

The Long Term Effects of Teacher Wage Differentials

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- The body of research on the effects of teacher salary on short-term and long-term student outcomes has expanded.
- We shift the focus to **teacher outcomes**: effects of unconditional pay raises on future career trajectories.
- We leverage experimental variation in salaries across a significant segment of Costa Rica's public sector workforce.
 - Pay variation stems from the algorithm used in nationwide centralized recruitment in state-funded schools.
 - Randomized offers from hard-to-staff schools paying an unconditional bonus on top of a base salary.
- **Research design.**
 - All offers are for tenured (open-ended) contracts.
 - Compare teachers receiving an offer with the bonus to teachers receiving an offer without the bonus.
- Dynamic selection into career choices following tenure with higher salaries, up to six years post-appointment.

- We begin by using administrative data to document **three facts**.
 - Teachers starting with a bonus experience steeper earnings trajectories post tenure (5% to 7% higher salaries).
 - No detectable effects on effort.
 - Higher long-term earnings are not due to longer tenure at hard-to-staff schools.
- **High mobility after tenure.**
 - Tenure status is not tied to a particular school.
 - Teachers can take leave from one school to temporarily work at another; about 30% do so in the data.
 - Schools cannot prevent tenured teachers from taking leaves; teachers may return to their original school at any time.
- Teachers consider external offers for temporary positions.
 - No monetary or reputational costs associated with applying for temporary positions or declining offers.

Initial Wage Differentials: Long-Term Implications

- Why does earning the bonus matter?
- We use **data on the wages offered for temporary positions**.
 - Teachers receive many offers!
 - Quality, quantity, and timing are unpredictable: decentralized process by uncoordinated regional offices.
 - However, the risk of receiving offers must depend only on observables.
- Compare same-risk teachers who start with and without the bonus.
 - Tenure with higher salaries lead to more patient job searches.
 - Job searches focus more on managerial (principal) positions.
 - Reduced forgone earnings from future offers.
- On the research design.
 - RDs from discontinuities in the eligibility to receive the pay raise: teacher sorting plus effects of teacher compensations.
 - Our empirical approach: randomized offers.

Institutional Context

- **Primary education in state-funded schools.**
 - Free, mandatory and organized over six years (ages 6 to 11).
 - Academic year: February to December.
 - About 8% of schools are private (11% Mexico, 55% Chile).
 - About 4k schools and 500k students (~ 95% of students).
- Teachers work in a **highly regulated and unionized sector.**
 - About 80k employees (29% of the public workforce).
 - Good salaries (80% over the minimum wage for college graduates).
 - Salaries represent ~ 50% of public spending on education.
- Offers for **teaching (T) and administrative (P0 and P1) roles.**
 - All teaching positions in the country.
 - Principal positions in schools with up to 90 students.
 - Positions filled using a **centralized recruitment algorithm.**
 - ~ 93% of vacant jobs in primary schools.

National Recruitment

Step 1: November

Before Vacant Positions Are Published

- Offers are made to applicants enrolled in a **national registry**.
 - The registry is updated irregularly, every two to four years (**in November, before the academic year starts**).
 - No monetary or reputation costs associated with enrollment.
 - A new registry is advertised through major media outlets.
- Enrollment indicates an expression of interest to work in specific **districts** and **job profiles** (**not schools**).
 - Must report which **job profile** is sought (multiple options allowed).
 - Must rank the **school district** where employment is sought (can flag that all districts are equally liked).
 - Qualifications are automatically scored by the system.
 - Applicants are **ranked** using this score, proximity to the school district, experience (in days), and a random number to break ties.
 - **Separate rankings for P0, P1 and T profiles are formed.**
 - Applicants for multiple job profiles appear in multiple rankings.

