Information Friction and the Labor Market for Public School Teachers

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- One major obstacle to achieving this goal: information friction.
  - Teacher effectiveness is not strongly correlated with observable characteristics: It is hard to identify effective teachers upon hire.
  - Through daily interactions and observations, a teacher's employer can learn about her quality and thus has an information advantage about the teacher over other schools.

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        - There is little wage variation across schools for the same teacher.
        - The relative attractiveness of a school largely lies in non-pecuniary factors (e.g., student body).
    - In a typical labor market, optimality is largely equivalent to efficiency. However, in the case of teacher-school sorting, equity—providing students with equal access to effective teachers—is at least as important as efficiency.

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  - On the other hand, the market is not closed. The easier upward job mobility may pull effective teachers into the market, with whom schools can replace their ineffective incumbent teachers, thereby improving the overall quality of teachers in the market.
- The equity-efficiency implication of breaking information asymmetry becomes an empirical question, which we answer in this paper.

Background

- Our setting: the Houston Independent School District (HISD)
  - The largest in Texas and the 8th largest in the U.S.
  - Independent of the city of Houston and all other municipal and county jurisdictions.
  - Teachers in HISD do not have tenure and most are on one-year contracts, leaving schools with significant latitude in terms which teachers to hire and which teachers to exit.
- Two major policies introduced during our sample period (2007 to 2014): ASPIRE and ETI.

Background

- ASPIRE: a performance pay scheme, introduced in 2006-2007.
  - Each teacher is assigned a teacher-level value-added measure known as the EVAAS score.
  - Two types of rewards (detailed eligibility and reward amounts changed overtime)
    1. Individual rewards: Teachers with EVAAS scores above certain thresholds (e.g., 75th percentile in the district).
    2. Campus rewards: All eligible teachers employed at high-performance growth schools.
- Information: a teacher's EVAAS score was confidential but the list of ASPIRE winners and their reward amounts were widely disseminated information.
  - Prospective employers know whether or not one's EVAAS is in the top quartiles.

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- ETI: The Effective Teachers Initiative, introduced in 2010-2011.
- The cornerstone of ETI is a teacher evaluation system.
  - By 2012-13, fully developed to include three component scores: 1) instructional practice, 2) professional expectations, and 3) student performance.
  - 1) and 2) are based on in-person observations and scored using a standardized assessment form.
  - 3) is based on EVAAS and other teacher-value added measures.
- Other changes under ETI include, e.g., providing teachers with feedback on progress and opportunities for development.

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  - ETI significantly changed the information structure in the HISD teachers' labor market.

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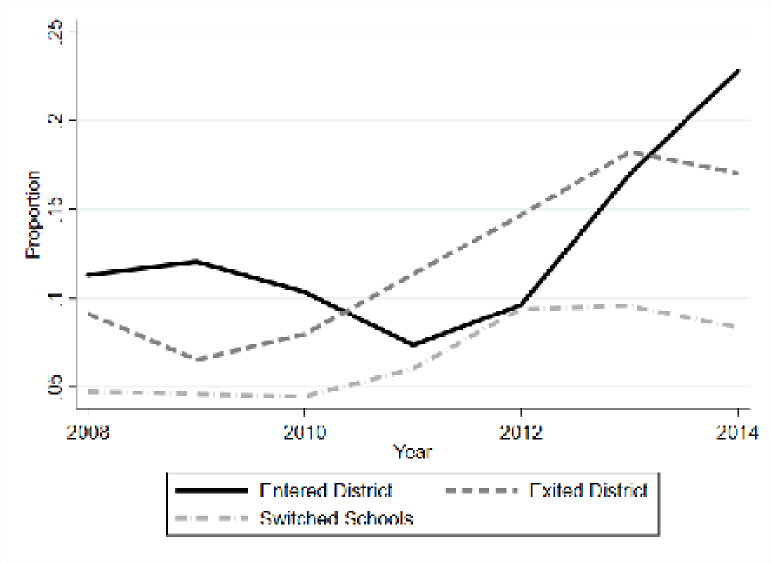
- We estimate teachers' preferences over schools and schools' preferences over teachers using post-ETI data and validate the model using pre-ETI data.
- Using the estimated model, we evaluate the role of information on the market and study counterfactual teacher bonus schemes to improve both efficiency and equity.

