Urban Transit Infrastructure: Spatial Mismatch and Labor Market Power

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Research Summary

- **What we do**
  - Examine the consequences of infrastructure expansions on labor market power and welfare
- **How we do it**
  - Leverage a large expansion of the subway system in Santiago, Chile
  - Estimate panel event studies with worker and firm fixed effects to obtain reduced-form estimates of the impact of receiving access to the subway network
  - Propose a commuting model with labor market power to conduct welfare calculations
- **What we find**
  - Workers start working further away
  - Both workers who stay or switch firms earn more
  - Calibrated counterfactuals suggest 10-20% additional welfare gains from infrastructure expansion when incorporating labor market power responses

Motivation

- Labor market integration can work as an additional benefit of infrastructure expansions besides commuting costs reductions
  - Traditional approach: Translate the reductions in commuting costs into changes in utility (McFadden 1978)
- Additional benefits
  - Creates firm-worker matches that were not available before
    - Direct efficiency gains
  - May reduce the labor market power that firms have over workers
    - Indirect efficiency gains and distributional consequences
- These additional benefits are important to evaluate the cost-effectiveness of subway networks
- Rapid urbanization in middle- and low-income countries highlights the need for evaluating the benefits of infrastructure projects

Contribution

- **Impacts of transportation infrastructure:**
  - On market integration: Faber, 2014; Redding and Sturm, 2008; Bartelme, 2015; Donaldson and Hornbeck, 2016; Alder, 2016; Donaldson, 2018
  - On property prices, population and welfare: Baum-Snow, 2007; Billings, 2011; Baum-Snow et al., 2017; Gonzalez-Navarro and Turner, 2018; Tsivanidis 2019; Brooks 2021
  - **Contribution:** Show that infrastructure expansions lead to labor market integration, with effects on wages and work location

- **Spatial mismatch:**
  - Kain, 1968; Hsieh and Moretti, 2019; Marinescu and Rathelot, 2018
  - **Contribution:** Show how infrastructure expansions may reduce spatial mismatch

- **Labor market power:**
  - Staiger et al., 2010; Dube et al., 2020; Naidu et al., 2016; Azar et al., 2017, 2019; Berger et al., 2019; Bhaskar et al., 2002; Lamadon et al., 2019; Brooks 2021
  - **Contribution:** Model of commuting and oligopsonistic labor markets and show how infrastructure may lead to welfare gains via reduced labor market power

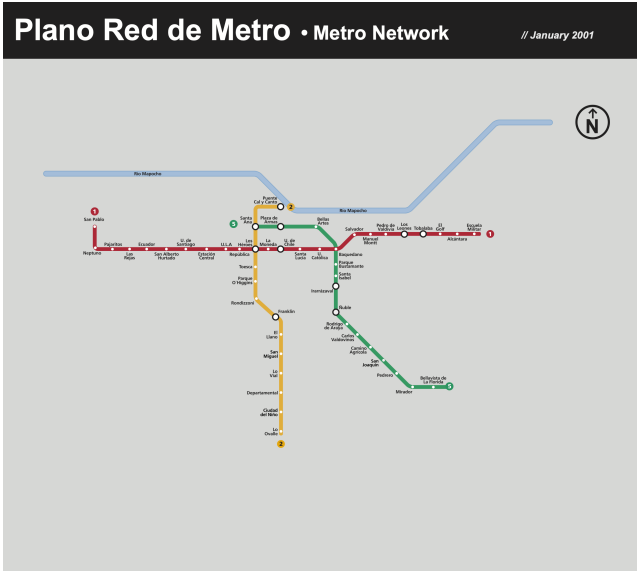
Context about Santiago's subway expansion

