsequent nearby station openings. This restriction is mild in practice: treated counts fall from 357 to 349 in the 0–10 km band, from 322 to 301 in the 10–20 km band, and from 204 to 187 in the 20–30 km band; the control group contains 740 municipalities that are never exposed within 30 km. Identification is assessed using event-study leads and joint tests of pre-treatment coefficients.

3.3 Outcomes

Outcomes are primarily grouped into five domains:

1. **Demographics and migration:** total population, live-births in-migration, out-migration, and net migration (when defined consistently in the source series).
2. **Economic and labor-market aggregates:** GDP, taxable income, labor force, unemployment counts.
3. **Land and housing markets:** commercial, residential, and industrial land values; residential construction and housing supply measures.
4. **Public finance:** prefectural and municipal fiscal outcomes, including municipal financial revenue and measures of fiscal need.
5. **Education and health:** education-related counts (e.g., kindergarten pupils) and health capacity measures (e.g., hospitals), where available.

3.4 Variable construction, transformations, and harmonization

To improve interpretability and comparability across outcomes, most outcomes are transformed into natural logarithms. Where outcomes can take zero values (particularly counts for smaller jurisdictions), I use log1p, defined as ln(1+x). All transformations are reported in the tables.

Several additional construction choices are relevant:

- **Population interpolation:** For prefecture population in early decades reported in multi-year increments, I linearly interpolate between observed years to construct annual series (no extrapolation beyond observed endpoints; confined to years prior to 1960).
- **Municipal five-year series interpolation:** For municipal outcomes reported in five-year increments (population, labor force, unemployment), I interpolate to annual frequency within municipalities without extrapolation.
- **Boundary harmonization:** Municipalities are harmonized to a consistent panel using merger/name crosswalks. When definitions change, series are reconciled to preserve continuity where feasible.

Outcome	Level	Years Covered
Population; Total Population (log)	Prefecture; Municipality	1950–2023; 1980-2020
Taxable Income (log)	Prefecture; Municipality	1985–2023; 1985–2023
GDP (log, real)	Prefecture	2001–2020
Labor Force (log)	Prefecture; Municipality	1975–2020; 1980–2020
Unemployed (log)	Prefecture; Municipality	1975–2020; 1980–2020
In-migrants (log)	Prefecture; Municipality	1975–2024; 1996–2023
Net Migration (log)	Prefecture	1975–2024
Residential Land Price (log)	Prefecture	1976-2023
Commercial Land Price (log)	Prefecture	1976–2023
Industrial Land Price (log)	Prefecture	1976-2023
New Residential Buildings (log)	Prefecture	1997–2023
Newly Constructed Dwellings (log)	Prefecture; Municipality	1975–2023; 2000–2023
Financial Revenue (log)	Prefecture; Municipality	1975–2021; 2000–2021
Financial Need (log)	Prefecture; Municipality	1975–2021; 2000–2021
Pref.Tax and Grant Revenue (log)	Prefecture	1975-2021
Municipal Tax Revenue (log)	Municipality	2000–2021
Live Births (log)	Prefecture; Municipality	1980–2022; 1995–2022
Hospitals (log1p)	Prefecture; Municipality	1975–2022; 1997–2022
General Hospitals (log1p)	Prefecture; Municipality	1975-2022
Kindergarten Pupils (log)	Prefecture; Municipality	1975-2023; 1980–2023
Kindergartens (log1p)	Municipality	1980–2023
Fertility Rate (log)	Prefecture	1980-2022
Number of Physicians (log)	Prefecture	1975-2022

Table 1. Description of Prefecture- and Municipal-Level Panel Data[1]

[1] Table 1 reports the years covered for each outcome at the prefectural and municipal levels. All main results are estimated on the maximum balanced sample available for each outcome.

Empirical Strategy

Shinkansen stations opened at different times across regions, and effects may differ across cohorts and evolve over event time. In staggered-adoption settings with heterogeneous treatment effects, conventional two-way fixed effects event studies can be difficult to interpret because they combine treated-versus-treated comparisons with potentially negative weights (Goodman-Bacon 2021). I therefore estimate dynamic effects using a staggered-adoption estimator that delivers interpretable cohort-by-time average treatment effects on the treated.

4.1 Estimator: Callaway and Sant'Anna (2021)

I estimate average treatment effects on the treated (ATT) using the Callaway and Sant'Anna (2021) group-time framework. Let G_i denote unit i's first treatment year (station opening), and let t index calendar time. The group-time ATT is:

$$ATT(g,t) = E[\, Y_t(1) - Y_t(0) \mid G_i = g \,],$$

which compares outcomes for units first treated in year g to a risk set of appropriate controls in year t.

Control group. I use the "not-yet-treated" comparison group in each period; never-treated units enter this risk set whenever they exist in the sample.

Dynamic aggregation and horizons. I aggregate group-time estimates into event time $e = t - g$ to produce event-study profiles. I additionally report horizon averages by averaging event-time effects over years 0–5 ("short run") and years 6–10 ("medium run") following opening.

Inference. Standard errors are clustered at the prefecture level for prefecture specifications and at the municipality level for municipal specifications.

4.2 Baselines and interpretation in levels

For interpretability, the tables report baseline pre-treatment levels computed as geometric means over the pre-window −10 to −2 (event time). For logged outcomes, baselines are obtained by exponentiating the mean of the logged outcome; for log1p outcomes, the baseline is exponentiated and one is subtracted to return to level units. Baselines are omitted for signed outcomes such as net migration.

Throughout, log-point effects are interpretable as approximate percent changes via $100 \times (\exp(\beta) - 1)$. For log1p outcomes, as percent changes in $1 + y$.

4.3 Multiple openings, anticipation, and interpretation

Treatment timing and exposure definitions follow Section 3.2, and I estimate dynamic ATTs around first exposure in event time over a ±10-year window.

Throughout, the estimates should be interpreted as reduced-form equilibrium responses to Shinkansen access and associated local adjustment, rather than as structural parameters or welfare effects.

Anticipation. Because station openings are preceded by planning and construction, outcomes could adjust prior to the opening date. I evaluate this using event-time leads and joint tests of pre-treatment coefficients over −10 to −2. While these diagnostics cannot rule out all anticipatory behavior, they provide a direct check for differential pre-treatment dynamics within the estimation window used to identify the post-opening effects.

Interpretation. The estimates capture equilibrium incidence of station openings within local commuting and housing markets. Outcomes can respond through residential relocation, commuting changes, firm re-siting, and redevelopment, so municipal ring effects should be interpreted as spatial redistribution across nearby jurisdictions rather than as pure residential migration.

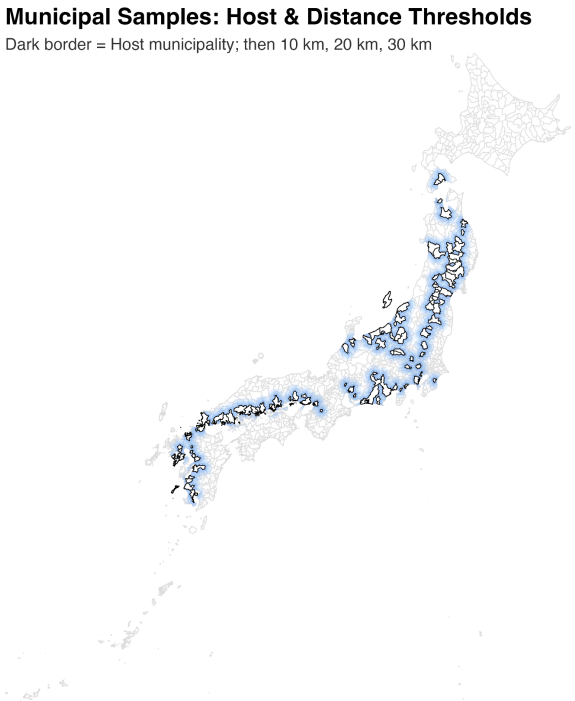


Figure 1: Japan Treated Municipalities Overlay[2]

[2] For the visualization depicted in Figure 1, the 10-20-30 km distance-bands are represented by progressively lighter icy blue rings surrounding treated municipalities. Treated municipalities are depicted with black borders.

4.4 Diagnostics and pre-trend screening

Identification relies on the assumption that absent treatment, treated and comparison units would have followed similar outcome trajectories. I assess the plausibility of this assumption using event-study leads and joint tests of pre-treatment coefficients over event time −10 to −2. These diagnostics provide transparency about pre-treatment dynamics and inform which specifications are emphasized in the main tables, while the appendix reports the full set of results.

Joint pre-trend diagnostic. For each estimator–sample–outcome specification, I assess pre-treatment comparability by testing whether the event-time lead coefficients over $k \in [-10, -2]$ are jointly equal to zero (with $k = -1$ as the reference period). The omnibus statistic is implemented using the estimated lead coefficients and their standard errors and reported as a joint p-value. I use this diagnostic to screen which outcome–sample specifications are emphasized in the main tables, and I report the complete set of joint tests and event-study plots for all specifications in the appendix.

The main tables report specifications that do not reject this joint pre-trend test at the 5 percent level; the appendix reports the full universe of tests and corresponding event-study plots. These tests are used as diagnostics of the plausibility of parallel trends rather than as outcome-significance filters, and the appendix mitigates selective reporting concerns by presenting results for all specifications.

At the prefecture level, 4 of 23 CS-DiD outcomes do not reject at the 5 percent level. In the municipal panel, 37 of 56 outcome–sample specifications for the baseline municipal designs do not reject at the 5 percent level for the joint pre-trend test. The full outcome tables for prefecture outcome and municipality outcome-sample data are included in appendix tables A1 and A2 respectively.

4.5 Robustness

The appendix reports event-study plots and additional checks showing that the main patterns are not driven by particular implementation choices.

I visualize dynamics using event-study plots produced by did::ggdid applied to the dynamic aggregation did::aggte(type = "dynamic"), which displays event-time ATT estimates with 95% simultaneous confidence bands.

4.6 Identification and station placement

A central concern is that station placement and timing may correlate with underlying local trajectories (e.g., planned redevelopment, anticipated demand, or political bargaining). The empirical strategy addresses this concern in three complementary ways. First, identification relies on within-period comparisons to not-yet-treated units, avoiding already-treated units as

controls and delivering cohort-specific effects that can be aggregated transparently. Second, I directly assess the parallel-trends implication of the identifying assumption using event-time leads and joint tests in a common pre-treatment window. Third, I focus on clean-window samples that isolate first access within a fixed event window and reduce mechanical contamination from subsequent nearby openings.

These diagnostics cannot rule out all forms of time-varying selection, particularly if unobserved shocks coincide with openings without generating detectable pre-trends. The results should therefore be interpreted as reduced-form equilibrium responses to Shinkansen access and associated station-area adjustment, conditional on the absence of differential pre-trends in the estimation window and the robustness patterns documented in the appendix.

