Innovation City Relocation Intensity and Host-Municipality Demographics

A dose-response event study of fertility, aging, and foreign residents

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Introduction and Question

- From 2012 to 2019, Korea relocated about **44,000 public-sector workers** to 10 Innovation Cities (혁신도시).
- I ask: did the **INTENSITY of relocation** change **host-municipality demographics?**
  - Headline outcome: the total fertility rate (TFR). Secondary: over-65 share and foreigners per 1,000.
- I treat relocation as a continuous dose and use an event study, with parallel trends as the assumption.
  - Framing is descriptive: only ~12 municipalities receive any relocation, so the dose variation is thin.

Motivation

- Korea has among the world's lowest fertility and rapid non-capital regional decline.
- Innovation Cities are a flagship balanced-development policy because they move public institutions and young workers out of the capital area.
- If relocating young workers and their families reshapes local demographics, fertility is a natural outcome to test.

    Fertility might be less commonly studied than migration and economic outcomes

Background: Innovation Cities and Relocation

- Officially 10 Innovation Cities hosted across 14 시군구 (국토교통부 혁신도시발전추진단).
- About 44,463 public workers relocated, mostly 2013–2015; the rollout was staggered 2012–2019.
- Relocation size varies widely by city – e.g., Gwangju–Jeonnam (나주) 7,641 vs Jeju 705.

**Worker counts hand-keyed from Problem Set 2 Table 1*

This Project

- Treatment = relocation intensity = workers per 1,000 baseline (2012) residents; 0 for non-hosts; time-invariant.
- Design = dose-response event study on a KOSIS 시군구 × year panel, 2007–2024, reference year 2012.
- Outcomes: TFR (headline), over-65 share, foreigners per 1,000.
- I estimate per-year intensity effects and one pooled post-2013 dose; I check pre-trends throughout.

Preview of Findings

- **TFR: a null–pooled dose +0.00084 (p≈0.45). No evidence relocation raised fertility.**
- **Foreigners/1k: a clean null–+0.037 (p≈0.54), with flat pre-trends.**
- **Over-65 share: a large, significant coefficient (−0.0499, p<0.001) BUT pre-trends are not parallel (p=4.2e-08).**
  - Interpretation: over-65 is a warning case, not an aging effect.
- **Bottom line: no credible evidence relocation intensity changed any of the three outcomes.**

Related Work

- IC effects are well-studied on migration/economics, via binary designs: SCM on population/net-migration (전미선·김정숙 2021); DiD on out-of-province in-migration (임소현·지수호 2024); DiD+FE on GRDP (유주희·박정수 2023); population/tax/employment (조규민·손동욱 2020); KDI review (문윤상 2021).
- Kang, Lee & Kim (2024, Urban Studies)--IC relocation attracts and retains young migrants.
- Open question: attracting young people ≠ raising fertility– young movers may just relocate childbearing. That motivates a TFR outcome.
- Fertility is a valid local outcome: its determinants differ metro vs non-metro (김동현·전희정 2021).
- Caution: ICs often under-deliver (siting/scale, weak embeddedness; 이성호 2024)-- consistent with modest demographic effects.
- This project: same policy, less-examined outcome (fertility/aging) + a continuous relocation-intensity dose-response design.

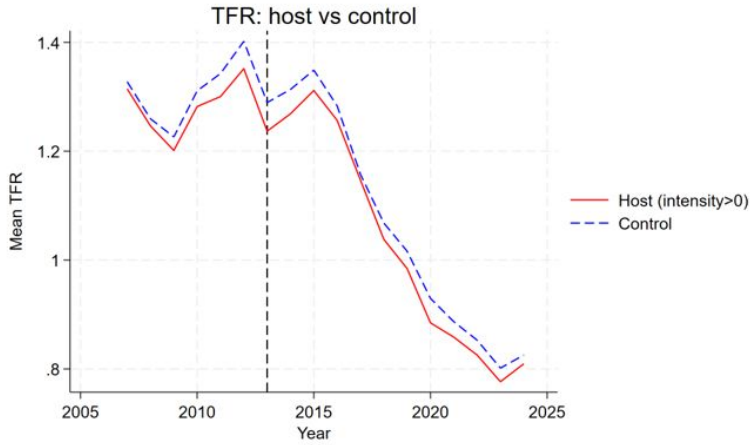
Data

• KOSIS e-지방지표 (e-Local Indicators) portal, 시군구 × year, 2007–2024: TFR, over-65 share, foreigners/1k, resident population (population = KOSIS table DT_1YL20651E, 행정안전부 주민등록).