Santiago's Subway Expansion

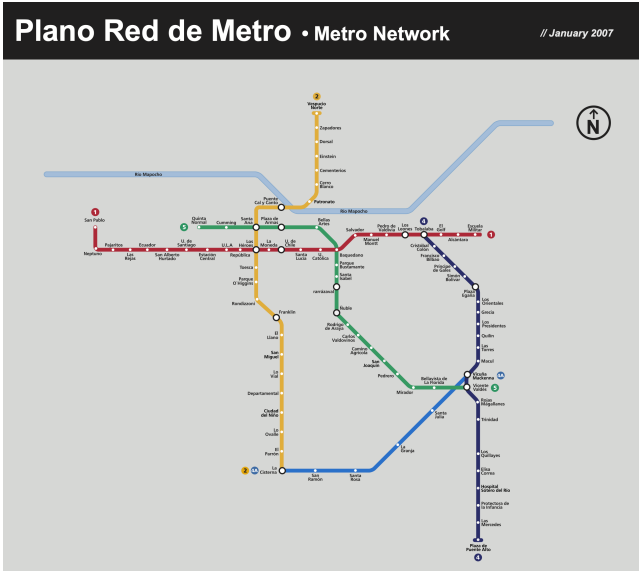
- Since 2004, the Santiago subway network has expanded drastically, increasing from:
  - 52 stations to 136 (+61%)
  - 39.7 km to 139.3 km (+250%)
  - 0.8 million to 2.5 million daily trips (+212%)

Master Plan

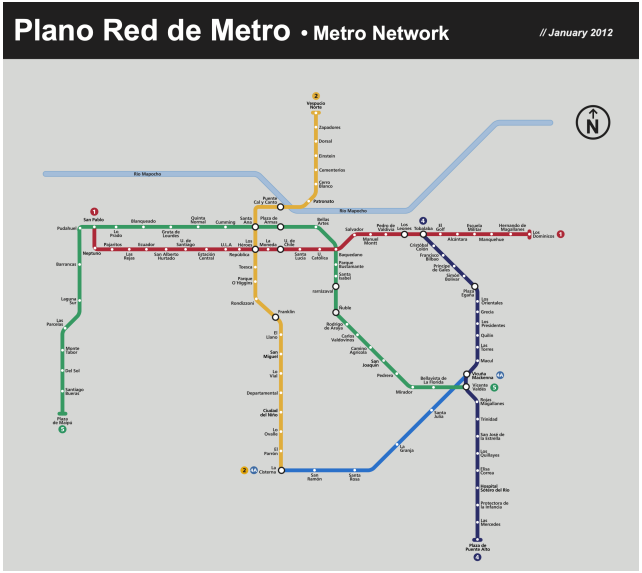
Santiago's Subway Expansion - Baseline



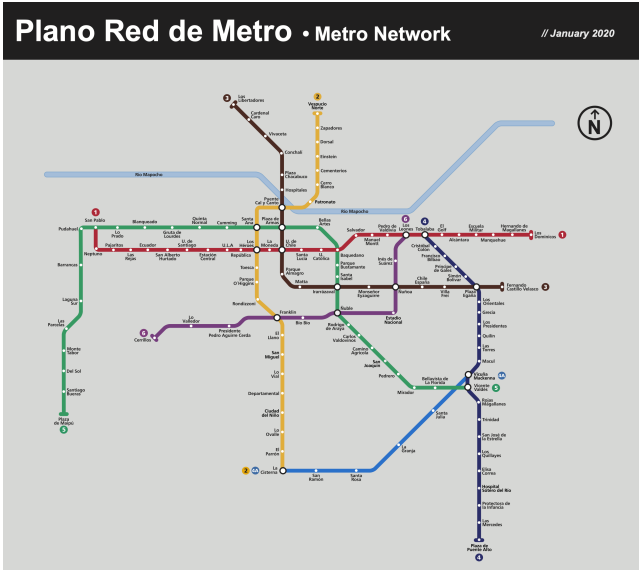
Santiago's Subway Expansion - After 1st Wave



Santiago's Subway Expansion - After 2nd Wave



Santiago's Subway Expansion - After 3rd Wave



Reduced-form evidence

Data

- Employer-Employee with monthly earnings (top-coded) from March 2002 to March 2019 for all private sector workers
  - District of worker's residence and of firm's location. For now only snapshot of locations, we cannot see migration +
- Origin-Destination Surveys for 2001 and 2012

Descr Stats

Reduced-Form Specification

$$y_{idt} = \sum_{k=-4}^{8} \beta_k T_{dt}^k * I_d + \lambda_i + \delta_t + \varepsilon_{idt}$$