A Glance at the Market: Pre vs Post ETI

- Job Mobility



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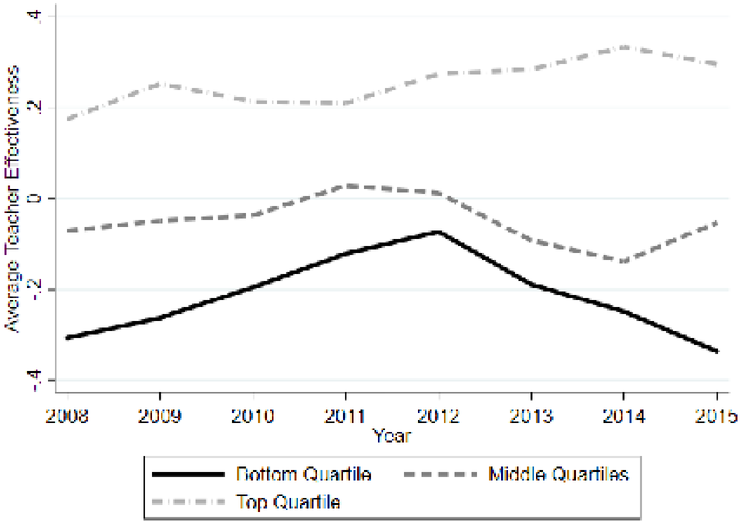
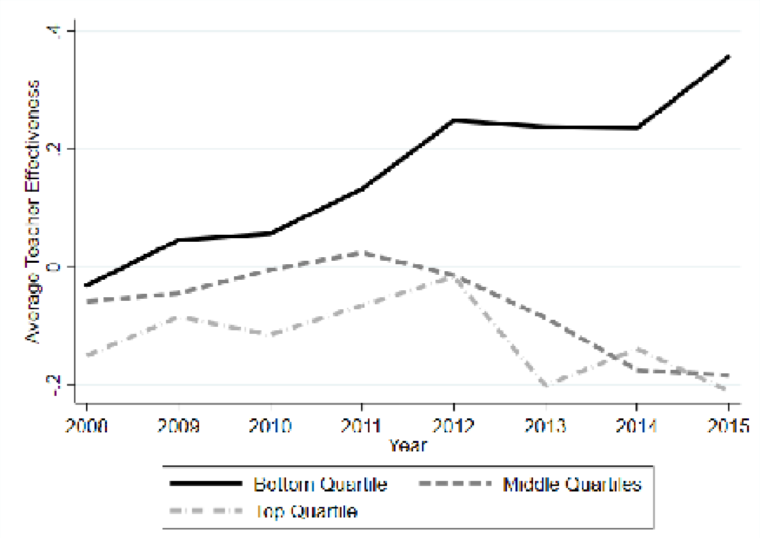
- Average teacher effectiveness in schools grouped by fraction of students meeting standard



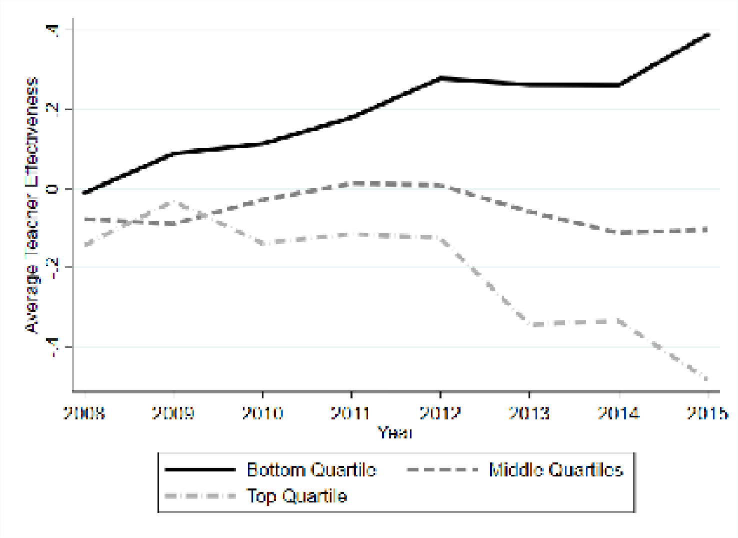
A Glance at the Market: Pre vs Post ETI

- Average teacher effectiveness in schools grouped by fraction of economically disadvantaged students