National Recruitment

Step 2: December

Offers for Tenured Positions: Centralized Recruitment

- Vacant positions for the new academic year are published.
- **Offers for tenured (open-ended) appointments** are used to fill vacancies, with offers determined through a two-step process.
 - The **first step** uses a Deferred Acceptance (DA) algorithm to select applicants who will receive an offer in a specific job profile and school district (e.g., P0 positions in San Jose).
 - In the **second step** vacant positions (e.g., P0 positions in San Jose) are matched to applicants **in the order of their random number**.
- Applicants have three days to accept the offer. No consequences if offer is rejected, and jobs turned down remain vacant.
- **Who is a tenured teacher?** Enrolled in the registry, received and accepted a tenured position offered through the centralized system.
- Vacant jobs and filled using a separate procedure for **temporary appointments** (usually with a duration of one year).

National Recruitment

Step 3: After December

Offers for Temporary Positions

- The national registry, along with the assigned rankings, is used for filling vacant positions nationwide.
- All applicants who have not accepted an offer for a tenured position in December are eligible for temporary appointments.
- Offers are made in a **decentralized and uncoordinated manner**.
 - The DoE must first approve the budget for each position.
 - Vacant positions are then handled by regional offices considering applicants with a preference for districts of that region.
 - Offices must offer positions following rankings in the registry, so that applicants ranked high and still available will be the first to know about a new vacancy.
 - Applicants receive uncoordinated phone calls from different offices with unpredictable timing.
 - Offer must be accepted within a few hours, or the process continues.
- **Teachers tenured in past recruitment drives can participate.**

Implications for Teacher Turnover

- **A tenured contract is not tied to a specific school.**
 - It serves as an entry point to the public sector.
 - The tenure status is portable in the event of transfers.
- There are **two types of transfer for tenured teachers** recognized and protected by the national labor laws.
 - Permanent move to another school: must enroll in the registry again and receive an offer for a tenured position (Step 2).
 - **Temporary transfer (or leave)**: tenured teachers may take leave from one school and hold a temporary job at another school, possibly to fill a vacant position not in the same job profile (Step 3).
- Tenured teachers may be transferred to temporary positions on short notice. Can return to their original school at any time.
- Base salary, pension benefits and salary top-ups are the same for open-ended and temporary contracts.
- About 30% of tenured teachers are on leave at another school.

National Recruitment

Step 4: Variation in Wages

School Districts and Administrative Geography

- **Base salary:** follows from a compensation scheme that rewards seniority and is independent of performance.
- **Salary supplements:** depend on two components.
 - The **job profile:** $T < P0 < P1$.
 - **Unconditional bonus payment** in schools of disadvantaged areas: 6% to 7.5% of average salary.
- The definition of disadvantaged areas depends on an index of economic development that varies between regions defined by the political and administrative geography of the country.
- School district boundaries are different from those of administrative regions: 90% of school districts consist of schools located in different administrative regions.
- These differences in boundaries imply that applicants selected by the DA algorithm (Step 2) will receive random offers to fill vacancies at schools with and without the bonus.

Characterization of Schools Paying the Bonus

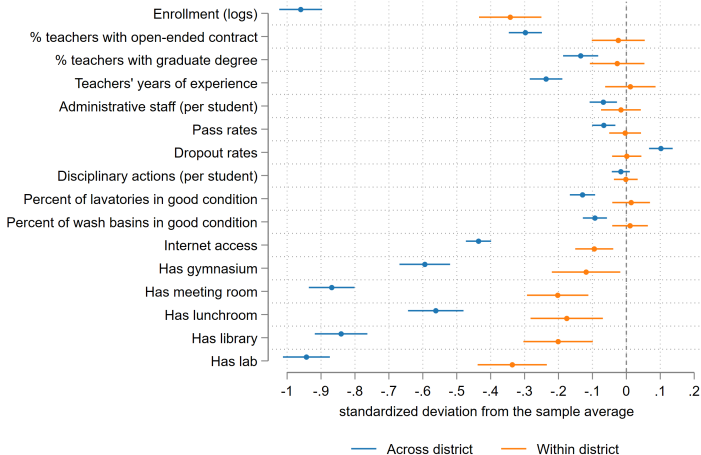


Figure 1: Standardized deviations from the sample average.