- y_{idt}: outcome of worker i, living in district d, for month t
- T_{dt}^k: dummies equal to 1 if a worker-month observation corresponds to k semesters around the semester of treatment
- I_d: district-level variable representing the intensity of the treatment (percentage change in avg. distance to the subway)
- λ_i: worker FE
- δ_t: month FE
- ε_{idt}: clustered at the district-level

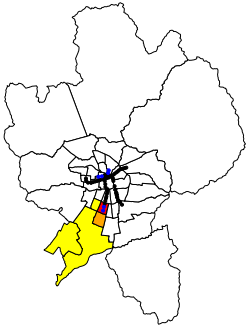
Defining Treatment

1. Take a representative sample of work-trip origins for each district
2. Each month, calculate the distance from each point to the closest existing subway station
3. Compute a monthly district-level average of those minimum distances. Calculate the % change in this distance each month
4. Find the month with the largest % reduction in distance for each district
5. All districts are treated at some point, with different intensities, distributed across 8 different periods

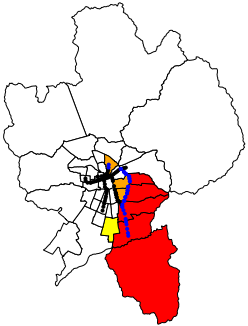
Distribution

Treatments

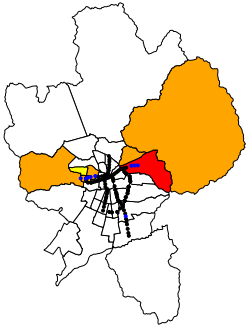
Treated in 2004



Treated in 2006



Treated in 2010

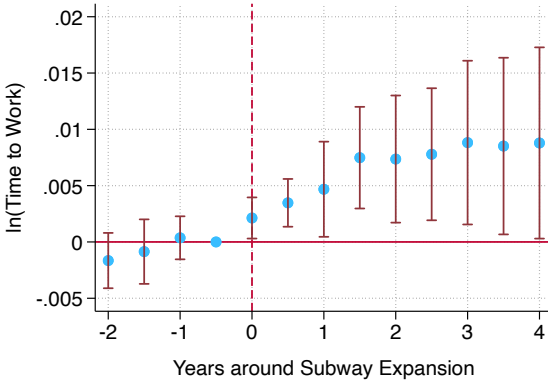


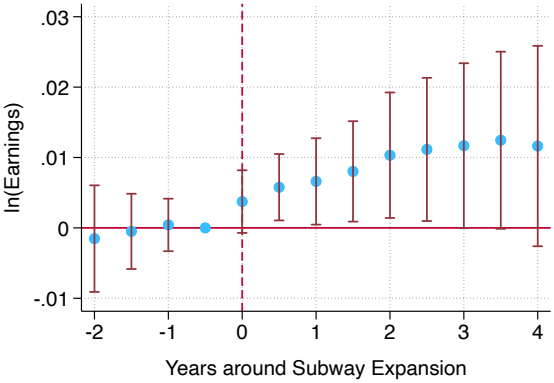
Notes: Districts in yellow reduced their distance to the subway by less than 25%, those in orange by 25-50%, and those in red by over 50%. Average treament intensity: 42%.

Reduced-form Results

1. Workers Start Working Further Away and Earn More
2. Workers Who do not Switch Jobs Earn More
3. Firms Hire From Further Away
4. Earnings Converge Across Space

Result 1: Workers Start Working Further Away and Earn More

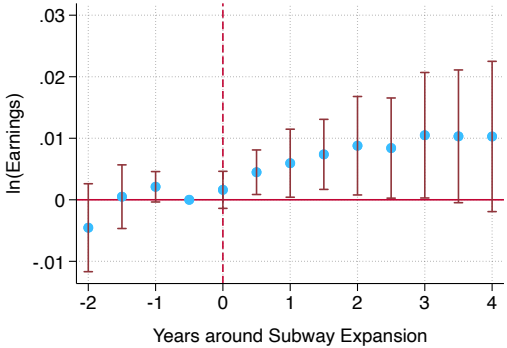




Notes: Coefficients are scaled by 0.42 to represent the effect on the average worker