A Glance at the Market: Pre vs Post ETI

- Average teacher effectiveness in schools grouped by fraction of minority students



Pre vs. Post

- These pre- versus post-ETI figures provide some suggestive evidence that, under ETI, teachers' job mobility increased and teacher-school sorting became more assortative.
- However, they cannot be interpreted as the effect of reducing information friction, because market conditions differ in other aspects before and after ETI (e.g., the great recession).
- To isolate the role of information in shaping the equilibrium allocation and to conduct counterfactual policy analysis, we need a model.

Model: Primitives

- There is a distribution of teachers and S schools in a district/market.
- A teacher is characterized by (x, q, v, s_0)
  - $x = [x_{1,} x_2]$: teacher experience and education
  - (q, v) : two measures of teacher effectiveness
    q : EVAAS scores; v : ETI scores based on in-person evaluations.
  - s_0: the school one is attached to at the beginning of the model.
    $s_0 \in \{1, ..., S\}$ for district incumbent teachers, $s_0 = 0$ for potential entrants.
- School s is characterized by (z_s, κ_s)
  - z_s: a vector of school characteristics, including z_{s1} (student composition).
  - κ_s : capacity.

Model: Timing

1. Schools simultaneously make job offers to teachers.
2. A teacher observes her taste shocks and chooses her most preferred option within her offer set, which always includes the outside option.

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- Information on (q, v) varies across policy eras and across schools.

Model: Information Structure

Table 1: School's Information Set $\Gamma_s(x, q, v, s_0)$

	District Incumbent Teacher		Potential Entrant
	Current school ($s = s_0$)	Other schools ($s \neq s_0$)	All schools
Pre-ETI	x,q,v,s_0	$x,A(q),s_0$	x,s_0
ETI	x,q,v,s_0	x,q,v,s_0	x,s_0

- $\Gamma_s(x, q, v, s_0)$: the set of information available to school s about teacher (x, q, v, s_0).
- $A(q)$: ASPIRE award outcome.
- The researcher observes school characteristics (z, κ), teacher characteristics (x, q, v, s_0) for all incumbents and entrants, and the distribution of (x, q, v) for potential entrants.

Model: Teachers' Preferences

- Teachers' utility of working in school s, net of moving costs

$$\begin{aligned} U_s(x, q, v, s_0) &= W(x, q, v, z_s) + z_s\alpha_0 + z_{s1}(\alpha_1 q + \alpha_2 v) \\ &\quad - I(s \neq s_0)(d_1 + d_2 x_1). \end{aligned}$$

  - $W(\cdot)$: the pay function set by the district.
  - α_0 : teachers' preferences for school characteristics;
  - α_1 and α_2 capture potentially different preferences for student composition (z_{s1}) among teachers with different q and v.
  - d_1 and d_2 capture the cost of moving and how it may vary by experience.
  - To avoid the problem of multiple equilibria (teachers' coordination), we assume that teachers use previous-year campus reward outcomes to infer which schools are eligible for campus reward (part of z_s).

- The value of the outside option, net of moving costs:

$$U_0(x, q, v, s_0) = u_0(x, q, v, s_0) - I(0 \neq s_0)(d_1 + d_2 x_1).$$

Model: Incumbent Teachers' Problem

- District Incumbent Teachers' Problem

$$V_1\left(x, q, v, s_0, \epsilon\right) = \max_{s: o_s\left(x, q, v, s_0\right)=1} \left\{ U_s\left(x, q, v, s_0\right) + \epsilon_s \right\}$$

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  - ϵ_s is an i.i.d. taste shock.

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- A potential entrant's problem is
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$$\max\left\{\max_{s:o_s(\cdot)=1}\left\{\begin{array}{l} U_s(x, q, v, 0) + \epsilon_s + \\ \beta E\left[V_1(x, q, v, s_0 = s, \epsilon')\right]\end{array}\right\}, U_0(\cdot) + \epsilon_0\right\}.$$

Model: Schools' Preference

- A teacher's value to school s may vary by school characteristics z_s, given by

$$B\left(x, q, v, z_s\right)$$

$B\left(\cdot\right)$ is weakly increasing in teacher traits x, q, and v.