Data

- Administrative records over a 13-year period linked through identifiers of individuals, contracts, and schools.
- **Applications** considered in **four** national recruitment drives (from registries formed in November of 2013, 2015, 2016 and 2017).
 - 5,670 tenured positions offered in total.
 - About 7k to 10k applicants per drive.
- **Teacher employment records and payrolls** (from 2008 to 2020).
 - Teacher **demographics**.
 - Month-to-month **wages**.
 - **Contract** (job profile, location, type and duration).
- **Social security records** (if not in the public sector).
- **School Census Data** (from 2008 to 2020).
- **No student scores** (only pass rates and drop-out rates).

- **Wage offers** for **temporary positions** that became available in the 2018 school year (from the November 2017 recruitment registry).
 - 284 positions.
 - Timing of phone calls made by regional offices inferred from national rankings.
 - We know if the offer was accepted, the order of the phone call among those received by each teacher, and those made by the regional offices to fill the position.
 - Information on the wage offered (baseline figure and the bonus payment) and the current wage (including outside the public sector).

Effects of the Bonus

- **Population:** teachers selected by the DA algorithm in any of the recruitment drives (November 2013, 2015, 2016 and 2017).
- **Treatment:** indicator z_i for offers for a tenured position in a school paying the bonus (instead of a school not paying this bonus). We leverage randomness in z_i generated by the algorithm.
- **Causal parameter:** effects of z_i on some variable $outcome_{it}$ in a panel of teachers i in academic years $t = 2008, \dots, 2020$.
- We group teachers using the cross-tabulation of:
 - the recruitment drive when the offer was received, using the year of the first offer in case of repeated offers (about 20% of teachers).
 - deciles of the qualification score, which summarizes experience and qualifications when the offer was received.
- We estimate event study regressions, considering that the **timing of treatment is staggered** across drives.

- We consider **dynamic effects** from difference-in-differences equations separately for each group g :

$$outcome_{it} = \beta_{0g}(i, t) + \sum_{j \in [-6, \tau_r]} \beta_{jg} \mathbf{1}(t - r = j) z_i + u_{it}.$$

- Specification:
 - $\beta_{0g}(i, t)$ is shorthand for TWFE (teacher and year).
 - j 's are leads and lags around the recruitment drive r when group g received the offer.
 - the upper limit of the window, τ_r , is constrained by the length of the panel and depends on the recruitment drive.
- The event-study graphs plot weighted averages of the β_{jg} 's across groups g , with weights representing the relative number of offers from schools paying the bonus in each group.

Causal Effects of Receiving an Offer with Bonus

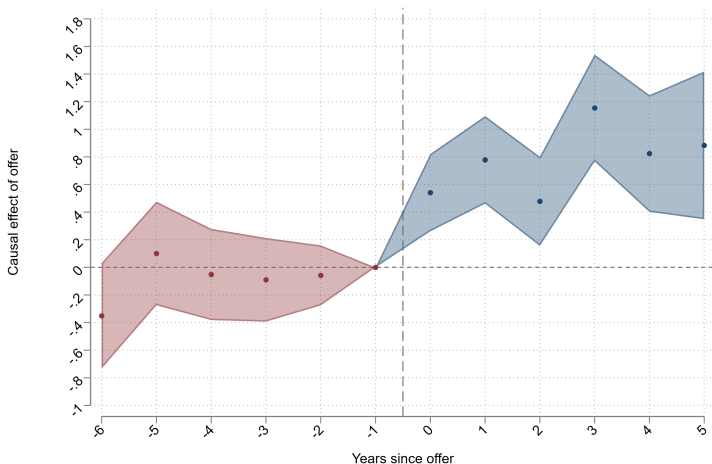


Figure 2: Annual earnings in thousands of USD. Treatment is defined at zero.