Time

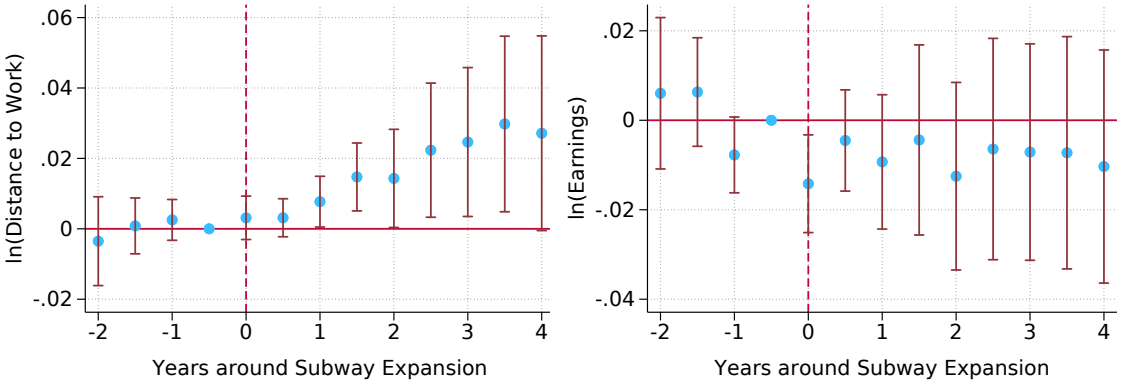
Result 2: Workers Who do not Switch Jobs Earn More



Notes: Event Study results on earnings using worker-firm fixed effects. Coefficients are scaled by 0.42 to represent the effect on the average worker

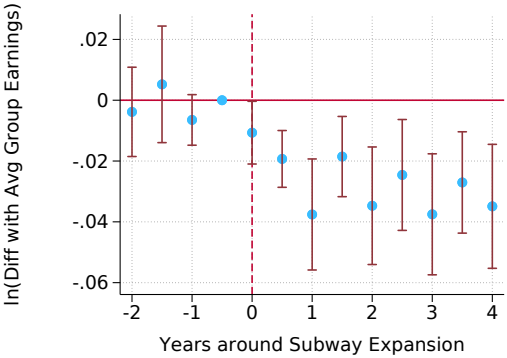
Ruling out hours Ruling out agglomeration

Result 3: Firms Hire From Further Away



Notes: Event Study results on distance to work and earnings using firm fixed effects. Coefficients are scaled by 0.42 to represent the effect on the average worker

Result 4: Earnings Converge Across Space

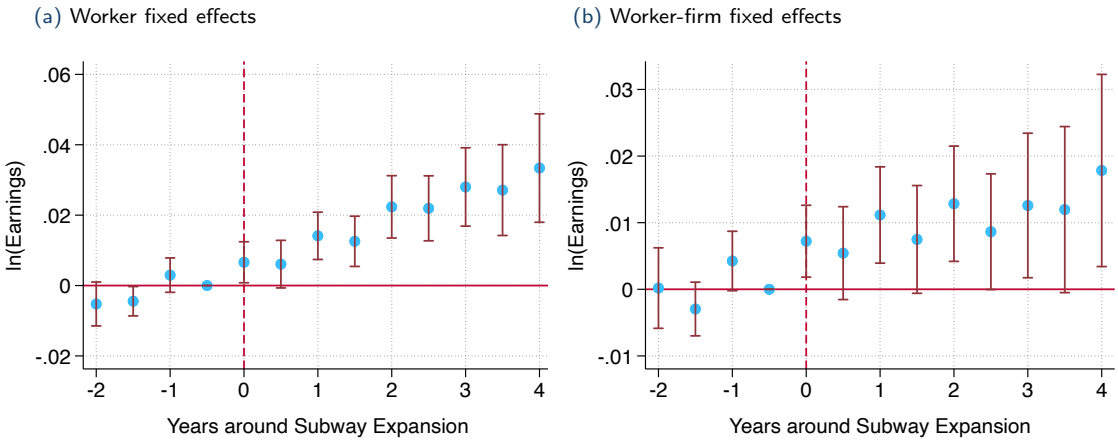


Notes: The dependent variable is the log absolute value of the difference between each worker's monthly earnings and the average earnings for the worker's sector-education-age bin average wage. Event Study with firm fixed effects. Coefficients are scaled by 0.42 to represent the effect on the average worker

Using another region as the control group

- We use the 33 districts from the Bio-Bio Region as controls, and all of the Santiago districts as treated.
- Stacked dif-in-dif to avoid using early treated units as controls for later treated units
- If there are spillovers within Santiago, this estimate is closer to the "pure" treatment effect

Using Another Region as Control



Notes: Stacked Dif-in-Dif using districts from the Bio-Bio region as controls. Coefficients are scaled by 0.42 to represent the effect on the average worker.