Model: Schools' Problem

- For a teacher (x, q, v, s_0), a school observes $\Gamma_s(x, q, v, s_0)$; based on this information, a school makes its job offer decision $O_s(\Gamma_s(\cdot)) \in [0, 1]$ to maximize the total expected value from its hired teachers:

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  - Both $h_s(\cdot)$ and $\overline{B}_s(\cdot)$ are derived from the teachers' acceptance probabilities $P_s(x, q, v, s_0)$ implied by teachers' optimal decisions.

Model: Equilibrium

- An equilibrium requires that

  1. teachers accept job offers optimally;
  2. given their belief about teachers' acceptance probabilities $\{P_s(x, q, v, s_0)\}$, schools choose job offers optimally;
  3. belief about $P_s(\cdot)$ be consistent with decisions made by teachers and schools.[6]

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- Relaxing information friction will make it easier for high-quality teachers to get more job offers and move to more desirable schools.
- This will affect not only school-teacher sorting among incumbent teachers, but also teacher entry and exit.

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  2. Given 1) and 2) estimated in Stage 1, we allow parameters in 3) to differ across the two periods (e.g., recession effects).
     - Estimate pre-ETI outside value parameters by matching pre-ETI exit and entry moments *only*.
     - We then use all the other auxiliary models computed from the pre-ETI data to validate our model.

Identification

- A challenge involved in identification is the fact that the researcher observes only the accepted offers, rather than all offers made.
- To separately identify teacher preferences and school preferences, we fully exploit the school's optimization problem.

Identification: Optimal Job Offers and Observed Matches

- The expected marginal benefit of hiring a teacher for school s given its information set $\Gamma_s(\cdot)$ is given by $\overline{B}_s(\Gamma_s(x, q, v, s_0))$. The marginal cost is the shadow price of a slot, which is common for all teachers.

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- If school s hired teacher i, then teacher j must also have had an offer from s if j has weakly higher x, q, v than i.
- From observed matches, we can construct, for each teacher, a subset of all offers they received $\widetilde{O}_i$.
- Teachers' choices within $\widetilde{O}_i$ inform us of their preferences, because all schools in $\widetilde{O}_i$ are viable choices.

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- For each teacher i, the entire set of schools S is

$$S = O_i \cup (S \backslash O_i)$$

O_i : offer set (of which $\widetilde{O}_i$ is a subset), non-offer set $S \backslash O_i$.

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- The discrepancy between the two sets of inferred teacher preferences depends on the composition of $S \backslash O_i$ for each teacher i; $S \backslash O_i$ in turn is governed by schools' preferences over teachers.
- We can learn about schools' preferences from this discrepancy: Schools' preference parameters have to generate not only the observed offers, but also the lack of offers ($S \backslash O_i$ for each teacher i) that would reconcile this discrepancy.

Auxiliary Models

- We design auxiliary models closely following the identification argument, which include, e.g.,
  - Two regressions of the same format characterizing teacher-school matches:
    - In one, a teacher chooses from the inferred subset of offers.
    - In the other, a teacher chooses from ALL schools.
  - Moments that capture teacher entry patterns.

Data

- Our data consists of three linked data sets from HISD (2008-2015)
  - **Teacher Data:**
    - Panel data on HISD teachers: education, experience, EVAAS scores, school and class identifiers, grades and subjects taught, and wages. For post-ETI years, ETI component scores.
    - Texas Academic Performance Reports: the distribution of teachers' experience and education (x) in all 64 non-HISD districts in Houston MSA (potential entrants).
    - Assuming the conditional distribution $F(q, v|x)$ is the same bw teachers in HISD and *potential* entrants, we obtain the joint distribution of $F(q, v, x)$ for the latter.
  - **Student Data:** demographics and state standardized test scores for all public school students.
  - **School Data:** Common Core and the Texas Education Agency.