Appendix guide. Appendix Tables A1-A2 report full outcome summaries for prefecture and municipal data. Appendix Tables B1–B2 report joint pre-trend tests for the full set of outcome–sample specifications, including those not shown in the main tables. Appendix Figures D1-D2 report event-study plots for all main outcomes, while Appendix C documents data sources and panel data construction. Finally, Appendix E depicts a visualization of the distribution of Shinkansen station openings throughout time.

Results

This section summarizes the estimated effects of Shinkansen station openings on migration, local adjustment, and economic outcomes. All estimates report average treatment effects on the treated (ATT) using the Callaway and Sant'Anna (2021) group-time estimator. I summarize dynamics by averaging event-time estimates over years 0–5 ("short run") and years 6–10 ("medium run") following the opening. Standard errors are clustered at the prefecture level for prefecture panels and at the municipality level for municipal panels. The main tables emphasize outcome–sample specifications that pass pre-treatment diagnostics; the appendix reports the complete set of tests and event-study figures.

Across specifications that pass pre-treatment diagnostics, the most robust prefecture-level responses to Shinkansen access appear in land prices, housing construction, and unemployment counts. In contrast, prefecture-wide population, migration, and income measures do not exhibit systematic post-opening dynamics once pre-trends are accounted for. This pattern suggests that the primary effects of Shinkansen access at the prefecture level operate through capitalization and local adjustment rather than broad-based regional growth.

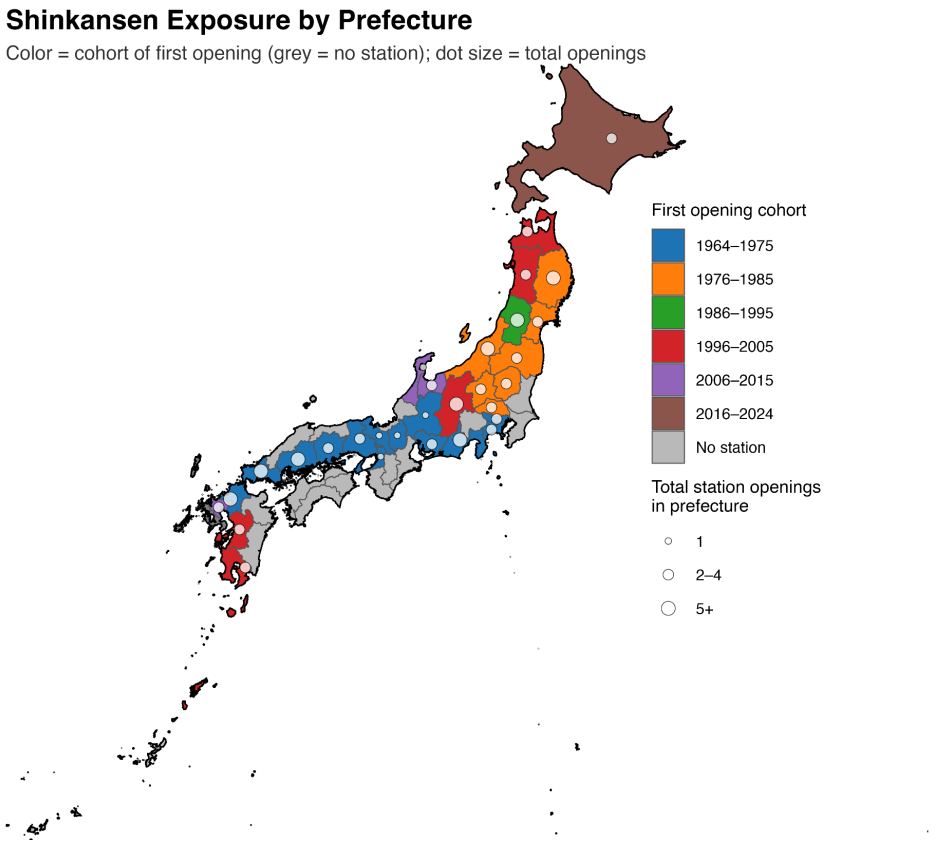


Figure 2. Shinkansen station exposure by prefecture.[3]

Outcome (log / log1p)	0-5 years ATT	6-10 years ATT	Baseline level (pre-period, geometric mean)	N (unit x year)
Land Price Commercial	0.0914** (0.046)	0.0451 (0.050)	73,893 (¥/m²)	1,296
Land Price Industrial	-0.0485** (0.021)	-0.0036 (0.040)	19,556 (¥/m²)	1,296
New Residential Builds (log1p)	0.0486*** (0.009)	0.0910*** (0.029)	4,249	729
Number of Unemployed	0.0424*** (0.011)	0.0268*** (0.009)	27,109	1,242

Table 2: Prefecture Main Results[4]

[3] Prefectures are shaded by the cohort of the first Shinkansen station opening (color). Point symbols denote the total number of Shinkansen station openings in the prefecture over the sample period (1, 2–4, 5+). Prefectures with no Shinkansen stations are shown in grey.

[4] The only outcomes included in Table 2 are those that pass the joint pre-trend test at the 5% level. Full table data of Table 2 outcomes along with # of units (prefectures), # of treated units per outcome, and pre-trend test results summaries as well as full joint pre-trend information are included in appendix table A1.

5.1 Prefecture-level migration and labor-market adjustment

The prefecture-level estimates do not indicate clear, systematic migration responses following station openings in the specifications that pass the joint pre-trend test. In contrast, labor-market adjustment is visible in unemployment counts. The number of unemployed rises by approximately 4.2 percent in years 0–5 and 2.7 percent in years 6–10. Relative to the reported pre-treatment baseline of 27,109 unemployed persons, these effects correspond to an increase of roughly 1,139 unemployed persons per prefecture-year in the short run and 732 in the medium run.

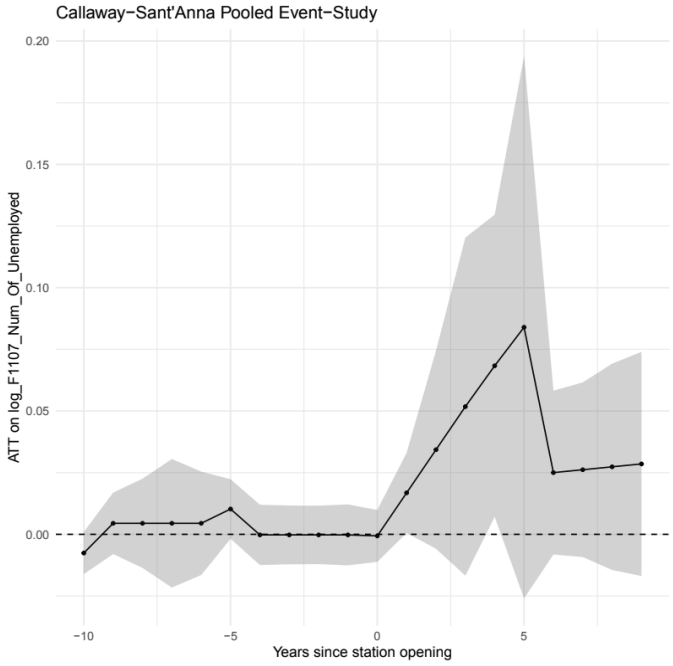


Figure 3: Number of Unemployed - Prefecture

5.2 Prefecture land and housing markets: capitalization and supply response

Land and housing outcomes show pronounced adjustment. Commercial land prices rise by about 9.1 percent in years 0–5 and 5.4 percent in years 6–10, while industrial land prices fall by about 4.9 percent in the short run and 0.4 percent in the medium run.

Housing construction responds strongly. New residential builds (log1p) increase by about 4.9 percent in years 0–5 and 9.1 percent in years 6–10. Taken together, these patterns indicate substantial capitalization into commercial land values alongside a meaningful housing supply response in treated prefectures. While these movements are consistent with increased demand for station-proximate locations, they are also compatible with other accessibility-driven channels (e.g., commuting expansion, firm entry, and amenity changes) and therefore should be interpreted as reduced-form equilibrium responses.

Outcome (log / log1p)	Sample	0-5 years ATT	6-10 years ATT	Baseline level (pre-period, geometric mean)	N (unit x year)
Number of Unemployed	host	0.0543*** (0.004)	0.1308*** (0.009)	1,367	34,850
Number of Live Births	host	0.0378*** (0.008)	0.0899*** (0.013)	656	23,800
Municipal Financial Revenue	host	0.0516*** (0.007)	0.0816*** (0.010)	8,009,870 (¥ thousand)	18,634
Municipal Financial Need	host	0.0052* (0.003)	0.0072 (0.009)	16,594,551 (¥ thousand)	18,634
Number of Kindergarten Pupils	host	0.0230 (0.024)	0.0682 (0.058)	207	9,280
Number of Hospitals (log1p)	host	0.0038 (0.005)	-0.0053 (0.013)	8.16	22,100
Number of General Hospitals (log1p)	host	0.0377* (0.021)	0.0214 (0.026)	4.72	19,576
Newly Constructed Dwellings (log1p)	host	0.0299 (0.047)	0.1087** (0.046)	599	7,288
Number of Kindergartens (log1p)	host	0.0047 (0.005)	0.0103 (0.009)	8.43	36,883
Number of Live Births	0-10	0.0078 (0.007)	0.0464*** (0.011)	185	30,492
Municipal Tax Revenue	0-10	0.0125*** (0.004)	0.0152** (0.007)	6,860,531 (¥ thousand)	9,308
Number of Kindergarten Pupils	0-10	0.0167 (0.030)	0.0719 (0.075)	75.04	10,190
Number of Hospitals (log1p)	0-10	0.0146*** (0.003)	0.0224*** (0.008)	2.27	28,314
Newly Constructed Dwellings (log1p)	0-10	0.1162** (0.049)	0.3440*** (0.063)	253	9,241
Number of Kindergartens (log1p)	0-10	-0.0071 (0.005)	0.0017 (0.008)	2.24	47,332
Total Population	10-20	0.0212*** (0.002)	0.0580*** (0.004)	21,052	42,681
Taxable Income	10-20	0.0014 (0.004)	-0.0165** (0.007)	1,8109,873 (¥ thousand)	40,599
Pop in Labor Force	10-20	0.0233*** (0.002)	0.0678*** (0.005)	11,073	42,681
Number of Unemployed	10-20	0.0431*** (0.004)	0.1435*** (0.009)	313	42,681
Number of Live Births	10-20	0.0246** (0.010)	0.0058 (0.015)	165	29,148
Municipal Financial Need	10-20	-0.0015 (0.003)	-0.0053 (0.007)	5,637,889 (¥ thousand)	22,902