Model

Model - Labor Supply

Indirect utility of worker ω that lives in i, works in sector s, location j, and firm f:

$$V_{\omega ijsf} = \frac{\overbrace{u_i}^{\text{Residential amenity}} \; \overbrace{w_{j(f)s(f)f}}^{\text{Wage}} \; \overbrace{\epsilon_{\omega ij(f)s(f)}}^{\text{Nested Fréchet match productivity}} \; \overbrace{d_{ij(f)}^{-1}}^{\text{Commuting cost}}}{\underbrace{P^{\alpha}}_{\text{Price index}} \; \underbrace{r_i^{1-\alpha}}_{\text{Housing cost}}} \tag{1}$$

$$H(\epsilon) = \exp\left[-\sum_s B_s \left(\sum_a B_{a(js)} \epsilon_{ia(js)}^{-\beta}\right)^{\frac{\kappa}{\beta}}\right], \quad \text{with} \quad \kappa \leq \beta$$

Sector-workplace shares:

$$\lambda_{j(f)s(f)f|i} = \underbrace{\frac{B_{is} W_{is}^{\kappa}}{\sum_{s'} B_{is'} W_{is'}^{\kappa}}}_{\text{Prob. of working in sector } s} \; \underbrace{\frac{B_{j(f)s(f)f} w_{js(f)f}^{\beta} d_{ij}^{-\beta}}{\sum_{f' \in \mathcal{F}_s} B_{j'(f')s'(f')} w_{j'(f')s'(f')f'}^{\beta} d_{ij'(f')}^{-\beta}}}_{\text{Prob of working in } jf \text{ conditional on working in } s}, \tag{2}$$

Labor Demand

- M_{js} firms in each sector and location
  - Working on entry and exit
- Heterogeneous firm productivity, no trade costs, homogeneous consumption good
- Oligopsonistic competition between firms in the same sector
  - Bertrand competition
- Firms post wages per efficiency units assuming that their posted wage:
  - affects wages within each sector in the entire city
  - mass of sectors

Labor Demand-Markdown

Firms set wages at a markdown below the marginal productivity of each worker:

$$w_{jsf} = \left(\frac{\epsilon_{jsf}}{1 + \epsilon_{jsf}} \right) MRPL_{jsf}$$

Where ϵ_{jsf} is the labor supply elasticity faced by the firm:

$$\epsilon_{jsf} = \sum_i \underbrace{\omega_{ijsf}}_{\substack{\text{Share of workers} \\ \text{from firm } f \\ \text{that live in } i}} \left[\underbrace{\lambda_{ijsf|s}}_{\substack{\text{Share of workers} \\ \text{from location } i \\ \text{that work in } f \\ \text{cond. on sector } s}} \overbrace{\kappa}^{\substack{\text{“Substitution} \\ \text{across} \\ \text{sectors”}}} + (1 - \lambda_{ijsf)|s}) \overbrace{\beta}^{\substack{\text{“Substitution} \\ \text{across firms} \\ \text{within sector”}}} \right], \tag{3}$$

Main Lemmas

1. Firm heterogeneity in productivity and commuting costs generates dispersion of markdowns across firms and factor misallocation

2. If there is more than one firm in each sector, when $\beta \to \infty$, firms do not have labor market power and we go back to the case of perfect competition

3. When commuting costs $d_{ij} \to \infty$, firms only operate in the local labor market in which $i = j$ and exert the highest level of market power