Summary Statistics

Summary Stats: Teacher Characteristics

	All	Incumbents	Entrants
Experience	9.74 (8.9)	11.07 (8.89)	4.51 (6.72)
Graduate Degree	0.28	0.29	0.23
q	-.06 (1.02)	0.01 (1.00)	-0.34 (1.06)
v	-.09 (0.85)	0.02 (0.81)	-0.53 (0.86)
# Teachers	2,033	1,620	413

Summary Statistics

School Summary Stats (Post-ETI)

	All		Bottom Quar z_1		Top Quar z_1	
z_1 Fr(students above std)	0.73	(0.15)	0.52	(0.07)	0.90	(0.04)
Fund/teacher ($1,000)	21.35	(6.51)	25.48	(9.76)	20.74	(4.82)
Capacity (# slots)	10.23	(3.86)	7.67	(3.15)	12.10	(4.29)
# Schools	169		42		42	

Summary Statistics

Outcome Sorting, Entry, and Exit (post-ETI)

A. Average School Employee Characteristics[a]			
School Group by z_1	Experience	q	v
Quartile 1	8.00	-0.46	-0.24
Quartile 2	8.85	-0.18	-0.15
Quartile 3	9.99	0.01	-0.08
Quartile 4	10.49	0.24	0.03
B. Entry and Exit			
Exit rate	0.19	$\frac{\#Entrants}{\#Stayers}$	0.24

[a] School-level teacher characteristics, cross-school std dev in paretheses

Parameter Estimates

Parameter Estimates: Teacher Preferences

wage (\$1,000)	1 (normalized)	Outside opt. (incumbents)	
z_1(Fr. students above std)	16.65	constant	109.63
$z_1 \times q$	14.61	experience	2.10
$z_1 \times v$	8.04	retirement age	7.70
funding/teacher (\$1,000)	0.09	grad degree	4.39
moving: $I(s \neq s_0)$	-69.11	q	18.04
$I(s \neq s_0)$ $\times$experience	-1.29	v	5.44
σ_ϵ	10.04	Outside opt. (entrants)	
		constant	57.01
		experience	0.71
		grad degree	2.04
		q	16.40
		v	10.79

- Higher-quality teachers have stronger preferences for higher-performing schools.

Parameter Estimates

- $B(x, q, v, z_1)$ is weakly increasing in (x, q, v) and varies with z_1

Parameter Estimates: School Preferences

q (value-added)	$\exp(0 + b_1 z_1)$	graduate degree	0.10
constant	0	Yrs of experience:	
b_1	1.60	1-2	1.09
		3-4	1.30
v (daily practice)	$\exp(b_2 + b_3 z_1)$	5-8	1.53
b_2	-0.12	9-13	1.53
b_3	0.42	≥ 14	1.53

- Schools value whether or not one has ever taught, beyond which, teachers' experience and education per se are not very important.
- Both q and v are increasingly more valued (relative to x) in higher-performing schools.
- All schools value q more than v.

Parameter Estimates

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Parameter Estimates

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  - Without frictions, these preferences would directly lead to assortative matching between teachers and schools, leaving lower-performing schools behind.
  - Sorting can be less assortative with information friction, as schools are reluctant to hire teachers from other schools in fear of the winner's curse.

Model Fit

Model Fit: OLS of Teacher-School Match (Post-ETI)

Teacher's Choice Set	Inferred Offer Set		All Schools	
	Data	Model	Data	Model
wage	0.001	0.001	0.0004	0.0003
funding	0.00004	0.00005	0.00001	-0.00001
$I\left(s = s_0\right)$	0.839	0.904	0.708	0.676
$\times$ experience	0.0002	-0.0022	0.003	0.005
z_1	0.004	0.004	0.002	0.001
$\times q$	-0.002	-0.002	0.001	0.003
$\times v$	-0.002	-0.003	-0.00008	0.0001
$I\left(s = 0\right)$	0.264	0.212	0.236	0.179
$\times$ experience	-0.003	0.002	-0.003	0.001
$\times$ retirement age	0.104	0.070	0.088	0.078
$\times$ grad degree	0.034	0.026	0.034	0.020
$\times q$	-0.002	0.002	-0.010	-0.015
$\times v$	-0.03	-0.03	-0.048	-0.048

Model Fit

Model Fit: Average School Employee Characteristics (Post-ETI)

	Experience		q		v	
School z_1	Data	Model	Data	Model	Data	Model
Quar 1	8.00	7.83	-0.46	-0.45	-0.24	-0.23
Quar 2	8.85	8.72	-0.18	-0.23	-0.15	-0.18
Quar 3	9.99	9.59	0.01	0.11	-0.08	-0.003
Quar 4	10.49	10.55	0.24	0.33	0.03	0.09