Number of Kindergarten Pupils	10-20	0.0727* (0.042)	0.1001 (0.093)	40.41	9,627
Number of General Hospitals (log1p)	10-20	-0.0144 (0.010)	-0.0179 (0.018)	1.36	24,773
In-migrants	10-20	-0.0991*** (0.031)	-0.1125 (0.094)	172	2,008
Newly Constructed Dwellings (log1p)	10-20	0.1426 (0.087)	0.1928* (0.112)	199	8,767
Number of Kindergartens (log1p)	10-20	-0.0241*** (0.007)	-0.0113 (0.009)	2.03	45,182
Total Population	20-30	0.0147*** (0.003)	0.0439*** (0.007)	19,327	38,007
Taxable Income	20-30	0.0122* (0.007)	-0.0148* (0.008)	16,801,987 (¥ thousand)	36,153
Pop in Labor Force	20-30	0.0193*** (0.003)	0.0490*** (0.008)	10,142	38,007
Number of Unemployed	20-30	0.0425*** (0.009)	0.1034*** (0.015)	269	38,007
Number of Live Births	20-30	0.0247** (0.012)	0.0216 (0.016)	137	25,956
Municipal Financial Need	20-30	0.0001 (0.004)	0.0075 (0.009)	5,296,359 (¥ thousand)	20,394
Municipal Tax Revenue	20-30	-0.0051 (0.004)	-0.0546*** (0.011)	6,378,079 (¥ thousand)	7,658
Number of Kindergarten Pupils	20-30	-0.0554 (0.038)	-0.2680* (0.142)	108	8,797
Number of General Hospitals (log1p)	20-30	0.0067 (0.010)	0.0383** (0.019)	1.73	21,337
Newly Constructed Dwellings (log1p)	20-30	-0.0745 (0.064)	-0.0158 (0.074)	143	7,077
Number of Kindergartens (log1p)	20-30	-0.0147** (0.007)	-0.0387*** (0.014)	1.78	40,206

Table 3: Municipal Main Results[5]

5.3 Municipal-level effects in station-hosting jurisdictions

Municipal-level estimates reveal where adjustment concentrates following Shinkansen access. Station-hosting municipalities experience clear and economically meaningful increases in live births, housing construction, and municipal financial revenue, with effects that grow over time. These patterns indicate localized demographic and fiscal adjustment centered on station nodes rather than diffuse gains across surrounding regions.

[5] The only outcomes included in Table 3 are those that pass the joint pre-trend test at the 5% level. The full table Table 3 sample outcomes along with # of units (municipalities), # of treated units per outcome, and pre-trend test results summaries as well as full joint pre-trend information are included in appendix table A2.

The increase in live births in station-hosting municipalities is best interpreted as a compositional demographic response rather than a change in fertility behavior conditional on age. Improved accessibility and station-area housing development likely attract younger households and families, shifting the local age distribution toward cohorts with higher baseline birth rates. This interpretation is consistent with the absence of robust prefecture-wide fertility responses and with the concentration of birth increases in station-hosting jurisdictions rather than across broader regions.

Economic and labor-market measures also rise in station-hosting municipalities. Municipal financial revenue increases by about 5.2 percent in years 0–5 and 8.2 percent in years 6–10. Using the reported baseline (about ¥8.01 billion), the medium-run increase corresponds to roughly ¥657 million per municipality-year. Municipal "financial need" does not change meaningfully (a small increase in the short run), implying that station openings strengthen measured revenue capacity without a commensurate rise in measured need.

Unemployment counts also increase in station-hosting municipalities about 5.4 percent in years 0–5 and 13.1 percent in years 6–10, mirroring the prefectural pattern and suggesting that improved access is associated with higher measured labor supply and/or transitional slack within station nodes.

Importantly, the municipal public-finance response should not be interpreted as a direct operating return from rail services. In Japan's post-privatization institutional setting, Shinkansen infrastructure and operations are not generally structured such that municipalities receive rail operating surpluses in the manner of a municipal utility. Instead, increases in municipal revenue are more naturally read as reflecting tax-base and transfer channels associated with station placement: capitalization into property values, station-area redevelopment and commercial activity, and population-linked changes in local tax collections and formula-driven transfers.

For housing, there is no statistically significant short-run change in newly constructed dwellings in station-hosting municipalities, but the medium-run effect is large: newly constructed dwellings increase by about 10.9 percent. The number of kindergartens and the number of hospitals do not exhibit statistically significant changes in the station-hosting sample.

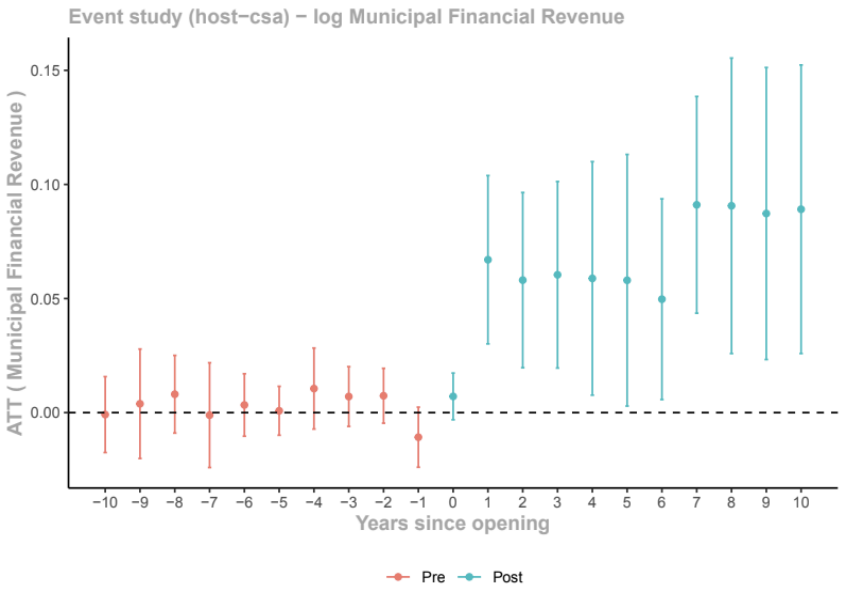


Figure 4: Municipal Financial Revenue - Municipal - Host

5.4 Station spillovers: housing expansion and demographic responses

To characterize spatial spillovers, I estimate separate specifications for municipalities located in 0–10 km, 10–20 km, and 20–30 km rings around a Shinkansen station (excluding station-hosting municipalities).

Demographic responses are heterogeneous across distance bands. Live births rise only close to station-hosting municipalities, with a medium-run increase of about 4.6 percent in the 0–10 km ring. In-migrants fall sharply in the 10–20 km ring in the short run (about −9.9 percent), while total population increases 2.2 and 5.8 percent in the same band. It is important to note the small number of treated municipalities used for the 10-20 km ring sample in-migrants outcome analysis (totalling three; 69 controls were used; Appendix A2). Farther out, total population increases 4.5 and 4.4 percent in the 20-30 km range.

Housing construction exhibits the clearest spatial gradient. Newly built housing rises substantially in the closest ring (0–10 km): about 11.6 percent in years 0–5 and 34.4 percent in years 6–10. This is compared to the 10-20 km band's medium run increase of 19.3 percent. Unemployment counts rise in multiple rings, with increases of about 4.3 percent (short run) and 14.4 percent (medium run) in the 10–20 km band, and about 4.3 percent and 10.3 percent in the 20–30 km band. Measures of labor force also rise in the 10–20 km and 20–30 km rings. In the closer ring, 2.3 and 6.8 percent. In the farther ring, 1.9 and 4.9 percent.

Several additional outcomes show mixed spatial patterns. Health infrastructure changes are modest but detectable in some bands (e.g., hospitals increase in the 0–10 km ring, while general hospitals increase in the 20–30 km ring in the medium run). Municipal tax revenue rises slightly

near stations (0–10 km) but falls in the farthest band (20–30 km) in the medium run. Kindergarten outcomes show pronounced reallocation: kindergarten pupils increase in the 10–20 km band but decline in the 20–30 km band, alongside small reductions in the number of kindergartens in both bands. Taxable income falls in the medium-run in the 10-20 km band and rises in the 20–30 km band in the short run but declines in the medium run.

5.5 Synthesis: what adjusts, where it adjusts, and what remains ambiguous

Two broad patterns emerge. First, the strongest and most consistent prefecture-level responses are in land prices and housing construction, consistent with meaningful capitalization and housing-supply adjustment following improved access. Second, municipal estimates show that gains in births, fiscal revenue, and housing construction are concentrated in station-hosting municipalities and their immediate surroundings, with additional evidence of reallocation across nearby jurisdictions.

At the same time, the results do not support a simple "prefecture-wide migration surge" narrative in the specifications that clear the joint pre-trend screen. Instead, the evidence points to spatial reshuffling within affected areas, toward station nodes and nearby municipalities where housing supply expands, combined with rising unemployment counts that may reflect transitional labor-market frictions, compositional change, or changes in measured labor supply as accessibility improves. This is consistent with node-centered reallocation within local markets.

5.6 Limitations and interpretation boundaries

Several limitations are important for interpreting the estimates. First, the data primarily capture changes in residence (and local administrative outcomes), but improved accessibility can increase commuting without permanent relocation. As a result, changes in labor-force measures and unemployment counts may reflect a mix of movers, commuters, and compositional shifts that this design cannot fully disentangle.

Second, income and fiscal outcomes may move for compositional reasons even when underlying productivity changes are modest. For example, taxable income can decline in the medium run if inflows differ systematically from incumbents (age, earnings capacity, household structure), if retirees relocate, or if sectoral employment shifts change the taxable base.

Third, these estimates reflect equilibrium reallocation across space rather than isolated local shocks. Negative effects on in-migration in some distance bands and revenue declines in farther rings are consistent with displacement within the broader commuting region. Consequently, the results speak most directly to where activity locates following network expansion, not to aggregate welfare or national-level gains.

Robustness and Sensitivity

This section evaluates whether the core findings are robust to reasonable alternative design choices and to standard identification diagnostics. Throughout, the analysis uses the Callaway and Sant'Anna (2021) group-time estimator, which forms cohort-specific comparisons using the not-yet-treated risk set (with never-treated units entering whenever available) and aggregates these cohort-specific effects into event-time profiles.

6.1 Multiple openings and exposure overlap (prefecture panel)

A central sensitivity issue is that some prefectures experience multiple station openings. Closely spaced openings can mechanically overlap the event-study window around first access and confound interpretation of "first network entry" effects. To avoid mechanically overlapping event windows from multiple openings, the baseline prefecture design uses the clean-window-10 restriction defined in Section 3.2. Here I show that the main qualitative patterns are not driven by a small subset of cohorts or prefectures by (i) plotting cohort-specific event studies and (ii) re-estimating after dropping each cohort one-at-a-time (leave-one-cohort-out). The appendix documents opening histories and the clean-window construction and reports event-study profiles to verify that the main patterns are not driven by a small subset of treated prefectures.