4. Reductions in commuting costs d_{ij} weakly decrease labor market power for all firms

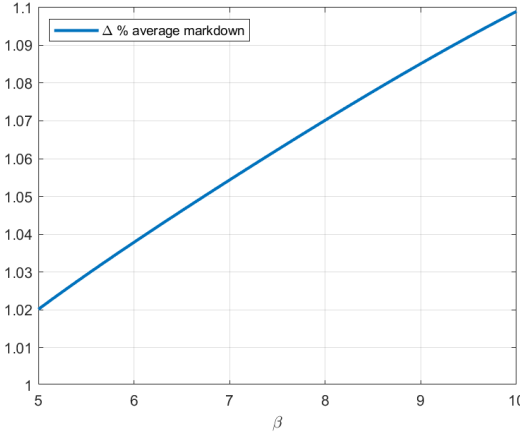
Model Calibration

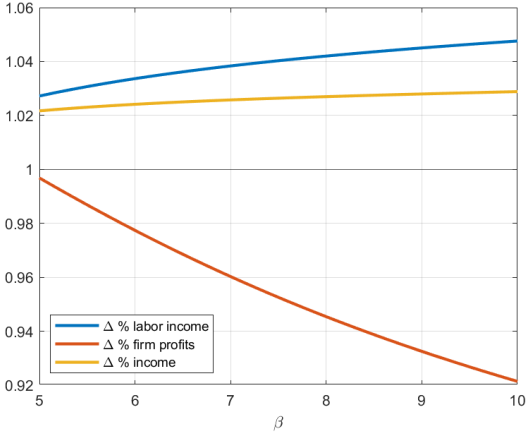
- We calibrate the parameters using the employer-employee data set in 2004:
  - We recover productivity and amenity parameters by inverting the model
  - We calculate travel times across districts in Chile with and without the new subway lines

- We focus on two margins:
  - Efficiency gains considering labor market power effects
  - Distributional effects between firms and workers

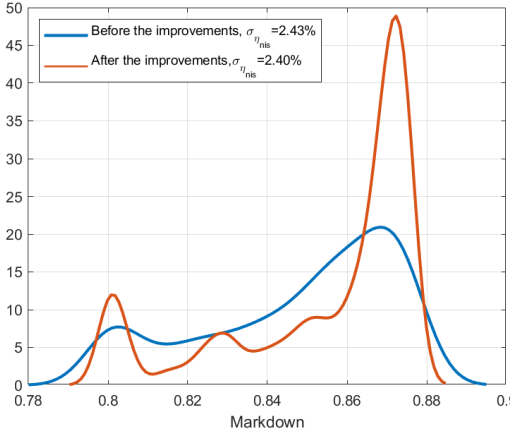
Parameter	**Interpretation**	**Value**
κ	Elasticity of substitution across sectors	3
β	Elasticity of substitution across firms within a sector	5-10
γ	Decreasing returns to scale	0.9
Commuting costs	Travel times	$\exp(\delta t_{ij})$

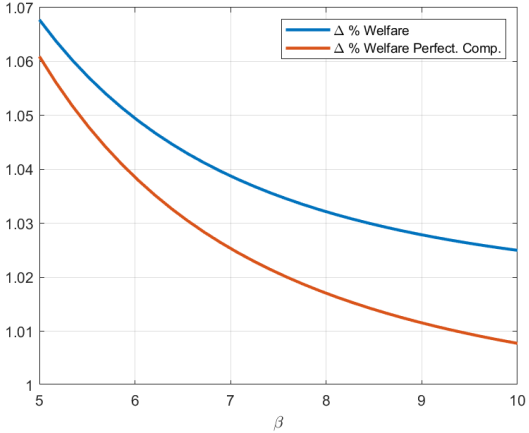
Model result 1: Markdowns and Profits Decrease After a Subway Expansion





Model result 2: Markdowns Become Concentrated, Welfare Increases More than in Perfect Competition



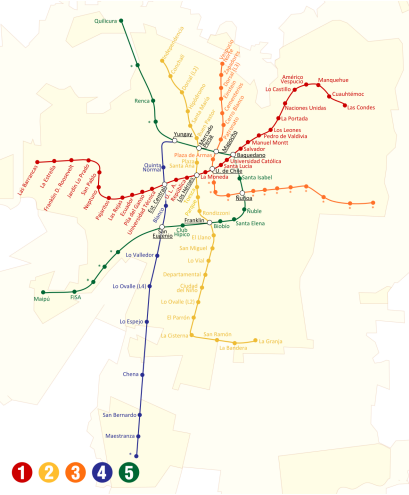


Conclusions

1. Access to the subway network changed workers' workplace decisions
2. Affected workers start earning more, even those who do not switch jobs
3. Total welfare gains are amplified when we consider labor market power responses
4. Next steps:
   - Estimate key parameters (β and κ) of the model to obtain welfare calculations