Causal Effects of Receiving the Bonus (Offer Takers)

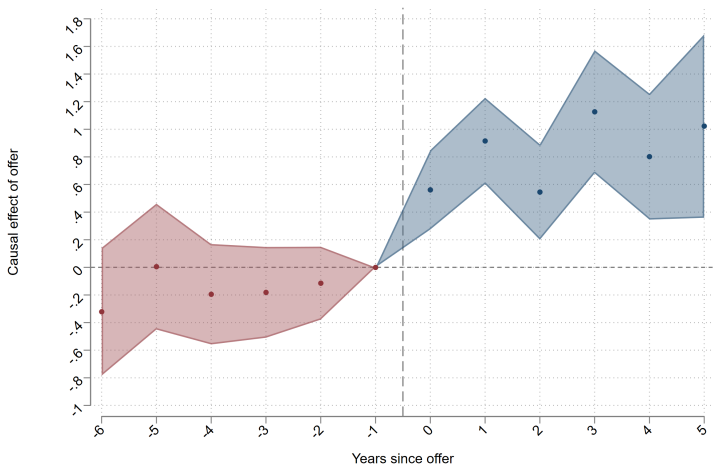


Figure 3: Annual earnings in thousands of USD. Treatment is defined at zero.

Working in a School with Bonus

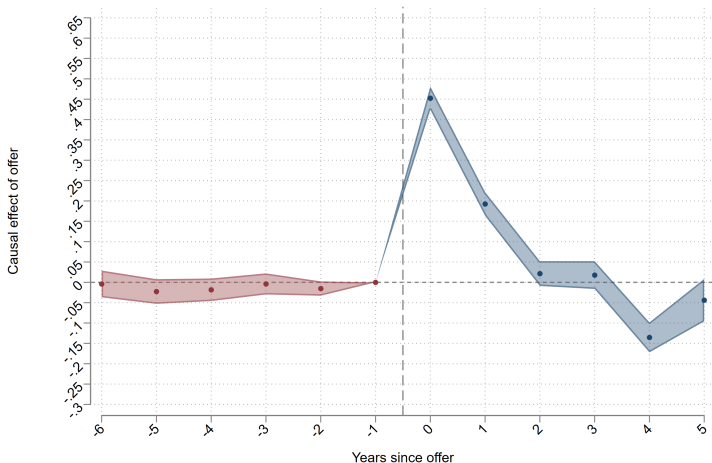


Figure 4: Indicator for working in a school with bonus. Treatment is defined at zero.

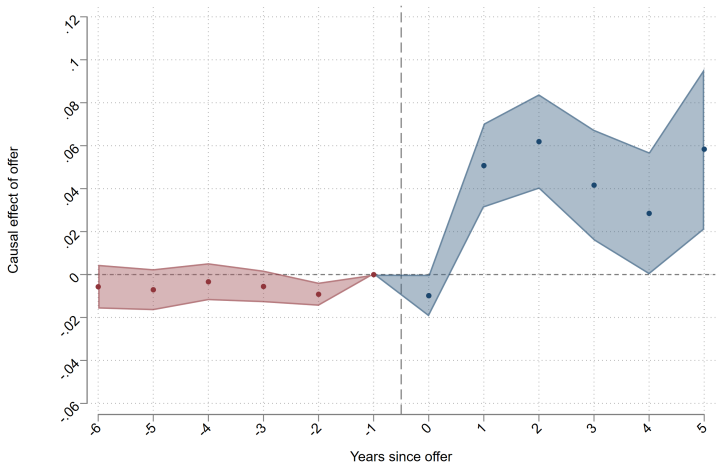


Figure 5: Indicator for being on leave from the school where tenure was originally granted. Treatment is defined at zero.

Employment in the Role of Principal

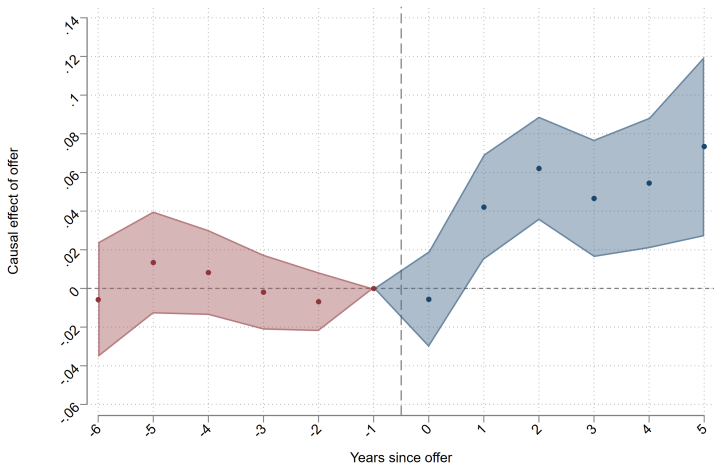


Figure 6: Indicator for school principal appointments. Treatment is defined at zero.