6.2 Spatial exposure definitions and local incidence (municipal panel)

At the municipal level, I distinguish direct and indirect exposure and assess sensitivity to how "nearby" is defined. I assess sensitivity to spatial definition by comparing host estimates to mutually exclusive rings. The cross-ring gradient provides a direct check on whether effects are tightly node-centered or diffuse across the broader commuting zone.

Two features provide robustness to spatial definition. First, comparing estimates across rings provides a direct check on whether effects are highly localized to station nodes or diffuse across broader areas. Second, within each ring design, I impose a clean-window restriction analogous to the prefecture case and also defined in Section 3.2. The clean-window restriction has a small effect on treated counts, so results are not driven by aggressive trimming.

6.3 Pre-treatment diagnostics

Identification requires that, absent treatment, treated and comparison units would have followed parallel trends. I assess this assumption using event-study leads and joint tests of pre-treatment coefficients over event time -10 to -2 for each outcome–sample specification. Section 4.4 reports the joint lead tests and explains how they are used; the appendix reports the full universe of specifications and event-study figures.

Conclusion

This paper studies how Japan's Shinkansen expansion affects internal migration and regional adjustment. Using staggered station openings and a group-time difference-in-differences estimator, the results show that the clearest responses occur in migration-linked adjustment, land and housing markets, and municipal fiscal capacity, while aggregate income measures move more modestly. Overall, the Shinkansen appears to operate primarily through spatial equilibrium channels such as capitalization into land values, housing supply response, and the reallocation of population and fiscal capacity across nearby jurisdictions, rather than generating uniform prefecture-wide growth.

7.1 Implications for internal migration and local adjustment

The results suggest that the most salient demographic responses are localized. At the municipal level, station-hosting jurisdictions and nearby areas exhibit changes consistent with spatial resorting toward station nodes, while more distant municipalities within the same commuting region can experience offsetting movements. Because improved access can affect commuting and firm location as well as residence decisions, these patterns should be interpreted as equilibrium reallocation within local labor and housing markets rather than as a pure migration elasticity.

A second implication is that accessibility gains are accompanied by measurable adjustment frictions. Unemployment counts rise in several specifications alongside changes in labor-force measures, consistent with transitional dynamics in which local labor supply and job matching adjust over time. These findings caution against interpreting short- and medium-run impacts solely through the lens of "winners" and "losers" in population counts: even places that gain activity may experience temporary slack during the reallocation process.

Finally, the municipal evidence indicates that local public finance is a first-order margin of incidence. Improvements in municipal revenue in station-hosting jurisdictions are most plausibly mediated through tax-base and transfer channels associated with population movements, redevelopment, and capitalization, rather than through direct capture of rail operating returns. This reinforces the broader conclusion that high-speed rail can redistribute fiscal capacity across space even when aggregate income responses are modest.

7.2 Policy implications

For policy evaluation in Japan's current demographic environment, these findings suggest that high-speed rail investments should not be assessed primarily on prefecture-level GDP or income growth. Instead, the more consequential margins are where population and housing demand relocate within regions, how local housing supply responds to accessibility gains, and how

municipal fiscal capacity shifts across jurisdictions, issues that are central to Japan's regional revitalization and local finance challenges.

From an implementation standpoint, the findings highlight the importance of complementary local policy in determining whether accessibility improvements translate into durable welfare gains rather than primarily reshuffling activity. In particular, housing supply and land-use policy near stations will shape whether inflows are accommodated through construction or instead capitalized into higher land prices, while workforce and firm-entry conditions can influence the persistence of transitional unemployment.

From this perspective, the distributional and fiscal consequences of Shinkansen access across municipalities may be at least as important as aggregate growth effects when considering long-run regional sustainability.

7.3 Future research

Three extensions would sharpen mechanism and welfare interpretation. First, distinguishing commuting adjustments from residential relocation, since Shinkansen access can expand labor-market reach without migration. Second, estimating treatment-effect heterogeneity by baseline urbanization, demographics, and housing constraints to identify when accessibility yields durable growth versus redistribution. Third, replacing the binary treatment with intensity measures such as changes in generalized travel costs and service frequency to test whether larger accessibility gains produce stronger population, housing, and transitional labor-market responses. Given the importance of spatial spillovers, spillover-aware designs are essential to distinguish net gains from intra-regional displacement.

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Appendix

Appendix A1. *Prefecture Full Outcome Summary Table*

Outcome (log / log1p)	0-5 years ATT	6-10 years ATT	Baseline level	N (unit x year)	Units	Treated	Pass 10%	Pass 5%	Pass 1%
Pop	0.0178** (0.007)	0.0328** (0.014)	1,835 (thousands)	728	27	11	No	No	No
Pop (linearly interpolated)	0.0402*** (0.008)	0.0862*** (0.018)	2,001 (thousands)	1,993	27	11	No	No	No
GDP	-0.0141** (0.006)	0.0130* (0.007)	3,409,428 (¥ million)	540	27	11	No	No	Yes
In-migrants	0.0302*** (0.004)	0.0283** (0.011)	17,841	1,350	27	11	No	No	No
Out-migrants	0.0324*** (0.010)	0.0492** (0.021)	19,594	1,350	27	11	No	No	No
Net Migration	-0.0022 (0.007)	-0.0209 (0.024)	0.9105	1,350	27	11	No	No	No
Land Price Residential	0.0294*** (0.008)	0.0624*** (0.021)	35,284 (¥/m²)	1,296	27	11	No	No	No
Land Price Commercial	0.0914** (0.046)	0.0451 (0.050)	73,893 (¥/m²)	1,296	27	11	Yes	Yes	Yes
Land Price Industrial	-0.0485** (0.021)	-0.0036 (0.040)	19,556 (¥/m²)	1,296	27	11	Yes	Yes	Yes
New Residential Builds (log1p)	0.0486*** (0.009)	0.0910*** (0.029)	4,249	729	27	11	Yes	Yes	Yes
Newly Constructed Dwellings (log1p)	0.0982*** (0.016)	0.1025*** (0.033)	6,393	1,323	27	11	No	No	No
Taxable Income	0.0033 (0.004)	0.0123 (0.009)	1,207,664,188 (¥ thousand)	1,053	27	11	No	No	No
Pop in Labor Force	0.0106*** (0.001)	0.0245*** (0.002)	524,580	1,242	27	11	No	No	No
Number of Unemployed	0.0424*** (0.011)	0.0268*** (0.009)	27,109	1,242	27	11	Yes	Yes	Yes
Number of Live Births	0.0158*** (0.004)	0.0291*** (0.005)	8,797	1,161	27	11	No	No	No
Prefecture Financial	0.0215*** (0.004)	0.0165** (0.007)	82,092,262 (¥ thousand)	1,269	27	11	No	No	Yes

Revenue									
Prefecture Financial Needs	0.0048 (0.003)	0.0045 (0.005)	218,840,901 (¥ thousand)	1,269	27	11	No	No	No
Prefecture Tax and Grant Revenue	-0.0027 (0.003)	0.0031 (0.005)	259,595,903 (¥ thousand)	1,269	27	11	No	No	No
Number of Kindergarten Pupils	0.0294 (0.032)	-0.1997*** (0.048)	9,210	1,323	27	11	No	No	No
Number of Hospitals	-0.0038 (0.003)	-0.0308*** (0.005)	107	1,296	27	11	No	No	No
Number of General Hospitals	-0.0057* (0.003)	-0.0392*** (0.006)	93.33	1,296	27	11	No	No	No
Fertility Rate	0.0086 (0.005)	0.0042 (0.004)	1.4684	1,053	27	11	No	No	No
Number of Physicians	-0.0003 (0.007)	-0.0169 (0.014)	2,513	756	27	11	No	No	No

Units represent the total number of prefectures used in both control and treated samples for outcome estimation. Treated represents only the treated number of units for that outcome estimation. Baseline level represents the pre-period geometric mean.

Appendix A2. *Municipal Full Outcome Summary Table*

Outcome (log / log1p)	Sample	0-5 years ATT	6-10 years ATT	Baseline level	N (unit x year)	Units	Treat-ed	Pass 10%	Pass 5%	Pass 1%
Total Population	host	0.0245*** (0.002)	0.0708*** (0.004)	82,170	34,850	850	110	No	No	No
Taxable Income	host	0.0172*** (0.003)	0.0413*** (0.006)	82,201,709 (¥ thousand)	33,147	850	110	No	No	No
Pop in Labor Force	host	0.0254*** (0.002)	0.0761*** (0.005)	42,112	34,850	850	110	No	No	No
Number of Unemployed	host	0.0543*** (0.004)	0.1308*** (0.009)	1,367	34,850	850	110	Yes	Yes	Yes
Number of Live Births	host	0.0378*** (0.008)	0.0899*** (0.013)	656	23,800	850	110	Yes	Yes	Yes
Municipal Financial Revenue	host	0.0516*** (0.007)	0.0816*** (0.010)	8,009,870 (¥ thousand)	18,634	847	107	Yes	Yes	Yes

Municipal Financial Need	host	0.0052* (0.003)	0.0072 (0.009)	16,594,551 (¥ thousand)	18,634	847	107	Yes	Yes	Yes
Municipal Tax Revenue	host	0.0394*** (0.009)	0.0237* (0.014)	7,150,945 (¥ thousand)	7,240	330	45	No	No	Yes
Number of Kindergarten Pupils	host	0.0230 (0.024)	0.0682 (0.058)	207	9,280	222	31	Yes	Yes	Yes
Number of Hospitals (log1p)	host	0.0038 (0.005)	-0.0053 (0.013)	8.16	22,100	850	110	Yes	Yes	Yes
Number of General Hospitals (log1p)	host	0.0377* (0.021)	0.0214 (0.026)	4.72	19,576	477	74	Yes	Yes	Yes
In-migrants	host	0.0616* (0.034)	0.0288 (0.064)	661	1,980	71	2	No	No	No
Newly Constructed Dwellings (log1p)	host	0.0299 (0.047)	0.1087** (0.046)	599	7,288	347	99	Yes	Yes	Yes
Number of Kindergartens (log1p)	host	0.0047 (0.005)	0.0103 (0.009)	8.43	36,883	850	110	Yes	Yes	Yes
Total Population	0-10	0.0268*** (0.001)	0.0791*** (0.004)	24,140	44,649	1,089	349	No	No	No
Taxable Income	0-10	0.0131*** (0.002)	0.0136*** (0.005)	22,331,689 (¥ thousand)	42,470	1,089	349	No	No	No
Pop in Labor Force	0-10	0.0285*** (0.007)	0.0882*** (0.004)	12,557	44,649	1,089	349	No	No	No
Number of Unemployed	0-10	0.0701*** (0.004)	0.1851*** (0.008)	369	44,649	1,089	349	No	No	No
Number of Live Births	0-10	0.0078 (0.007)	0.0464*** (0.011)	185	30,492	1,089	349	Yes	Yes	Yes
Municipal Financial Revenue	0-10	0.0298*** (0.003)	0.0534*** (0.005)	2,205,454 (¥ thousand)	23,518	1,069	329	No	No	Yes
Municipal Financial Need	0-10	0.0102*** (0.002)	0.0300*** (0.005)	5,365,936 (¥ thousand)	23,518	1,069	329	No	No	No
Municipal Tax Revenue	0-10	0.0125*** (0.004)	0.0152** (0.007)	6,860,531 (¥ thousand)	9,308	424	139	Yes	Yes	Yes

