Understanding School Competition Under Voucher Regimes

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January 4, 2019
2019 ASSA Conference

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- Research:
  - Mixed effects on test scores
  - Positive effects on graduation
  - Nonrandom migration to the private sector
  - Supply side?
- This paper:
  1. How do (private) schools respond to vouchers?
  2. How do such responses affect students' welfare?

This Paper

- Structural model of school competition with vouchers
  - Inspired by Chile's case, but encompasses other settings
- Two voucher designs:
  - *Universal:* all students receive voucher; all schools participate
  - *Targeted:* disadvantaged students receive voucher; private schools choose whether to participate
- Differentiated schools choose:
  - Program participation
  - Tuition

Preview of Results

- A higher *targeted* voucher:
  - Attracts more and higher quality schools to the program
  - Benefits disadvantaged students
- A higher *universal* voucher:
  - Induces schools to lower tuition
  - Benefits both disadvantaged and non-disadvantaged students
- Higher voucher amounts increase students' welfare, and government's spending
- Two equally costly programs (i.e. voucher combinations) may have different consequences
- The optimal design depends on the policymaker's preferences and budget constraint

Literature Review

- Effects of vouchers

  Epple et al. (2017), Angrist et al. (2002, 2006), Hoxby (2003), Chakrabarti (2008), Hsieh and Urquiola (2006), Wolf et al. (2010a, 2010b), Chingos and Peterson (2015), Sánchez (2017), Rau et al. (2018), Abdulkadiroglu et al. (2018)

- IO of Education Markets

  Ferreyra (2007), Dinerstein and Smith (2014), Bau (2017), Gazmuri (2017), Neilson (2017), Ferreyra and Kosenok (2018), Singleton (2018), Walters (2018)

Chile's Voucher System

Voucher Policies, by School-type (year 2013)

school-type:	public	private-voucher		private-non-voucher
in targeted voucher program:	yes	yes	no	no
receive universal voucher	✓	✓	✓	✗
receive targeted voucher	✓	✓	✗	✗
can charge tuition	✗	to non-disadv.	✓	✓
enrollment (%)	40	35	17	8

Size of the voucher subsidies (year 2013):

- Universal: $1,220
- Targeted: $717

Chile's Elementary Education System

Schools' Characteristics, by School-type (year 2013)

school-type:	public	private-voucher		private-non-voucher
in targeted voucher program:	yes	yes	no	no
enrollment - disadv. (%)	52	38	10	1
enrollment - non-disadv. (%)	27	31	26	16
avg. annual tuition ($)	0	0/121	711	4,960
teachers with specialization (%)	41	46	55	57