Appendix

Santiago's Subway - 1968 Master Plan



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Possible Sorting Bias

- Workers from another district experience a positive wage shock right around the time of the subway expansion and move to the district of the subway expansion
- But these selected workers would also have to switch jobs to ones further away from the district they just moved to...

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Commuting in Santiago

Variable	Mean 2001	Mean 2012	District-level Min–Max 2001	District-level Min–Max 2012
Commuting Time (min)	36.67 (25.3)	47.92 (29.5)	22.1–51	27.8–68.6
Commuting Distance (km)	7.27 (6.2)	8.5 (7)	3.5–13.3	4.1–14.4
Used Public Transport	0.49 (0.5)	0.54 (0.5)	0.19–0.67	0.19–0.81
Used Subway	0.08 (0.27)	0.25 (0.43)	0.01–0.22	0.05–0.51
N	18,143	17,331	38	38

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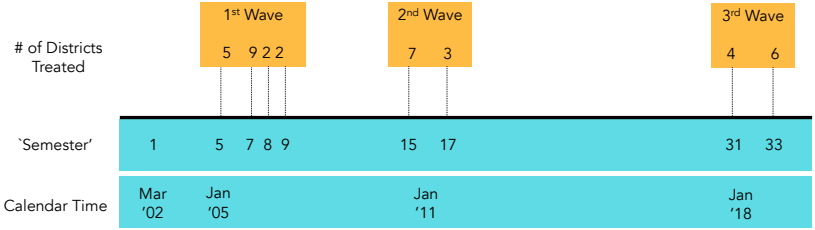
Empirical Strategy: Event Time Distribution



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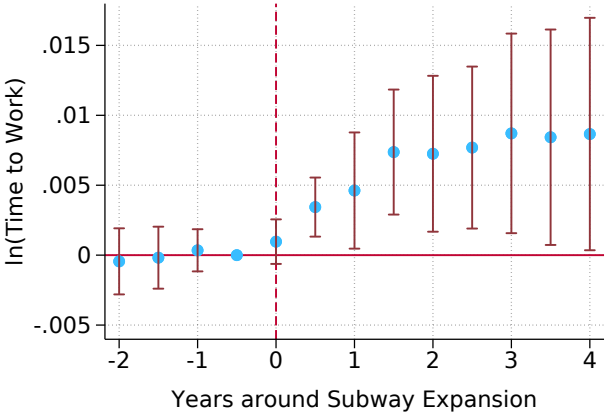
“Time” to Work



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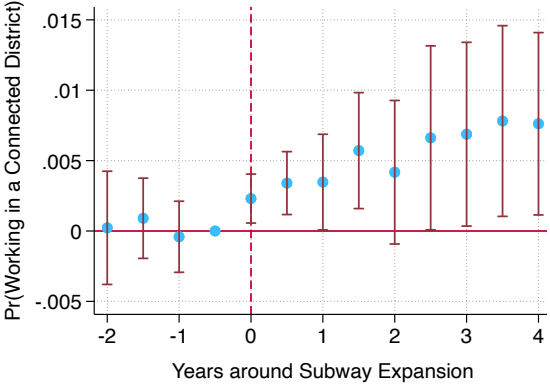
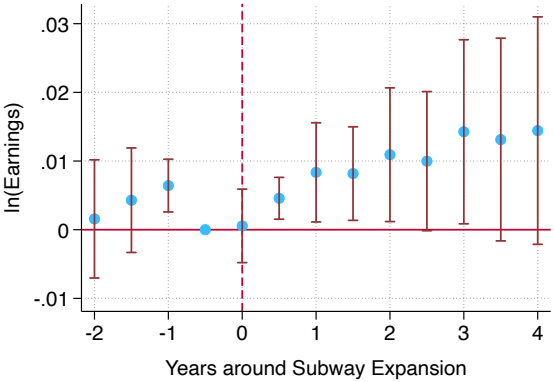
Ruling out hours & productivity