• I analyze 12 host 시군구 –note the official program lists 14: Busan IC assigned to its primary district 남구; 충북 and 전북 each kept as two units.

• 161 시군구 total (12 host + 149 control); control pool excludes the Seoul Capital Area and Sejong.

– Raw files mix two administrative code systems, so I merge on (sido, municipality name, year).



(L) weighted mean TFR, host vs control

Building the Intensity Treatment

- Hand-keyed relocation counts from Problem Set 2 Table 1 (sum = 44,463) mapped to host 시군구, then divided by 2012 baseline population × 1,000.
- Joint ICs split 50/50: 충북 (진천+음성), 전북 (전주+완주). 충북's equal split is grounded; 전북's is an assumption.
- Intensity is time-invariant and exactly 0 for non-hosts.
- Across the 12 hosts intensity ranges from ~4 per 1,000 (전주시, 서귀포시) to ~87 (나주시).

	Host		Control	
	mean	sd	mean	sd
(mean) tfr	1.376	0.222	1.385	0.278
(mean) over65	14.047	4.273	18.170	7.525
(mean) foreign	17.896	16.149	12.539	9.207
(mean) pop	230582.208	159872.810	140568.520	132606.137
Resident population in 2012 (intensity denominator / future weight)	233047.667	162902.245	141768.711	134970.766
= 1 if sigungu in a 광역시	0.250	0.436	0.245	0.430
Observations	72		883	

- Pre-period (≤2012) means compared for host vs control: TFR, over-65 share, foreigners/1k, population, metro share.
- Intensity across the 12 host 시군구: min ≈ 4.2, mean ≈ 23.3, max ≈ 86.8 per 1,000.

Empirical Framework

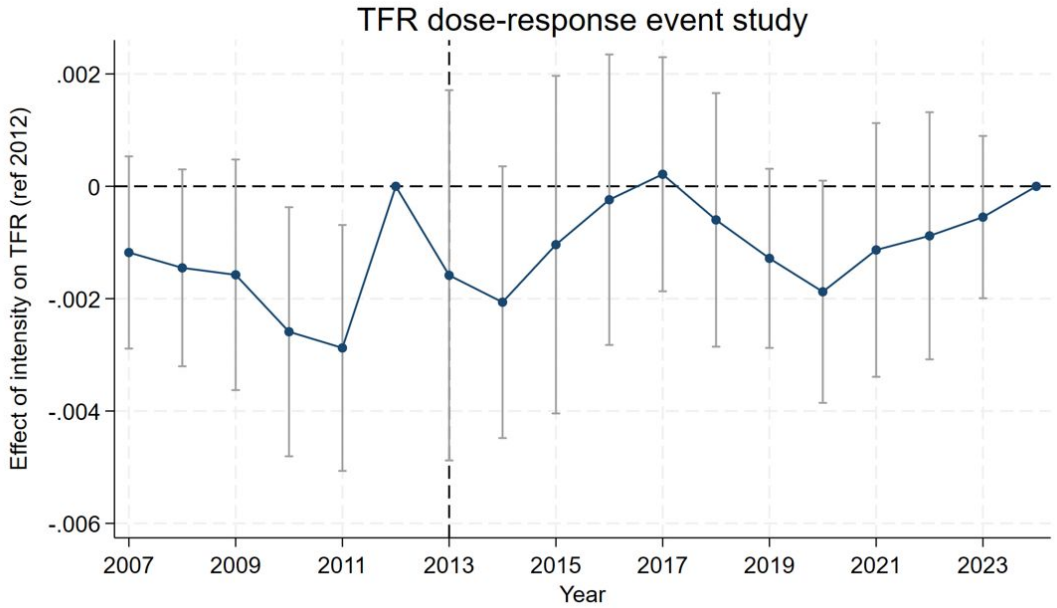
- areg y c.intensity#ib2012.year [baseline controls × year] i.year [aw=baseline_pop], absorb(sigungu) vce(cluster sigungu)
- β_t = effect of one intensity unit in year t relative to 2012 (the event-study coefficients).
- Municipality and year fixed effects; weighted by 2012 population; SE clustered by 시군구.
- Parallel trends is the identifying assumption; the pre-2013 β_t are its test.
  - Pooled summary uses ip = intensity × post (post = year ≥ 2013).