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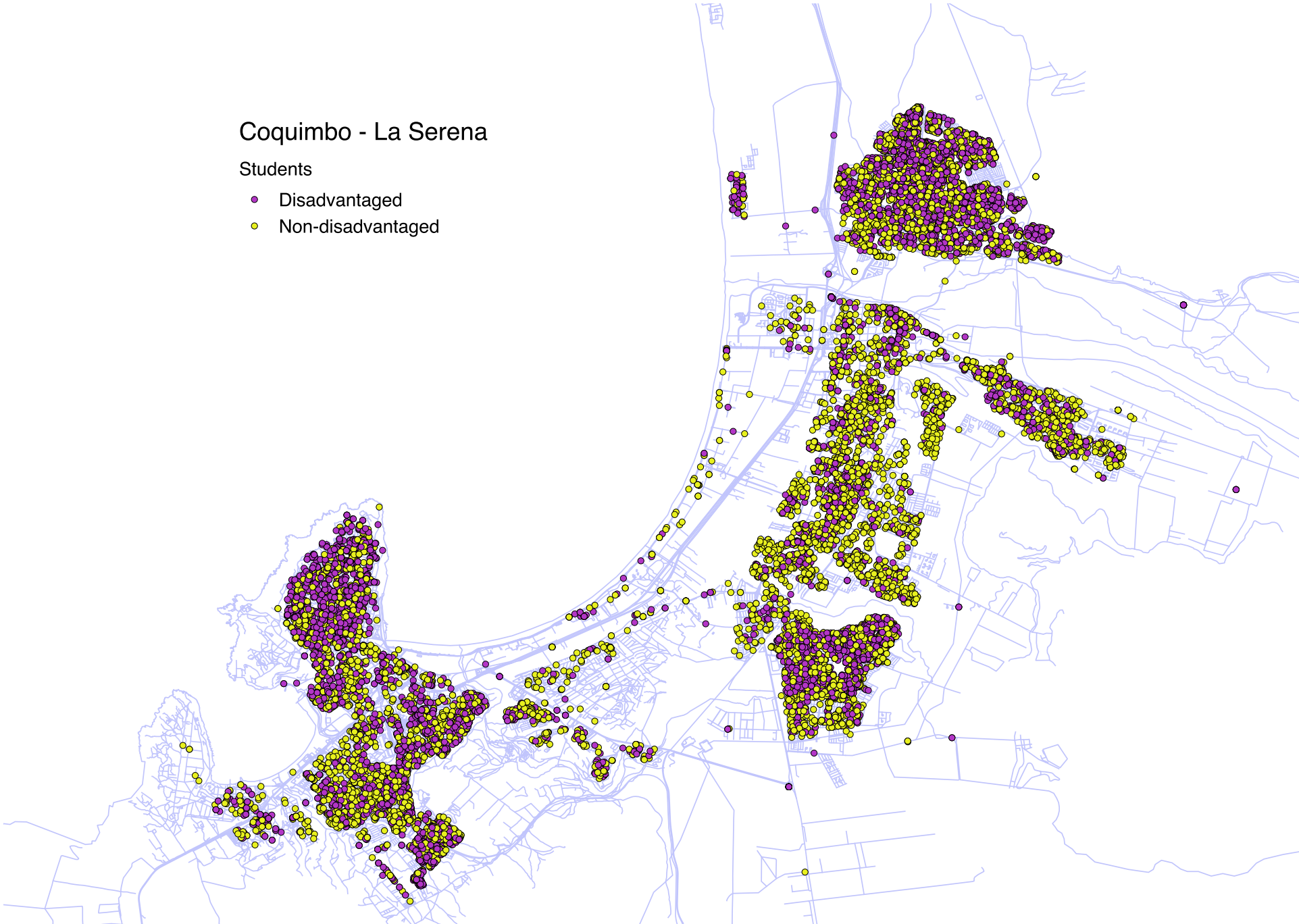
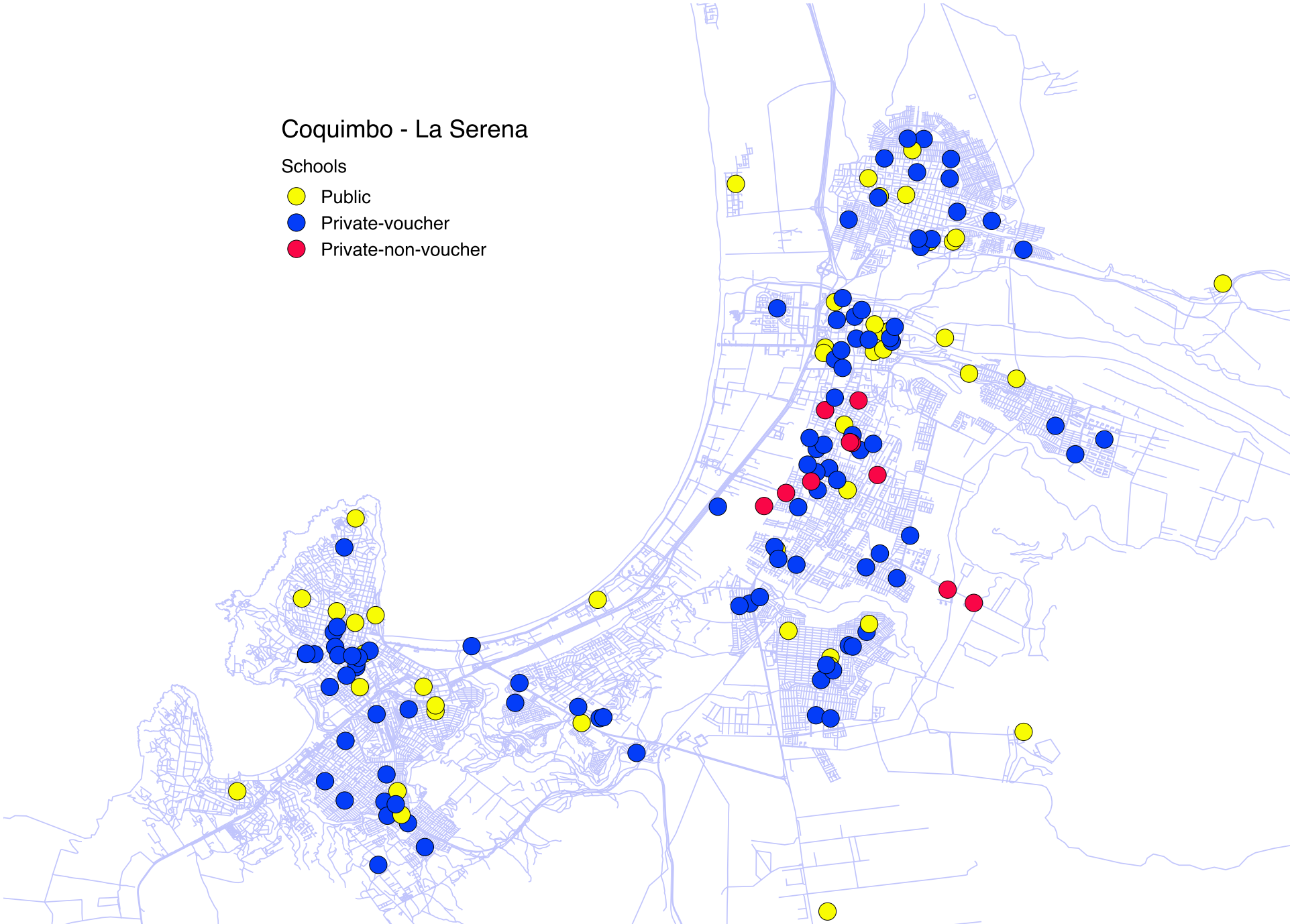
Education Markets