To sum up:

- Compared to the average in the sample (\$19,000), the premium on earnings caused by higher compensation in period zero ($z_i = 1$ vs $z_i = 0$) is $1,000/19,000 = 5.3\%$.
- After six years, teachers with higher compensation in period zero are less likely to earn a bonus than their peers.
- These teachers are more likely to hold a temporary job at another school ($6/30 = 20\%$) and be employed in more managerial roles.

Additional checks (see paper):

- Balancing tests.
- Offer compliers.
- Heterogeneity by our measure of teacher value-added: no effects on effort, better career prospects post-tenure for low value-added teachers before tenure.

Job Search and Upward Mobility

- **All 284 temporary positions** that became available in the 2018 school year (filled using the November 2017 registry).
- **All 6,847 teachers** enrolled in the November 2017 registry, to form a panel of $6,847 \times 284$ teacher-job combinations.
 - $z_i = 0$ and $z_i = 1$ teachers with offers for a tenured position in any of the recruitment drives (November 2013, 2015, 2016 and 2017).
 - teachers without previous offers for a tenured position.
- For each combination, we know the order of the phone call among those received by each teacher, if the offer was accepted, the wage offered, and the current wage and position.
- Teacher's stated preferences in the November 2017 registry. National rankings for P2 to P5 positions as well (i.e., principals in schools with 90+ students).
 - Stated preferences vs actual choices.

- **Causal parameter:** effects of z_i on job search and take-up of offers. We leverage the unpredictable timing of job openings.
 - Do teachers with $z_i = 1$ and $z_i = 0$ accept offers at different rates?
 - Do they have different forgone earnings from potential future offers?
 - Since DoE offices operate independently, teachers who have accepted offers may still receive calls offering positions.
- Two empirical challenges for interpreting this comparison.
 - Teachers should share same ex-ante risk of receiving offers.
 - They should have “enough offers” to choose from.
- **Solution:** use the process followed by DoE regional offices to compute teacher-specific risks of receiving offers.

Timing and Quality of Jobs Are Unpredictable

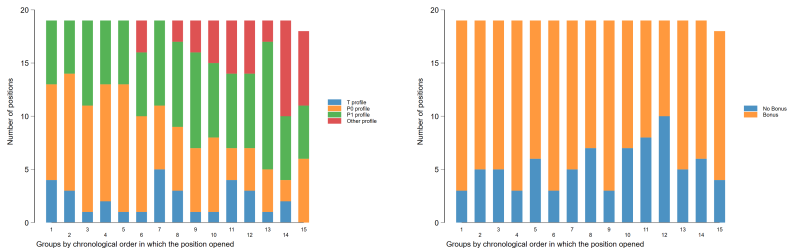


Figure 7: 284 jobs into 15 groups based on the chronological order in which the job became vacant, and within-group distribution of job characteristics.

Stated Preferences from the National Registry

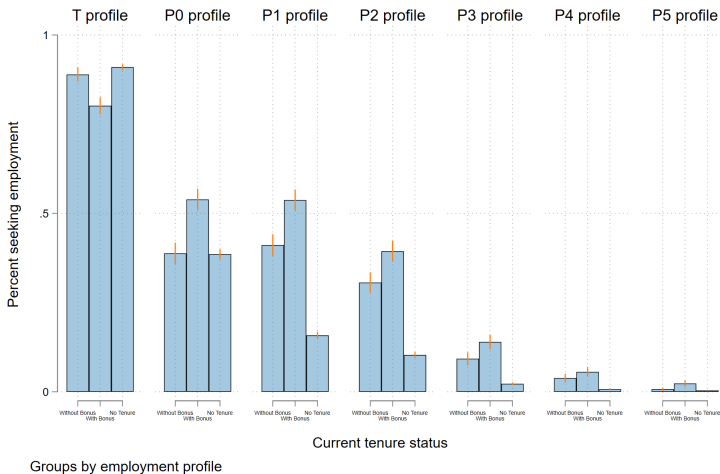


Figure 8: $z_i = 0$ (without bonus), $z_i = 1$ (with bonus), and those who have not received any offers up to and including the November 2017 drive (no tenure).