Outcomes

- TFR: births per woman (합계출산율).
- Over-65 share: population aged 65+ as a percent of residents (고령인구비율).
- Foreigners per 1,000 residents (인구 천명당 외국인수).
  - All are rates/ratios, used in levels. Population enters only as a log control and as the weight

Main Result: TFR Event Study

- Per-year intensity effects are flat around zero, with no break at 2013 (2012 = reference).
- **I do not detect a dose-response of fertility on relocation intensity.**



Main Result: Pooled Dose Estimates

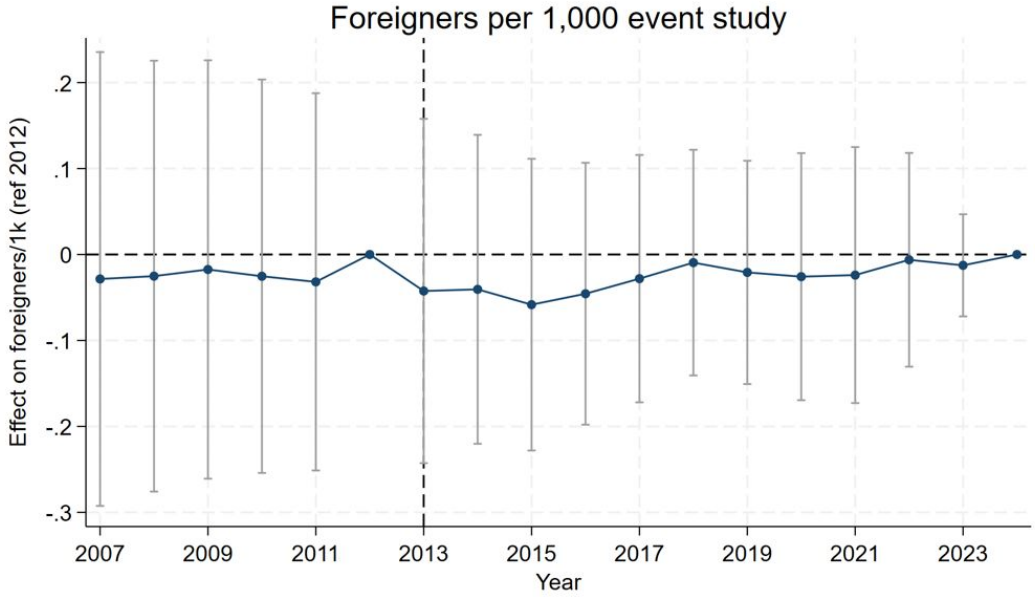
Outcome	Coef. (dose)	SE	N	R^2	Pre-trend p	Read
TFR (headline)	0.00084	(0.00110)	2,873	0.884	0.0694	**Null**
Over-65 share	-0.04992***	(0.01386)	2,873	0.977	0.0000	**Cautionary**
Foreigners/1k	0.03657	(0.05926)	2,873	0.871	0.8204	**Clean null**

- Pooled dose = intensity × post; a 1-unit higher intensity → +0.00084 TFR (10-unit → +0.0084).
- **At Naju's dose (86.76/1,000) the implied TFR effect ≈ +0.073, 95% CI ≈ [−0.11, +0.26] —small and indistinguishable from zero, but meaningful high-dose effects are not ruled out (underpowered, descriptive).**
- I do not detect an effect on TFR or foreigners; the over-65 coefficient is significant but fails parallel trends (next slides).

Why the Pre-trend Check Matters?

- The pre-2013 β_t test whether high- and low-intensity municipalities were on parallel paths before treatment.
- **TFR: joint pre-trend test borderline (p ≈ 0.069).**
- **Foreigners/1k: joint pre-trend p = 0.82 — flat.**
- **Over-65 share: joint pre-trend p = 4.2e-08 — pre-trends are not parallel.**
- TFR and foreigners are acceptably/cleanly identified; over-65 is not (next slide).