Education Markets

- Education markets defined by the union of all contiguous urban areas (Gazmuri, 2015; Neilson, 2017)
- Non-overlapping markets
- I focus on large markets (i.e. 10,000+ elementary students)
- 28 large markets across the country

MarketsChar


Coquimbo - La Serena
Students
Disadvantaged
Non-disadvantaged


Coquimbo - La Serena
Schools
Public
Private-voucher
Private-non-voucher

Model

Demand

- The indirect utility that student i gets from attending school j is:

$$U_{ij} = \beta_{1i} p_{ij} + \beta_2 d_{ij} + \beta_3' X_j + \xi_j + \varepsilon_{ij},$$

where

  - $\beta_{1i} = \beta_1 + \sum_r z_{ir} \beta_{1r}$
  - $p_{ij} = (1 - D_i \tau_j) p_j$

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  - $p_{ij} = (1 - D_i \tau_j) p_j$

- Assuming $\varepsilon_{ij} \sim$ TIEV, the probability that student i chooses school j is logistic:

$$P_{ij} = \frac{e^{\mu_{ij} + \delta_j}}{\sum_k e^{\mu_{ik} + \delta_k}}$$

Supply

- I model private-voucher schools decisions:
  - Program participation
  - Tuition

Supply

- I model private-voucher schools decisions:
  - Program participation
  - Tuition
- Profit maximization:

$$\max_{\tau_j \in \{0,1\}, p_j \geq 0} \quad E[\Pi_j] = E_{\tau_{-j}} \Bigg[(p_j + v^u - c_j) \sum_i (1 - D_i) P_{ij}(\cdot) + \tau_j (v^u + v^t - c_j) \sum_i D_i P_{ij}(\cdot) - \tau_j \kappa_j + (1 - \tau_j)(p_j + v^u - c_j) \sum_i D_i P_{ij}(\cdot) \Bigg]$$

- c_j public information, κ_j private information

Optimality conditions: p_j

- In-program:

$$p_{j|\tau_j=1}(\tau) \quad \leq \quad c_j^{nonD} - v^u - \frac{\sum_i (1-D_i) P_{ij}(\cdot)}{\sum_i (1-D_i) \frac{\partial P_{ij}(\cdot)}{\partial p_j}},$$

- Not in-program:

$$p_{j|\tau_j=0}(\tau) \quad \leq \quad c_j^{D\&nonD} - v^u - \frac{\sum_i P_{ij}(\cdot)}{\sum_i \frac{\partial P_{ij}(\cdot)}{\partial p_j}},$$

Optimality conditions: τ_j

$$\tau_j \quad = \quad \mathbb{1}\left\{E_{\tau_{-j}}\left[\Pi_{j|\tau_j=1}(\tau_{-j}) - \Pi_{j|\tau_j=0}(\tau_{-j})\right] - \kappa_j > 0\right\}$$

Equilibrium

- Related to *Cursed Equilibrium* concept (Eyster and Rabin, 2005)
- Each school makes decisions based only on its own type and a belief of the expected equilibrium in the market

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- Equilibrium is defined as a set of participation probabilities, $(u_1, \ldots, u_J)$, and tuitions, $(p_1, \ldots, p_J)$, such that:
  - Schools' profits are maximal given their beliefs about the expected equilibrium
  - Beliefs are consistent