Revealed Preferences from Offer Acceptance

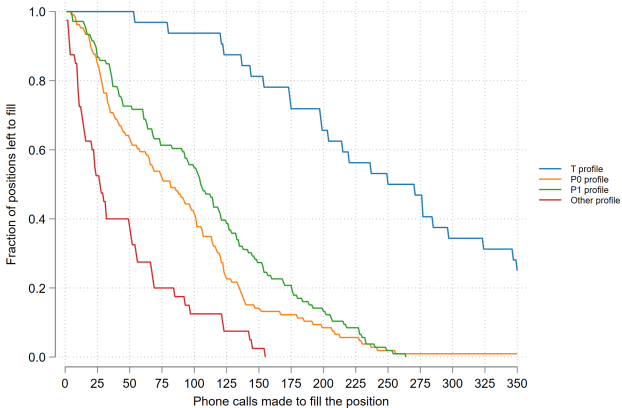


Figure 9: Ordered preferences over job profiles.

Effects of the Bonus on Offers Received

- We begin by using **teacher-job combinations** after excluding teachers who have never received offers for tenured positions:

$$offer_{ij} = \eta_0(j, r_i) + \eta_1 z_i + u_{ij}.$$

- Specification:
 - $offer_{ij} = 1$ if teacher i has received an offer for temporary job j .
 - $\eta_0(j, r_i)$ is a set of job and recruitment drive effects (year when offer with tenure was received, $r_i \in \{2013, 2015, 2016, 2017\}$).
- Not surprisingly given the preferences stated, there are differences in the offer rates between teachers with $z_i = 1$ and $z_i = 0$.
- We further adjust for the ex-ante risk of receiving offers.

- The key insight is that the sequence of phone calls made by DoE regional offices reflects an ordering determined by two variables:
 - The teacher's indication of interest in a position in the district.
 - The teacher's job-profile specific score.
- The probability of receiving a phone call is zero for positions in districts that were not flagged in the national registry.
- Conditional on interest in the district, the ex-ante probability of receiving a call depends on the demand for job profiles and the score attributed to the teacher.
- Risk-adjusted regressions control for:
 - teacher-job specific risks: p_{ij} ; or
 - teacher's average risks: $\mathbf{p}_i = [\bar{p}_i^T, \dots, \bar{p}_i^{P5}]$ (same risk across all job-profiles).

Risk-adjusted Effects on Offers Received

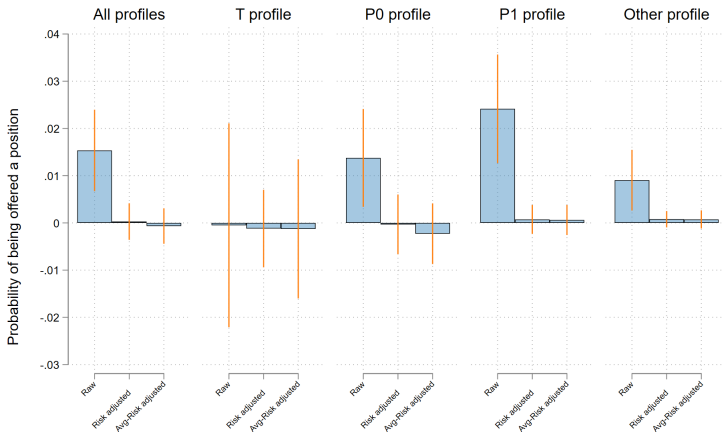


Figure 10: Risk-adjusted comparisons between bonus ($z_i = 1$) and no bonus ($z_i = 0$).