(a) Validation



(b) Stayers - Unconnected



- Connected districts: Top half of districts according to reduction in simulated commuting time
- Unconnected districts: Bottom half of districts according to reduction in simulated commuting time

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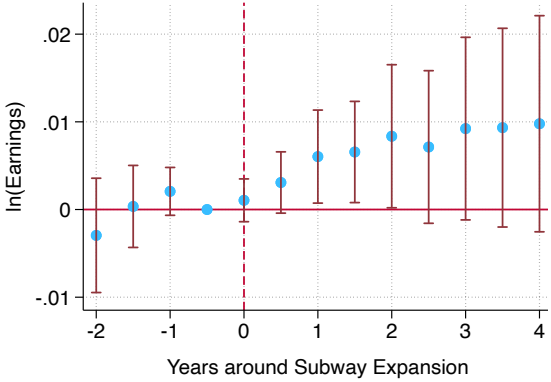
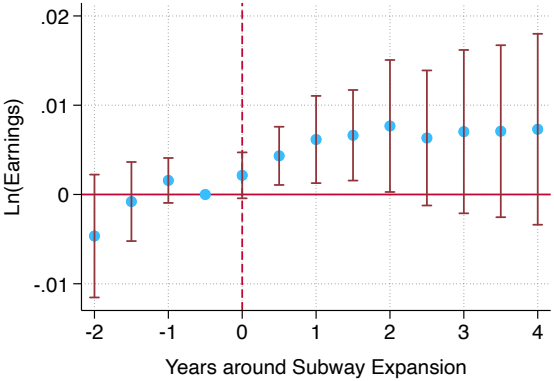
Ruling out agglomeration

(a) Month x Firm-District FE



(b) Month x Firm-District x Sector FE



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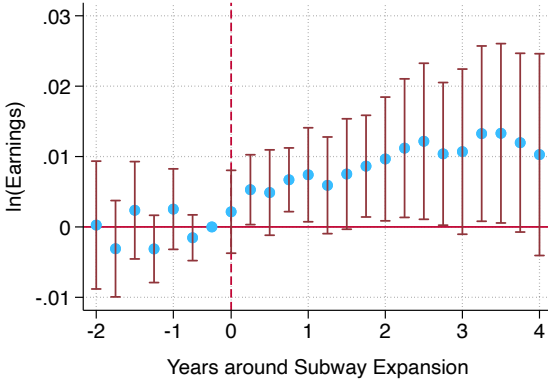
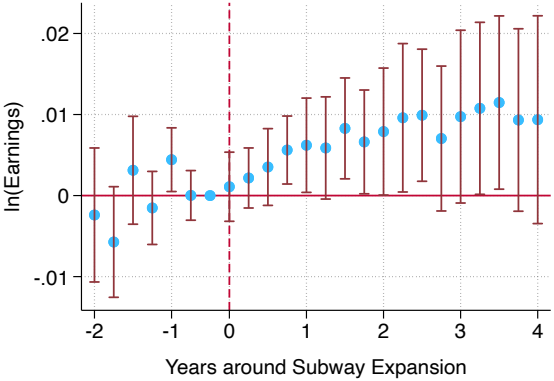
Trimester-level coefficients

(a) Earnings



(b) Earnings-Stayers



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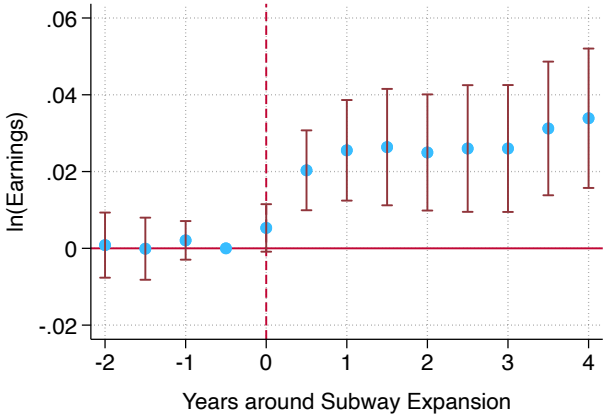
Ruling out increased firm productivity - Only Manufacturing



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