Estimation and Identification

- Identification is ensured through a combination of instruments, functional form assumptions, and economic theory

Demand:

- Two-step procedure (Hackmann, 2018)
- Instruments: non-price attributes of all other schools in the market (BLP)

Demand Estimation

Supply:

- I parameterize $c_j = X_j\omega_1 + \epsilon_j$, and $\kappa_j = W_j\lambda + \nu_j$
- Tobit model for p_j, probit model for τ_j
- GMM - NFXP

Supply Estimation

Data

- 28 geographic markets for the year 2013
- 662,237 students and 2,224 schools (959 public, 1,110 private-voucher, 155 private-non-voucher)
- Covariates:
  - p_j: annual tuition
  - d_{ij}: distance from home to school
  - X_j: public, secular, rural, proxies for school's unobserved and teachers quality
  - z_{ir}: mother's level of education
  - Z_j: other schools' unobserved and teachers quality, type

Summary Statistics Quality Construction

Data

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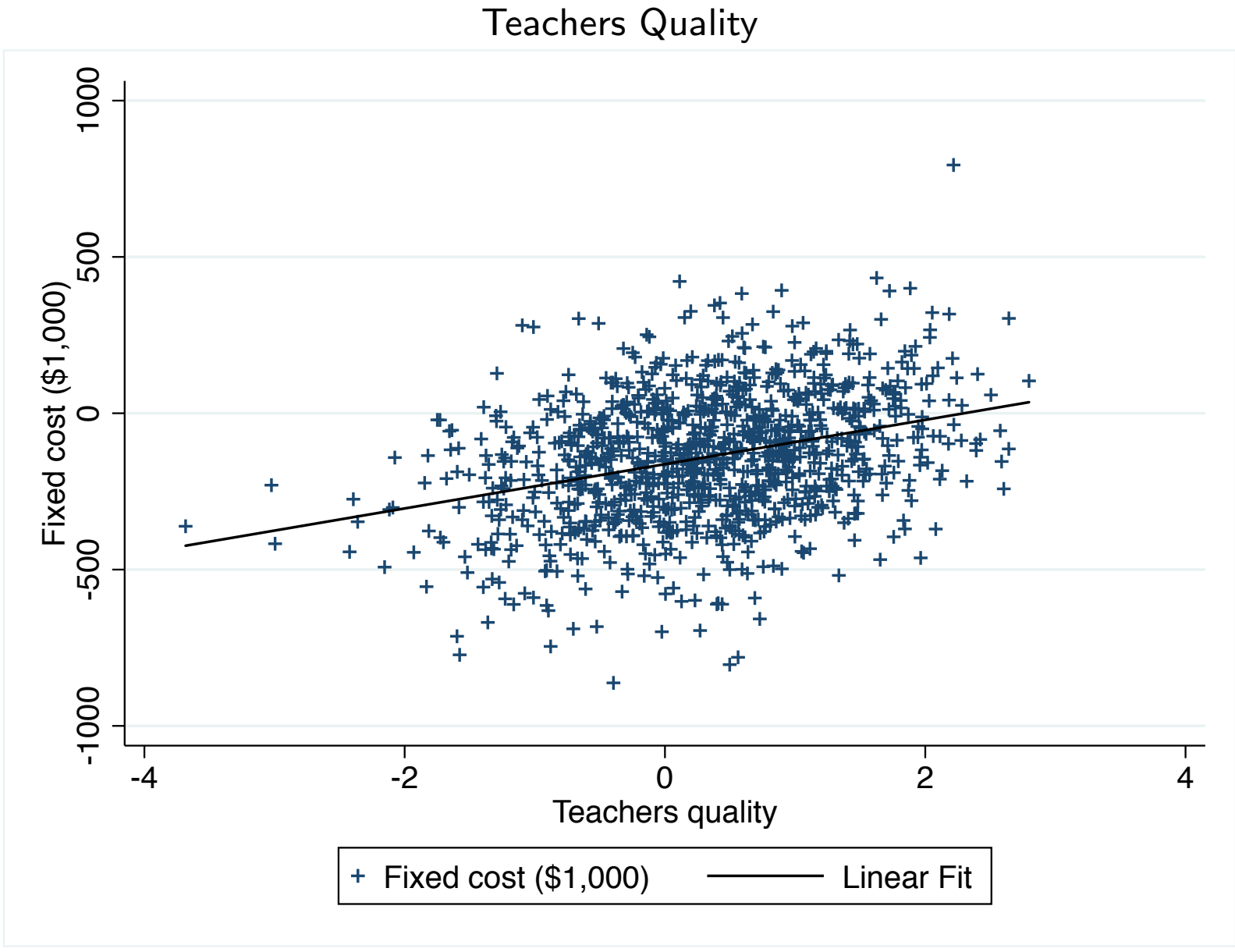
Summary Statistics Quality Construction