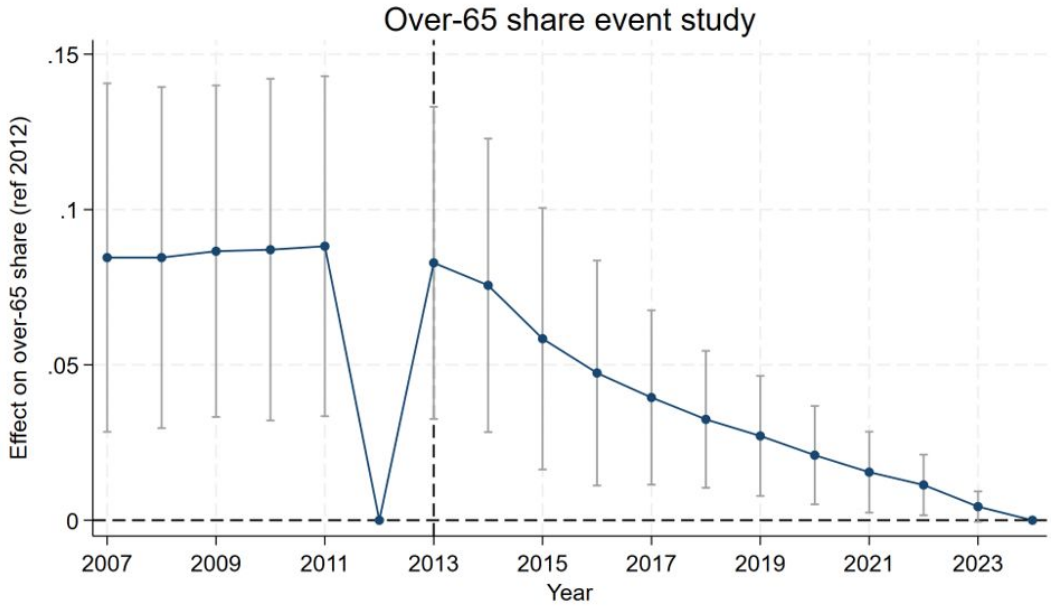
Secondary Outcome: Foreigners per 1,000



- Pooled dose +0.037 (SE 0.059), p≈0.54; flat pre-trends (p=0.82).
- **I do not detect an effect on foreigners per 1,000; at Naju's dose the implied effect ≈ +3.2/1,000, 95% CI ≈ [−6.9, +13.2] –indistinguishable from zero but not a tight zero.**

Over-65: The Cautionary Case

- The pooled coefficient (−0.0499, p<0.001) looks significant.
- But the pre-trend joint test is p=4.2e−08: high-intensity hosts were already on a different aging path before relocation.
- So this is confounded, not a credible aging effect.
- The event-study pre-trend check is the main lesson: it prevents overreading a significant coefficient.



Robustness

Check (TFR pooled dose)	Coef.	SE	p	Note
Headline (full, weighted)	**0.00084**	**0.00110**	**0.45**	**reference**
Drop Naju	−0.00018	0.00186	0.92	SE nearly doubles
Unweighted	0.00050	0.00136	0.71	
Joint split 70/30 (larger)	0.00106	0.00093	0.26	
Joint split 30/70 (smaller)	0.00061	0.00127	0.63	
Pre-trend, 2011 reference	—	—	0.13	comfortably flat

- **The TFR null is stable across every check (no coefficient is significant).**
- Over-65 stays a pre-trend artifact (2011-reference pre-trend p ≈ 0); foreigners stay null throughout

Limitations

- Thin dose: only 12 host 시군구 have non-zero intensity → weakly identified; descriptive, not clean causal.
- Selection: hosts were chosen non-randomly, so intensity is not randomly assigned (the over-65 pre-trend is a symptom).
- Staggered rollout: relocations spread 2012–2019 but the design uses a single 2013 cutoff, attenuating estimates toward zero.
- Spillover / geography: relocated workers may live in adjacent municipalities → contaminates controls and understates the dose.
- TFR is a blunt period measure: if movers skew male/unmarried or commute without families, TFR can stay flat even if individual fertility responded.