Number of Kindergarten Pupils	0-10	0.0167 (0.030)	0.0719 (0.075)	75.04	10,190	243	52	Yes	Yes	Yes
Number of Hospitals (log1p)	0-10	0.0146*** (0.003)	0.0224*** (0.008)	2.27	28,314	1,089	349	No	Yes	Yes
Number of General Hospitals (log1p)	0-10	0.0037 (0.009)	0.003 (0.017)	1.49	26,397	646	243	No	No	Yes
In-migrants	0-10	-0.0239 (0.025)	-0.0584 (0.043)	805	2,064	74	5	No	No	Yes
Newly Constructed Dwellings (log1p)	0-10	0.1162** (0.049)	0.3440*** (0.063)	253	9,241	435	187	Yes	Yes	Yes
Number of Kindergartens (log1p)	0-10	-0.0071 (0.005)	0.0017 (0.008)	2.24	47,332	1,089	349	Yes	Yes	Yes
Total Population	10-20	0.0212*** (0.002)	0.0580*** (0.004)	21,052	42,681	1,041	301	No	Yes	Yes
Taxable Income	10-20	0.0014 (0.004)	-0.0165** (0.007)	1,8109,873 (¥ thousand)	40,599	1,041	301	Yes	Yes	Yes
Pop in Labor Force	10-20	0.0233*** (0.002)	0.0678*** (0.005)	11,073	42,681	1,041	301	Yes	Yes	Yes
Number of Unemployed	10-20	0.0431*** (0.004)	0.1435*** (0.009)	313	42,681	1,041	301	Yes	Yes	Yes
Number of Live Births	10-20	0.0246** (0.010)	0.0058 (0.015)	165	29,148	1,041	301	Yes	Yes	Yes
Municipal Financial Revenue	10-20	0.0114** (0.005)	0.0301*** (0.008)	2,043,433 (¥ thousand)	22,902	1,041	301	No	No	No
Municipal Financial Need	10-20	-0.0015 (0.003)	-0.0053 (0.007)	5,637,889 (¥ thousand)	22,902	1,041	301	No	Yes	Yes
Municipal Tax Revenue	10-20	0.0071 (0.005)	-0.0001 (0.010)	4,627,708 (¥ thousand)	9,000	410	125	No	No	No
Number of Kindergarten Pupils	10-20	0.0727* (0.042)	0.1001 (0.093)	40.41	9,627	230	39	Yes	Yes	Yes

Number of Hospitals (log1p)	10-20	-0.0016 (0.006)	-0.0154 (0.013)	1.92	27,066	1,041	301	No	No	No
Number of General Hospitals (log1p)	10-20	-0.0144 (0.010)	-0.0179 (0.018)	1.36	24,773	605	202	Yes	Yes	Yes
In-migrants	10-20	-0.0991*** (0.031)	-0.1125 (0.094)	172	2,008	72	3	No	Yes	Yes
Newly Constructed Dwellings (log1p)	10-20	0.1426 (0.087)	0.1928* (0.112)	199	8,767	413	165	Yes	Yes	Yes
Number of Kindergartens (log1p)	10-20	-0.0241*** (0.007)	-0.0113 (0.009)	2.03	45,182	1,041	301	Yes	Yes	Yes
Total Population	20-30	0.0147*** (0.003)	0.0439*** (0.007)	19,327	38,007	927	187	No	Yes	Yes
Taxable Income	20-30	0.0122* (0.007)	-0.0148* (0.008)	16,801,987 (¥ thousand)	36,153	927	187	Yes	Yes	Yes
Pop in Labor Force	20-30	0.0193*** (0.003)	0.0490*** (0.008)	10,142	38,007	927	187	Yes	Yes	Yes
Number of Unemployed	20-30	0.0425*** (0.009)	0.1034*** (0.015)	269	38,007	927	187	Yes	Yes	Yes
Number of Live Births	20-30	0.0247** (0.012)	0.0216 (0.016)	137	25,956	927	187	Yes	Yes	Yes
Municipal Financial Revenue	20-30	-0.0091** (0.004)	0.0036 (0.009)	1,913,005 (¥ thousand)	20,394	927	187	No	No	No
Municipal Financial Need	20-30	0.0001 (0.004)	0.0075 (0.009)	5,296,359 (¥ thousand)	20,394	927	187	Yes	Yes	Yes
Municipal Tax Revenue	20-30	-0.0051 (0.004)	-0.0546*** (0.011)	6,378,079 (¥ thousand)	7,658	349	64	Yes	Yes	Yes
Number of Kindergarten Pupils	20-30	-0.0554 (0.038)	-0.2680* (0.142)	108	8,797	212	21	Yes	Yes	Yes
Number of Hospitals (log1p)	20-30	-0.0235*** (0.009)	-0.0695*** (0.024)	2.46	24,102	927	187	No	No	No
Number of General	20-30	0.0067 (0.010)	0.0383** (0.019)	1.73	21,337	520	117	Yes	Yes	Yes

Hospitals (log1p)										
In-migrants	20-30	-0.073*** (0.024)	-0.1497*** (0.039)	585	2,008	72	3	No	No	No
Newly Constructed Dwellings (log1p)	20-30	-0.0745 (0.064)	-0.0158 (0.074)	143	7,077	333	85	Yes	Yes	Yes
Number of Kindergartens (log1p)	20-30	-0.0147** (0.007)	-0.0387*** (0.014)	1.78	40,206	927	187	No	Yes	Yes

Units represent the total number of municipalities used in both control and treated samples for outcome estimation. Treated represents only the treated number of units for that outcome estimation. Baseline level represents the pre-period geometric mean.

Appendix B. Joint Pre-Trend Tests

Joint pre-trend test construction. For each estimator–sample–outcome output, I identify the set of pre-treatment event times $k \leq -2$ (excluding the reference period $k = -1$). Using the estimated coefficient $\hat{\beta}_k$ and its reported standard error $SE(\hat{\beta}_k)$, I compute an omnibus statistic

$$x^2 = \sum_{k \leq -2} \left(\frac{\hat{\beta}_k}{SE(\hat{\beta}_k)} \right)^2 .$$

The degrees of freedom are $df = n_{pre}$, the number of included pre-period coefficients. The reported p-value is

$$p = 1 - F_{x^2}(x^2; df),$$

and I define pass/fail indicators at $\alpha \in \{0.10, 0.05, 0.01\}$. This omnibus diagnostic summarizes whether the estimated pre-period coefficients are collectively small relative to their uncertainty.

Because the consolidated coefficient outputs include lead-specific standard errors but not the full variance–covariance matrix across event-time coefficients, this omnibus statistic is implemented as a sum of squared t-statistics (a Wald-type diagnostic under an independence approximation). When the full variance–covariance matrix is available, the corresponding covariance-aware Wald test can be formed as $\hat{\beta}' \hat{V}^{-1} \hat{\beta}$.

Appendix Table B1. *Prefecture Joint Pre-trend Tests (Event Time −10 to −2)*

outcome	chi²	df	p value	pass 10%	pass 5%	pass 1%
Pop	67.476	8	1.60E-11	No	No	No
Pop (linearly interpolated)	53.502	9	2.30E-08	No	No	No
GDP	18.183	9	0.0331	No	No	Yes
In-migrants	66.244	9	8.30E-11	No	No	No
Out-migrants	40.025	9	7.50E-06	No	No	No
Net Migration	52.325	9	3.90E-08	No	No	No
Land Price Residential	79.889	9	1.70E-13	No	No	No
Land Price Commercial	8.923	9	0.4444	Yes	Yes	Yes
Land Price Industrial	12.639	9	0.1796	Yes	Yes	Yes
New Residential Builds (log1p)	7.586	9	0.5763	Yes	Yes	Yes
Newly Constructed Dwellings (log1p)	49.571	9	1.30E-07	No	No	No
Taxable Income	41.015	9	5.00E-06	No	No	No
Pop in Labor Force	30.340	9	0.0004	No	No	No
Number of Unemployed	9.448	9	0.397	Yes	Yes	Yes
Number of Live Births	40.711	9	5.60E-06	No	No	No
Prefecture Financial Revenue	21.507	9	0.0106	No	No	Yes
Prefecture Financial Needs	31.660	9	0.0002	No	No	No
Prefecture Tax and Grant Revenue	25.404	9	0.0026	No	No	No
Number of Kindergarten Pupils	59.570	9	1.60E-09	No	No	No
Number of Hospitals	32.205	9	0.0002	No	No	No
Number of General Hospitals	21.993	9	0.0089	No	No	No
Fertility Rate	42.309	9	2.90E-06	No	No	No
Number of Physicians	25.926	4	3.30E-05	No	No	No

This table reports joint Wald χ^2 tests of the null hypothesis that all pre-treatment event-time coefficients are equal to zero over event time −10 to −2 for each prefecture-level outcome specification estimated using the Callaway–Sant'Anna (2021) group-time estimator. chi2 and df report the χ^2 test statistic and degrees of freedom (number of pre-treatment coefficients jointly tested). p_value is the corresponding p-value. pass_05 indicates whether the specification fails to reject the joint pre-trend test at the 5 percent level ($p \geq 0.05$) and is therefore eligible for

inclusion in the main results tables; specifications that do not pass are reported only here in the appendix.