The Option Value of Waiting

The Option Value of Waiting

- How are the $z_i = 0$ and $z_i = 1$ groups compared?
 - Same ex-ante risk of receiving offers: control for $\mathbf{p}_i = [\bar{p}_i^T, \dots, \bar{p}_i^{P^5}]$.
 - Survival functions for the time taken to accept a temporary job.
 - Number of offers must increase with risk: predict the number of phone calls received from the DoE's regional offices based on \mathbf{p}_i .
- How are these comparisons carried out?
 - Keep teachers who receive the highest number of phone calls (top tertile) as predicted from \mathbf{p}_i : 7 (10%) to 84 (90%) calls.
 - Re-weight teachers to ensure the same distribution of \mathbf{p}_i .
 - Treatment-control Kaplan-Meier comparisons.
- **Assumption:** similar number of offers received for $z_i = 0$ and $z_i = 1$ teachers, with differences in this count arising from teachers' decision-making regarding acceptance.

Time to Offer Take-Up

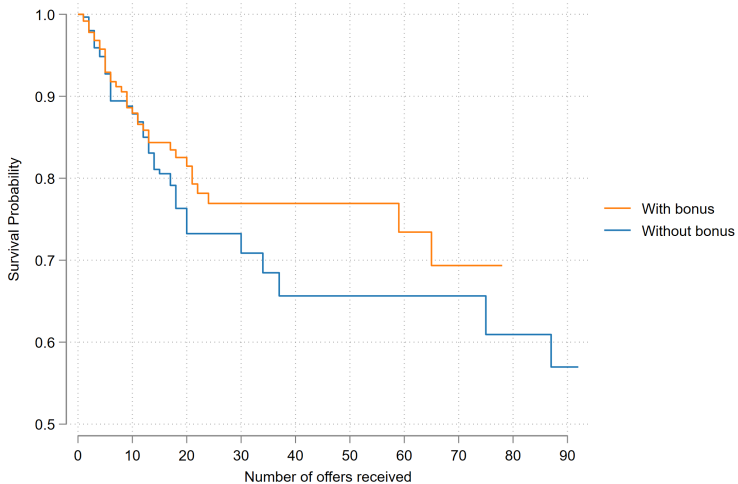
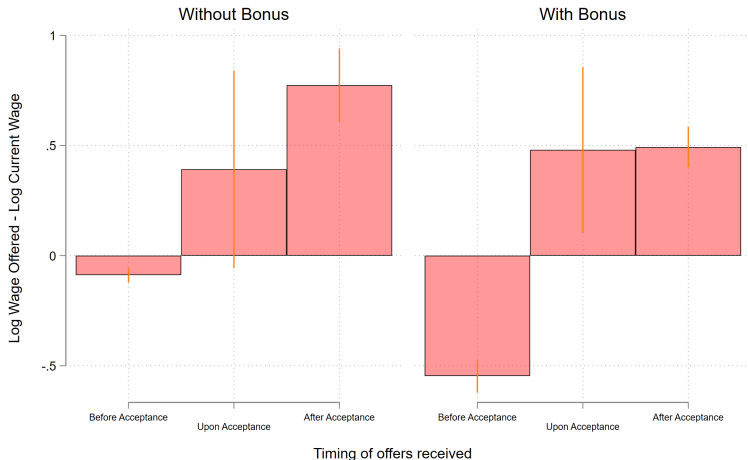


Figure 11: Re-weighted survival functions.