Model Fit

Model Fit: Entry and Exit

	Entrants Characteristics		Entrants Characteristics$\times z_1$	
	Data	Model	Data	Model
Experience	4.54	4.53	3.13	3.24
Grad Deg.	0.23	0.20	0.15	0.15
q	-0.34	-0.39	-0.20	-0.24
v	-0.53	-0.56	-0.38	-0.39
$E\left(z_1 \middle| entrants\right)$	0.70	0.71		
$\frac{\#Entrants}{\#Stayers}$	0.24	0.23		
Switching rate	0.08	0.07		
Exit rate	0.19	0.19		

Counterfactual Experiment

- Using the post-ETI data (initial conditions), we simulate the counterfactual equilibrium where we revert to the pre-ETI information structure.

Average School Employee Characteristics

	Experience		q		v	
School z_1	Base	New	Base	New	Base	New
Quar 1	7.83	8.14	-0.45	-0.42	-0.23	-0.20
Quar 2	8.72	8.85	-0.23	-0.22	-0.18	-0.16
Quar 3	9.59	9.62	0.11	0.09	-0.003	-0.004
Quar 4	10.55	10.47	0.33	0.29	0.09	0.06

Conclusion

- We have developed an equilibrium model of the market of public school teachers, with asymmetric information between a teacher's current employer and prospective employers.
- We are estimating the model using data from HISD after a transparent teacher evaluation system was introduced.
- To do:
  - Model Validation
  - Counterfactual bonus schemes to improve educational efficiency and equity, with versus without information friction.

Simplification

- An equilibrium boils down to a fixed point of teachers' acceptance probabilities $\{P_s(\cdot)\}_s$. However, forming exact beliefs about the high dimensional objects $\{P_s(\cdot)\}$ is a daunting task for any decision maker.
- We assume that schools make decisions based on a simplified parametric belief function $\widetilde{P}_s(\cdot;\zeta)$:

$$\widetilde{P}_s(x, q, v, s_0; \zeta) = \frac{\exp(g(x, q, v, s_0, s; \zeta))}{1 + \exp(g(x, q, v, s_0, s; \zeta))}.$$

- $\widetilde{P}_s(\cdot)$ captures all the factors governing its counterpart $P_s(\cdot)$
  - Teachers' preference over schools: salaries, school characteristics, moving costs.
  - The overall quality of the teacher: A school should expect more competitors for a better teacher.
  - Information and concerns about the lemon's problem.3

Related Literature

- Information Asymmetry and Labor Market Allocation
  - Theory work (e.g., Waldman 1984; Greenwald 1986; Lazear 1986; Milgrom and Oster 1987; Riordan and Staiger 1993; Laing 1994)
  - Empirical work (e.g., Gibbons and Katz 1991; Acemoglu and Pischke 1998; Schönberg 2007; Zhang 2007; Pinkston 2009; Hu and Taber 2011; DeVaro and Waldman 2012; Kahn 2013; Bognanno and Melero 2016; Cassidy et al. 2016).
    - Bates (2020) tests the existence of asymmetric employer learning in NC teachers' labor market.

Related Literature

- Teacher mobility and education inequality: Lankford et al. (2002), Ingersoll et al. (2004), Hanushek et al. (2004), Clotfelter et al. (2005), Jacob (2007), Mansfield (2015)
- HISD context: Brehm et al. (2017) and Imberman and Lovenheim (2015) on ASPIRE. Cullen et al. (2016) on ETI
- Structural work on the labor market of teachers
  - Individual decision models: Stinebrickner (2001a, 2001b), Scafidi et al. (2003), Boyd et. al (2005), Wiswall (2007), Behrman et al. (2016), Lang and Palacios (2018)
  - Equilibrium models: Boyd et. al (2013), Tincani (2020), Bates et al. (2022), Bobba (2022), Biasi et al. (2022)

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- Using the post-ETI data (initial conditions), we simulate the counterfactual equilibrium where we revert to the pre-ETI information structure.

Mobility

	Base	New
$\frac{\#Entrants}{\#Stayers}$	0.23	0.22
Switching rate	0.07	0.06
Exit rate	0.19	0.19