Appendix Table B2. *Municipal Joint Pre-trend Tests (Event Time −10 to −2)*

outcome	sample	chi^2	df	p value	pass 10%	pass 5%	pass 1%
Total Population	host	153.007	9	<1e-16	No	No	No
Taxable Income	host	32.519	9	0.0002	No	No	No
Pop in Labor Force	host	145.547	9	<1e-16	No	No	No
Number of Unemployed	host	14.567	9	0.104	Yes	Yes	Yes
Number of Live Births	host	4.706	9	0.859	Yes	Yes	Yes
Municipal Financial Revenue	host	8.398	9	0.495	Yes	Yes	Yes
Municipal Financial Need	host	7.033	9	0.634	Yes	Yes	Yes
Municipal Tax Revenue	host	20.982	9	0.013	No	No	Yes
Number of Kindergarten Pupils	host	6.275	9	0.712	Yes	Yes	Yes
Number of Hospitals (log1p)	host	7.293	9	0.607	Yes	Yes	Yes
Number of General Hospitals (log1p)	host	12.028	9	0.212	Yes	Yes	Yes
In-migrants	host	84.161	9	2.40E-14	No	No	No
Newly Constructed Dwellings (log1p)	host	6.111	9	0.729	Yes	Yes	Yes
Number of Kindergartens (log1p)	host	4.363	9	0.886	Yes	Yes	Yes
Total Population	0-10	197.930	9	<1e-16	No	No	No
Taxable Income	0-10	44.895	9	9.65E-07	No	No	No
Pop in Labor Force	0-10	212.603	9	<1e-16	No	No	No
Number of Unemployed	0-10	81.474	9	8.23E-14	No	No	No
Number of Live Births	0-10	6.291	9	0.710	Yes	Yes	Yes
Municipal Financial Revenue	0-10	18.621	9	0.029	No	No	Yes
Municipal Financial Need	0-10	23.123	9	0.006	No	No	No
Municipal Tax Revenue	0-10	10.358	9	0.322	Yes	Yes	Yes
Number of Kindergarten Pupils	0-10	6.285	9	0.711	Yes	Yes	Yes
Number of Hospitals (log1p)	0-10	16.142	9	0.064	No	Yes	Yes
Number of General Hospitals (log1p)	0-10	20.156	9	0.017	No	No	Yes
In-migrants	0-10	18.860	9	0.026	No	No	Yes
Newly Constructed Dwellings (log1p)	0-10	13.084	9	0.159	Yes	Yes	Yes

Number of Kindergartens (log1p)	0-10	10.673	9	0.299	Yes	Yes	Yes
Total Population	10-20	14.874	9	0.094	No	Yes	Yes
Taxable Income	10-20	14.095	9	0.119	Yes	Yes	Yes
Pop in Labor Force	10-20	5.713	9	0.768	Yes	Yes	Yes
Number of Unemployed	10-20	1.377	9	0.998	Yes	Yes	Yes
Number of Live Births	10-20	8.873	9	0.449	Yes	Yes	Yes
Municipal Financial Revenue	10-20	27.195	9	0.001	No	No	No
Municipal Financial Need	10-20	16.822	9	0.052	No	Yes	Yes
Municipal Tax Revenue	10-20	44.062	9	1.37E-06	No	No	No
Number of Kindergarten Pupils	10-20	4.251	9	0.894	Yes	Yes	Yes
Number of Hospitals (log1p)	10-20	47.938	9	2.62E-07	No	No	No
Number of General Hospitals (log1p)	10-20	10.312	9	0.326	Yes	Yes	Yes
In-migrants	10-20	15.787	9	0.071	No	Yes	Yes
Newly Constructed Dwellings (log1p)	10-20	8.220	9	0.512	Yes	Yes	Yes
Number of Kindergartens (log1p)	10-20	9.262	9	0.413	Yes	Yes	Yes
Total Population	20-30	15.016	9	0.090	No	Yes	Yes
Taxable Income	20-30	8.723	9	0.463	Yes	Yes	Yes
Pop in Labor Force	20-30	8.993	9	0.438	Yes	Yes	Yes
Number of Unemployed	20-30	1.838	9	0.994	Yes	Yes	Yes
Number of Live Births	20-30	7.220	9	0.614	Yes	Yes	Yes
Municipal Financial Revenue	20-30	22.969	9	0.006	No	No	No
Municipal Financial Need	20-30	12.524	9	0.185	Yes	Yes	Yes
Municipal Tax Revenue	20-30	12.508	9	0.186	Yes	Yes	Yes
Number of Kindergarten Pupils	20-30	10.961	9	0.278	Yes	Yes	Yes
Number of Hospitals (log1p)	20-30	23.340	9	0.005	No	No	No
Number of General Hospitals (log1p)	20-30	8.059	9	0.528	Yes	Yes	Yes
In-migrants	20-30	51.441	9	5.77E-08	No	No	No
Newly Constructed Dwellings (log1p)	20-30	2.417	2	0.299	Yes	Yes	Yes
Number of Kindergartens (log1p)	20-30	14.686	9	0.100	No	Yes	Yes

This table reports joint Wald χ^2 tests of the null hypothesis that all pre-treatment event-time coefficients are equal to zero over event time −10 to −2 for each municipal-level outcome–sample specification estimated using the Callaway–Sant'Anna estimator. chi2 and df report the χ^2 test statistic and degrees of freedom (number of pre-treatment coefficients jointly tested). p_value is the corresponding p-value. pass_05 indicates whether the specification fails to reject the joint pre-trend test at the 5 percent level ($p \geq 0.05$) and is therefore eligible for inclusion in the main results tables; specifications that do not pass are reported only here in the appendix.

Appendix C. Data Sources and Construction

C.1 e-Stat: Japan's National Data Portal

The majority of data in this study is sourced from e-Stat, Japan's official government statistics portal (https://www.e-stat.go.jp/). e-Stat is administered by the Statistics Bureau of Japan and serves as a central access point for official statistics compiled by national ministries and agencies. It contains both historical and contemporary data across the following domains:

- **Population and Demographics** (Population Census, Basic Resident Register).
- **Economic Activity** (Prefectural Accounts, Establishment and Enterprise Census, Labor Force Survey).
- **Finance and Public Accounts** (Local Government Finance Statistics, municipal and prefectural fiscal data).
- **Housing and Land** (Housing and Land Survey, Building Starts Statistics, Land Price Survey).
- **Social Indicators** (School Basic Survey, Vital Statistics).

e-Stat provides programmatic access through an API, which allows users to query and download series in machine-readable formats (CSV, JSON, XML). For this project, nearly all prefectural and municipal variables — including GDP, taxable income, labor force indicators, housing starts, municipal revenues, and service indicators such as hospitals and schools — were retrieved directly from e-Stat using custom API scripts.

C.2 Population and Yearbook Data

While e-Stat provides population counts from the modern censuses, its historical coverage is incomplete at the prefectural level before the 1970s. To extend the population series consistently back to 1950 (the start of our prefectural panel), I collected figures from prefectural statistical yearbooks. These volumes, published annually by each prefecture, contain historical census tabulations and intercensal population estimates. I digitized and manually reconciled these figures with the e-Stat population data, ensuring consistency in definitions and coverage. Where

necessary, I interpolated between census benchmarks to create a continuous annual panel. Prior to 1960, prefecture population data was reported in 5 year increments leading back to 1920.

The resulting population series is a synthesized panel:

- **1950–1970:** derived primarily from prefectural yearbooks.
- **1970 onward:** taken from e-Stat Population Census and Basic Resident Register data.
- **All years:** harmonized into a consistent series (log and log-linear versions), with adjustments for boundary changes.

C.3 Harmonization and Transformations

To address municipal mergers and naming inconsistencies (particularly during the Great Heisei Consolidation of the 2000s), we constructed a harmonized crosswalk linking our raw municipal panel to official municipality codes. We began from a GIS boundary shapefile containing municipality codes (adm_code) and names, and joined these to our master panel by prefecture and municipality name. Because municipality names vary across sources and over time (e.g., "Happou Cho" vs. "Happo Cho"), we manually standardized names and corrected common variants prior to joining. The procedure successfully matched all municipalities except for a handful of non-municipal aggregates (e.g., "Ku Area" in Tokyo), which were dropped.

The result is a panel where each observation is associated with a stable municipal identifier (Municipality_Code), ensuring consistency across the 1980–2023 period despite boundary changes and mergers.

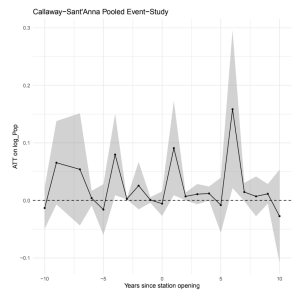
- **Monetary values:** deflated to constant prices using national GDP deflators.
- **Zeros in count data:** transformed using log(1+x) for outcomes such as hospitals, births, and kindergarten pupils.

Appendix D. Event-Study Figures

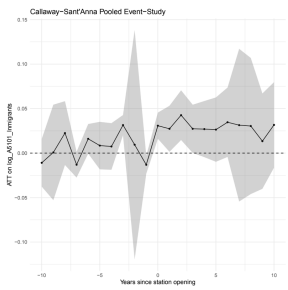
The appendix reports event-study figures for all outcomes displayed in Appendix tables A1 and A2.

Event-study figures plot dynamic average treatment effects on the treated (ATTs) from the Callaway and Sant'Anna (2021) group-time estimator, aggregated using did::aggte(type = "dynamic") and displayed with did::ggdid. Points (markers) denote event-time ATT estimates and the dashed horizontal line denotes zero. For prefecture plots, shaded bands report 95% confidence intervals (simultaneous bands as produced by did). For municipal plots, pre-treatment event-time estimates are shown in red and post-treatment estimates in blue.

D.1 Prefecture Dynamic ATT Plots (Outcomes)



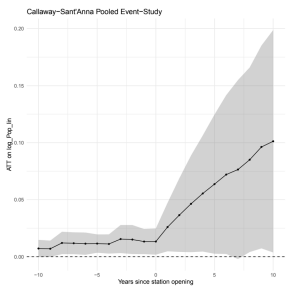
D1-1: Population - C&S DiD



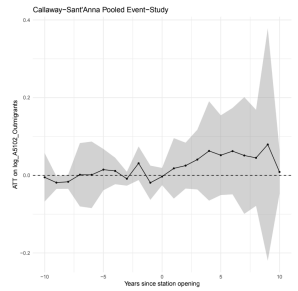
In-Migrants



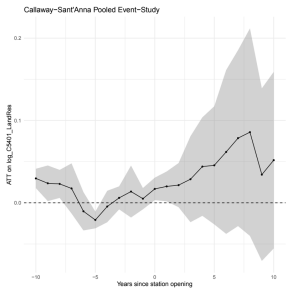
GDP



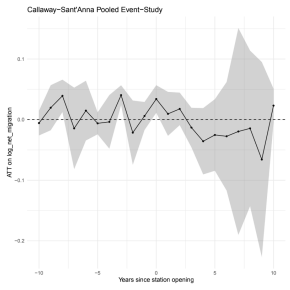
Population (linearly interpolated)