Forgone Earnings



Groups by status

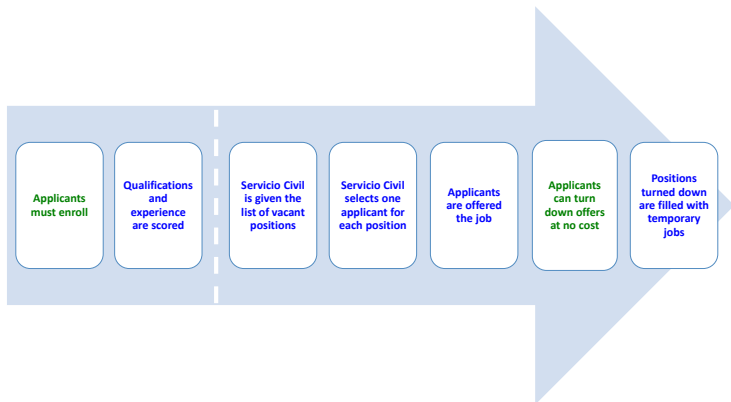
Figure 12: Difference between the wage offered and current wage.

Conclusion

- We show that experimentally-induced **unconditional** pay raises yield steeper trajectories of accomplishment for teachers.
- These wage differences fail to retain teachers at hard-to-staff schools.
- We show that teachers engage in rent extraction by considering external offers for temporary positions while enjoying enhanced job security.
- Wage differentials resulting from unconditional payments yield private returns for teachers in terms of future earnings and career progression but perpetuate inequalities in access to quality education at hard-to-staff schools.

Additional Figures

Timeline of the Recruitment Process



Back

Annual Earnings: Public Sector vs Private Sector Teachers

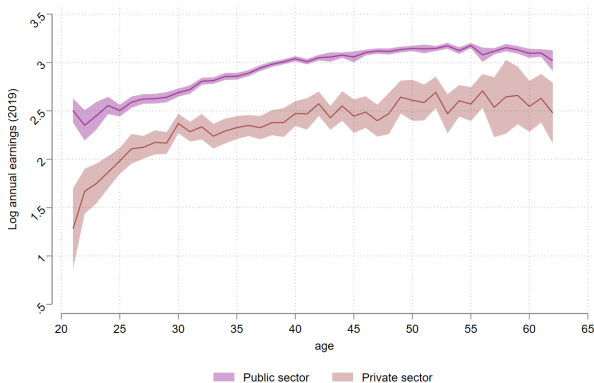


Figure 13: Age-specific averages of log annual earnings for 2019 by sector of employment. Residualized earnings from a regression on a quadratic polynomial in age and dummy for male individuals.

[Back](#)

School Districts and Administrative Geography

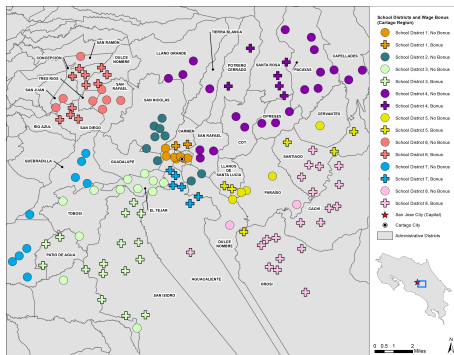


Figure 14: Only the Cartago region is considered. Same-color symbols are for schools of the same school district. Administrative district boundaries are drawn in the background. Crosses are for schools eligible for the bonus pay, and dots are for schools without the bonus.

[Back](#)

Job Profiles: T, P0 and P1

	School Enrollment					
Job Profiles	1-30	31-90	91-200	201-400	401-800	+801
Principal						
Teacher						

[Back](#)

Job Profiles: T, P0 and P1

	School Enrollment					
Job Profiles	1-30	31-90	91-200	201-400	401-800	+801
Principal	P0	P1				
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[Back](#)

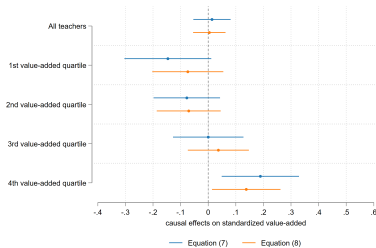
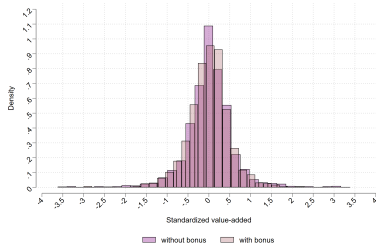


Figure 15: Effects on teacher value-added (dropout rates).

Back