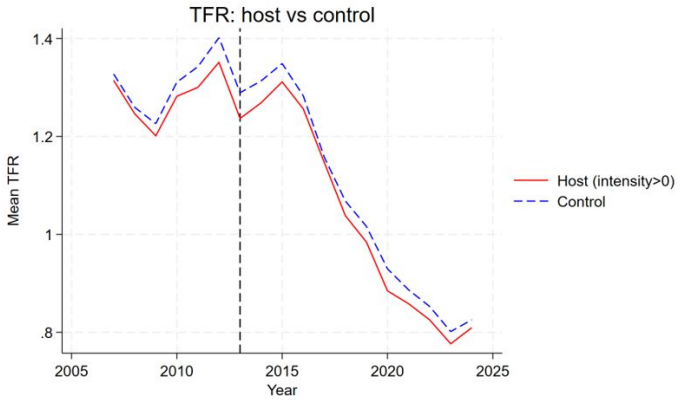
  – Plus: small treated N; Busan→남구 and 50/50 joint-IC assumptions; demographic outcomes move slowly.

Conclusion

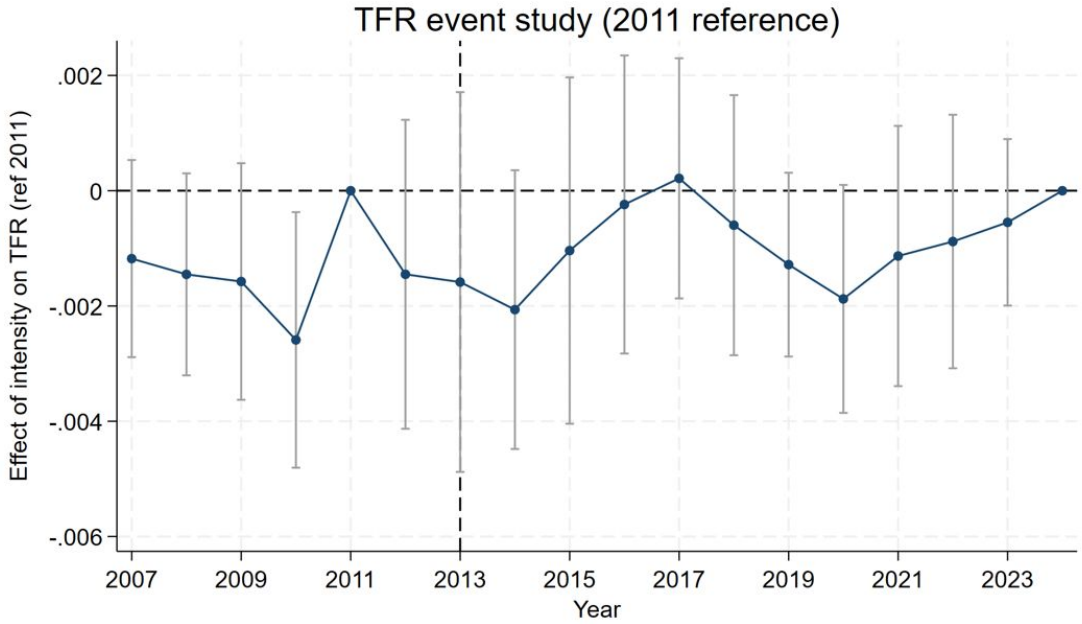
- Across all three outcomes I do not detect an effect of relocation intensity on host demographics.
- TFR and foreigners per 1,000 are nulls (wide CIs –meaningful high-dose effects not ruled out); the over-65 coefficient is significant but fails parallel trends.
- **Contribution: a design-based reading — the value is the pre-trend diagnostic, not a positive effect.**

Appendix: Metro vs Non-metro (exploratory)

- Pooled TFR dose split by host metro status (exploratory check).
- Non-metro hosts: +0.00038. Metro differential: +0.00508 (SE 0.00203) – n = 3 metro hosts, exploratory, not interpretable; NOT a finding.
- Only 3 of the 12 hosts are metro (부산 남구, 대구 동구, 울산 중구). I report this for transparency, not as evidence.



Appendix: TFR Event Study (2011 reference)



• Robustness only, 2012 remains the primary reference. Under a clean pre-relocation base (2011) the TFR pre-trend is comfortably flat (joint p ≈ 0.13).

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• 이성호 (2024). 혁신도시는 왜 혁신을 일으키지 못했나: 스케일 측면에서의 비판적 고찰. 국토지리학회지 58(4): 335–352.

• Data: KOSIS e-Local Indicators (e-지방지표), Statistics Korea, 시군구×year 2007–2024: resident population (table DT_1YL20651E, 행정안전부 주민등록), TFR, over-65 share, foreigners/1k.

• Innovation City relocation counts (44,463 workers): Problem Set 2 Table 1