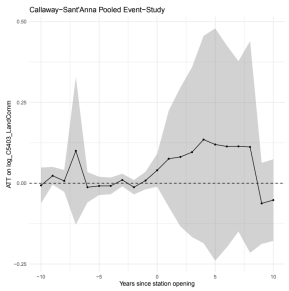
Out-migrants



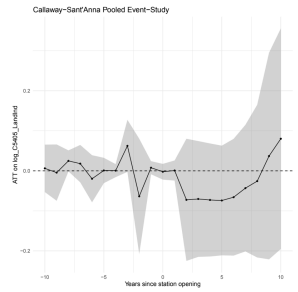
Land Price Residential



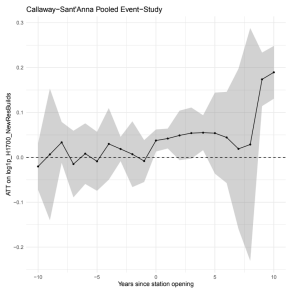
Net Migration



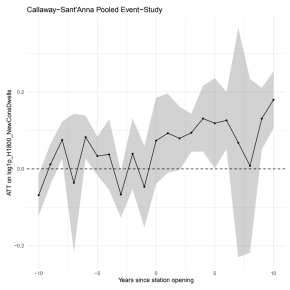
Land Price Commercial



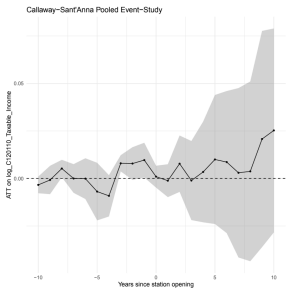
Land Price Industrial



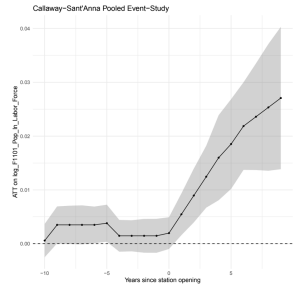
New Residential Builds



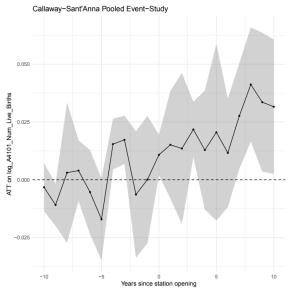
Newly Constructed Dwellings



Taxable Income



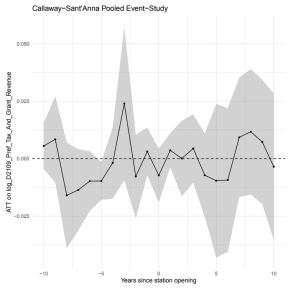
Population in Labor Force



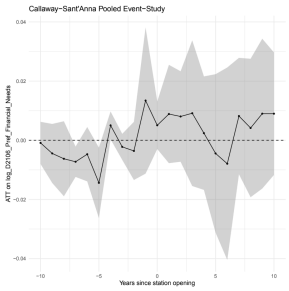
Number of Live Births



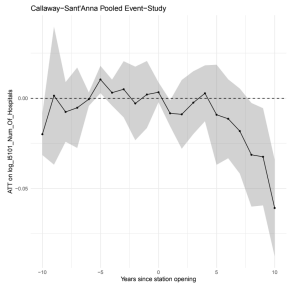
Prefecture Financial Revenue



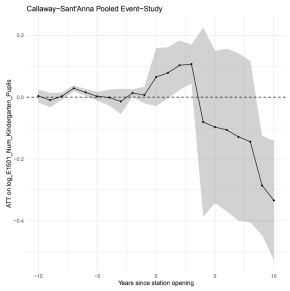
Prefecture Tax and Grant Revenue



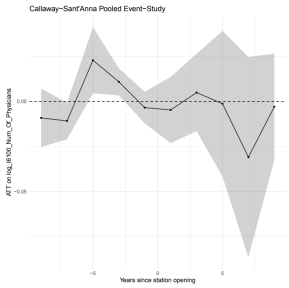
Prefecture Financial Needs



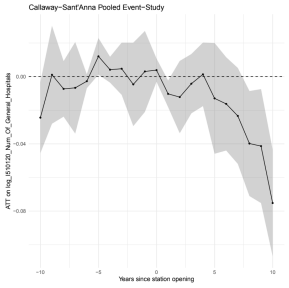
Number of Hospitals



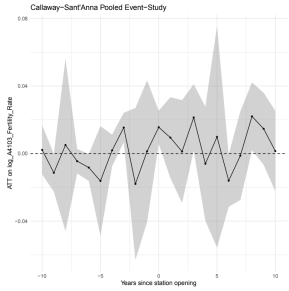
Number of Kindergarten Pupils



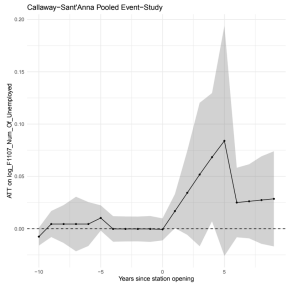
Number of Physicians



Number of General Hospitals



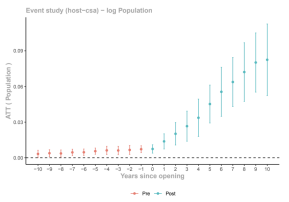
Fertility Rate



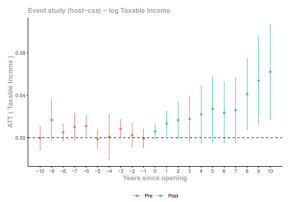
Number of Unemployed

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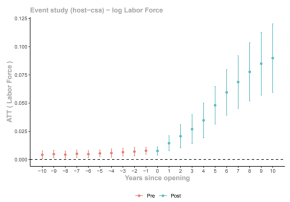
D.2 Municipal Dynamic ATT Plots (Outcome & Sample Combination)



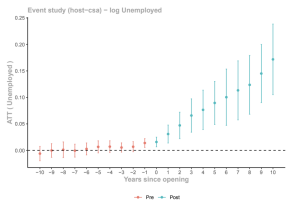
D2-1: Total Population - host



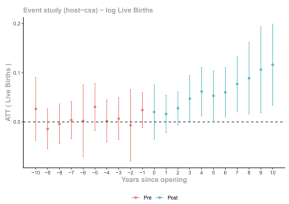
Taxable Income - host



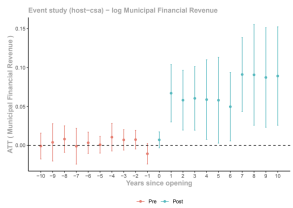
Labor Force - host



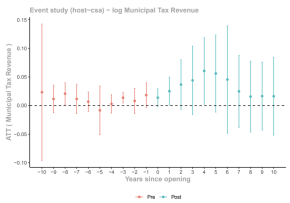
Number of Unemployed - host



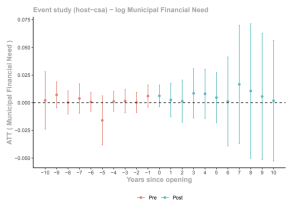
Number of Live Births - host



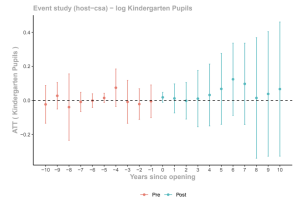
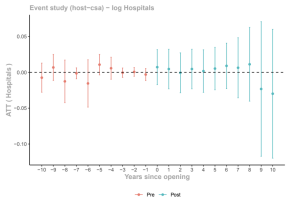
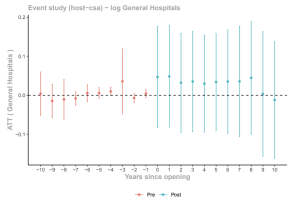
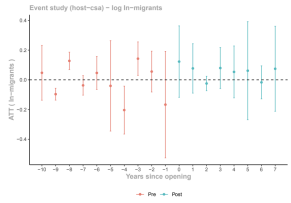
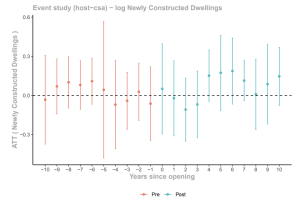
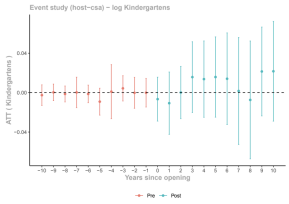
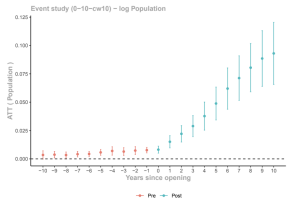
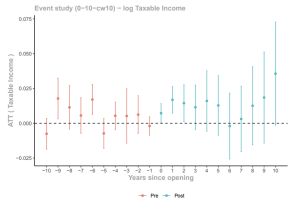
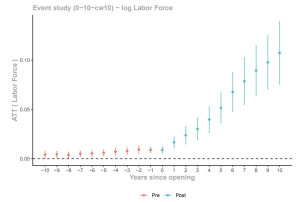
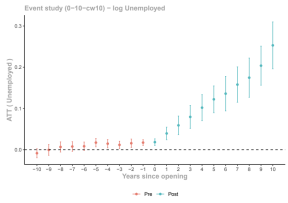
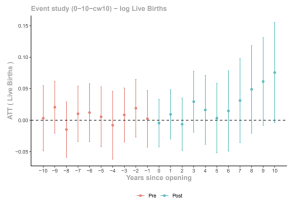
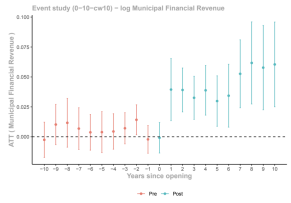
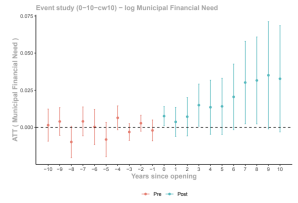
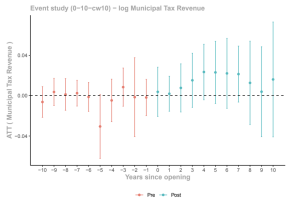
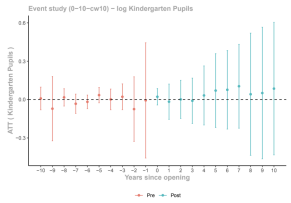
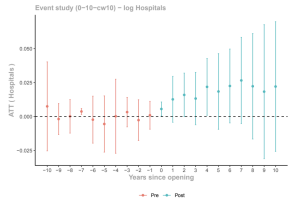
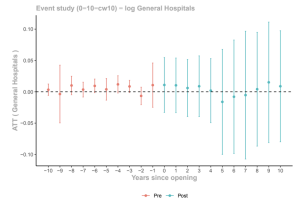
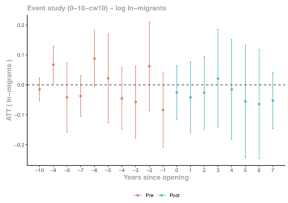
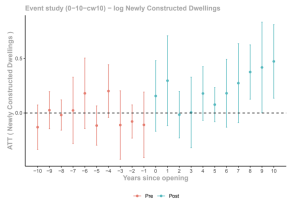
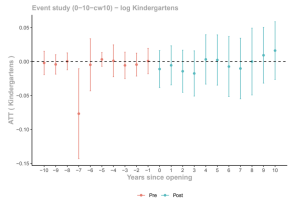
Municipal Financial Revenue - host

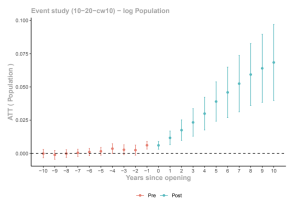


Municipal Tax Revenue - host

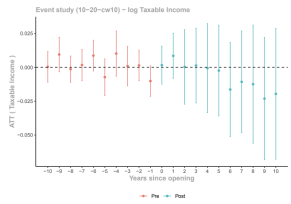


Municipal Financial Need - host

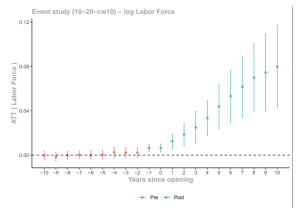
 Number of Kindergarten Pupils - host	 Number of Hospitals - host	 Number of General Hospitals - host	 In-migrants - host
 Newly Constructed Dwellings - host	 Number of Kindergartens - host	 Total Population - 0-10 km	 Taxable Income - 0-10 km
 Labor Force - 0-10 km	 Number of Unemployed - 0-10 km	 Number of Live Births - 0-10 km	 Municipal Financial Revenue - 0-10 km
 Municipal Financial Need - 0-10 km	 Municipal Tax Revenue - 0-10 km	 Number of Kindergarten Pupils - 0-10 km	 Number of Hospitals - 0-10 km
 Number of General Hospitals - 0-10 km	 In-migrants - 0-10 km	 Newly Constructed Dwellings - 0-10 km	 Number of Kindergartens - 0-10 km



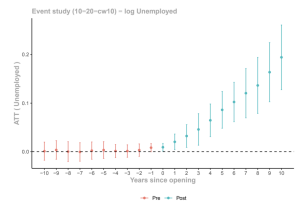
Total Population - 10-20 km



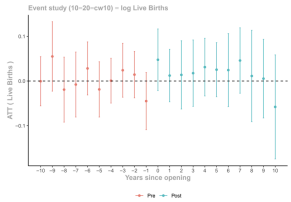
Taxable Income - 10-20 km



Labor Force - 10-20 km



Number of Unemployed - 10-20 km



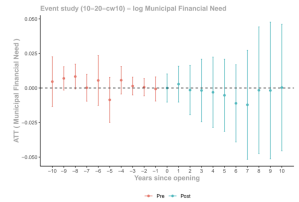
Number of Live Births - 10-20 km



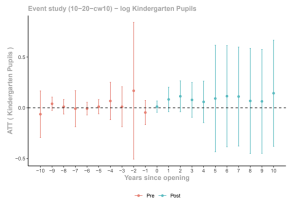
Municipal Financial Revenue - 10-20 km



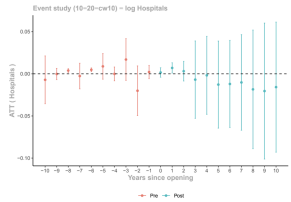
Municipal Tax Revenue - 10-20 km



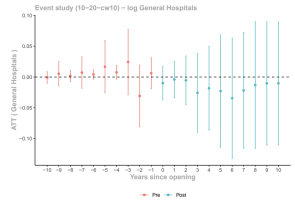
Municipal Financial Need - 10-20 km



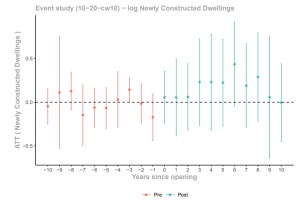
Number of Kindergarten Pupils - 10-20 km



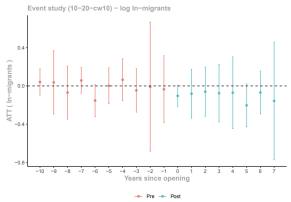
Number of Hospitals - 10-20 km



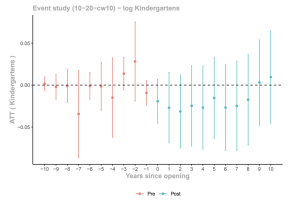
Number of General Hospitals - 10-20 km



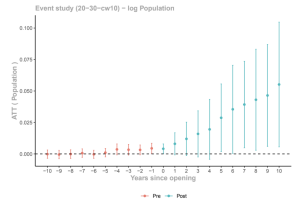
Newly Constructed Dwellings - 10-20 km



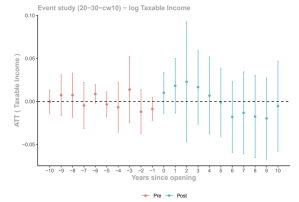
In-migrants - 10-20 km



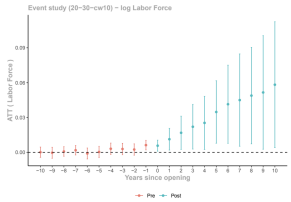
Number of Kindergartens - 10-20 km



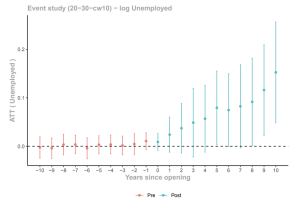
Total Population - 20-30 km



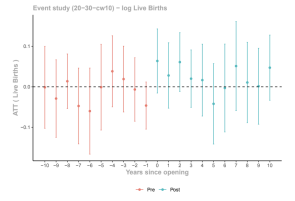
Taxable Income - 20-30 km



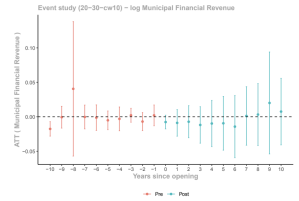
Labor Force - 20-30 km



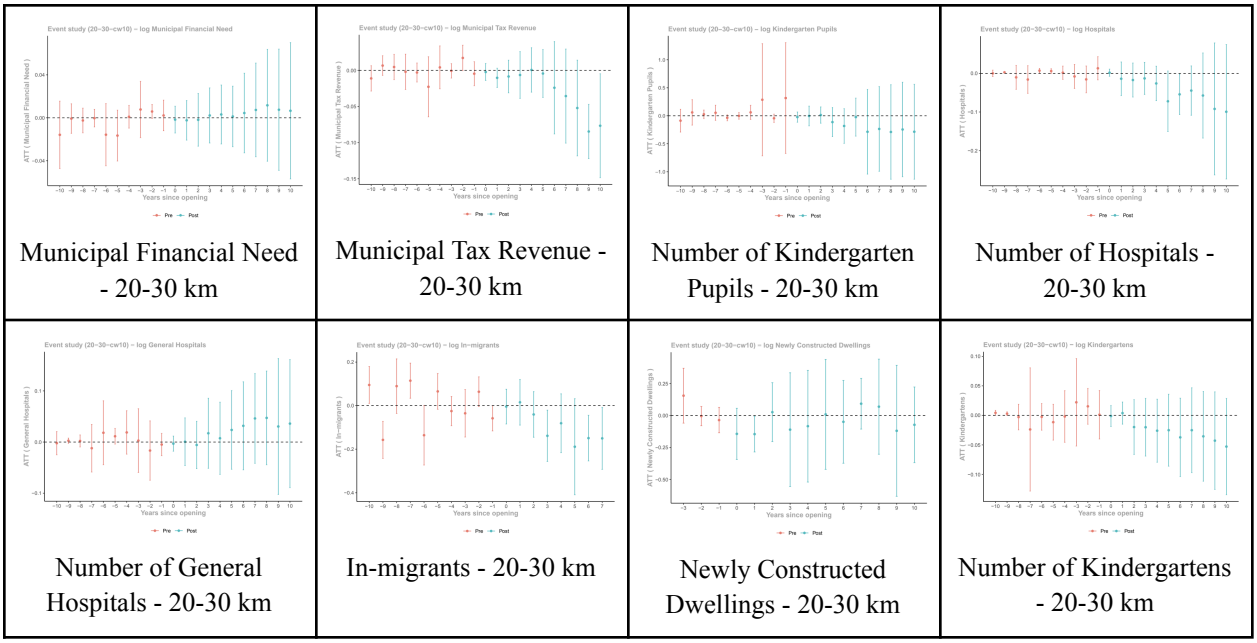
Number of Unemployed - 20-30 km



Number of Live Births - 20-30 km



Municipal Financial Revenue - 20-30 km



Municipal Financial Need - 20-30 km | Municipal Tax Revenue - 20-30 km | Number of Kindergarten Pupils - 20-30 km | Number of Hospitals - 20-30 km

Number of General Hospitals - 20-30 km | In-migrants - 20-30 km | Newly Constructed Dwellings - 20-30 km | Number of Kindergartens - 20-30 km

Appendix E. Shinkansen Station Openings Visualization

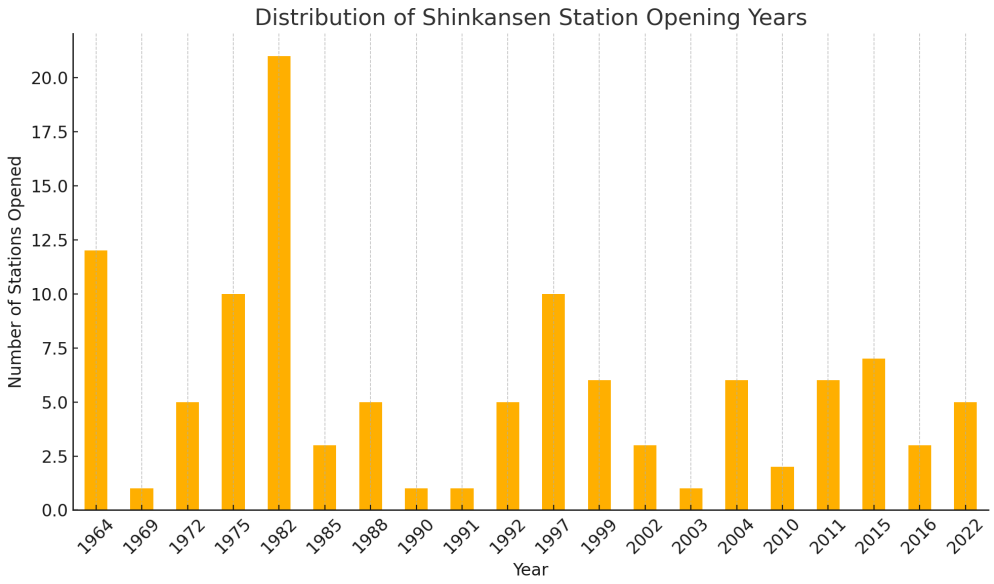


Figure E: Distribution of Shinkansen Station Openings Throughout Time