Results: Estimated Costs

	mean	median
marginal cost ($):		
$c_j^{D\&nonD}$	553	595
c_j^{nonD}	237	279
participation cost ($1,000):		
κ_j	-158	-156

Demand Coef Supply Coef GOF

Results: School Quality vs. Participation Cost

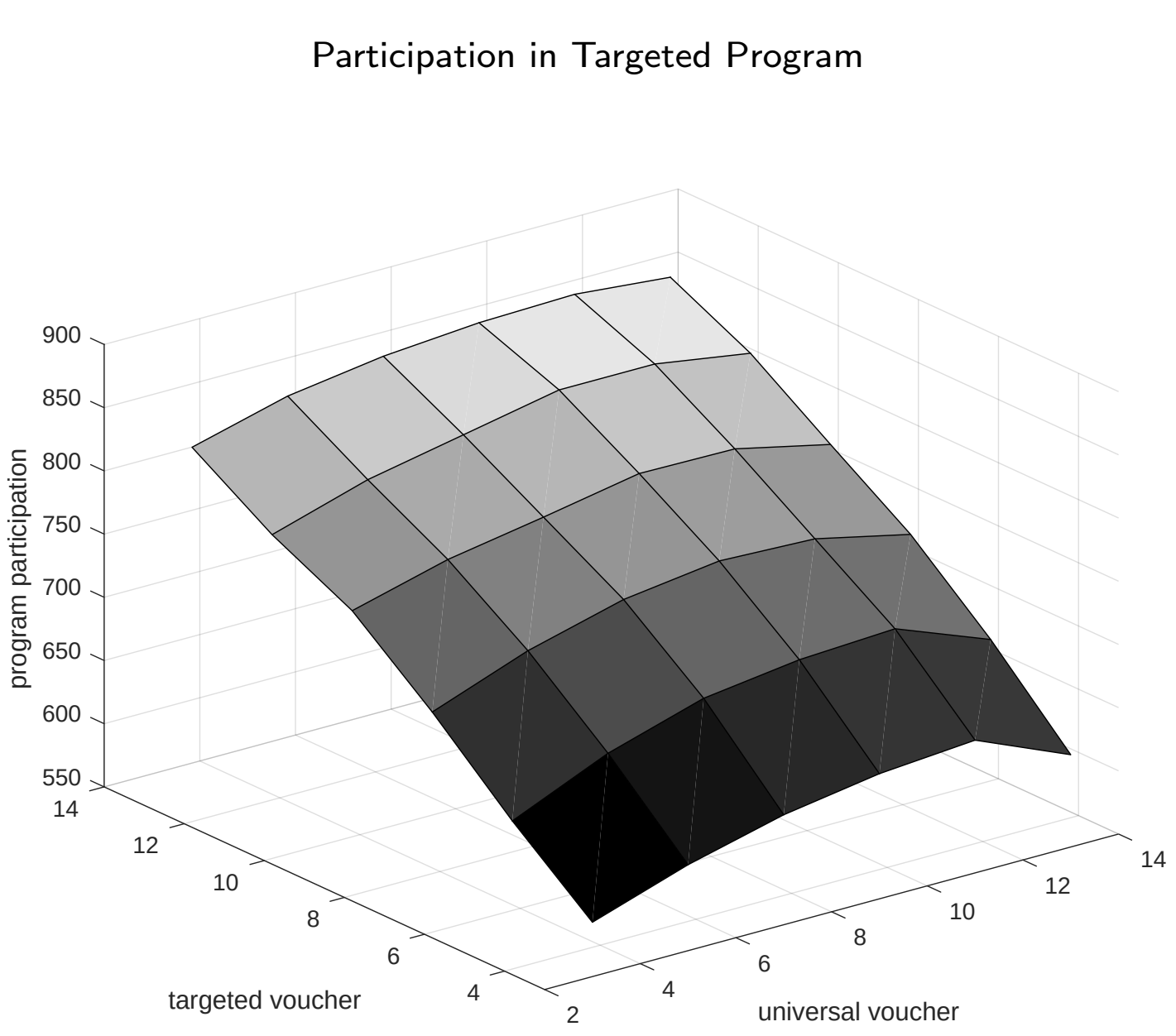


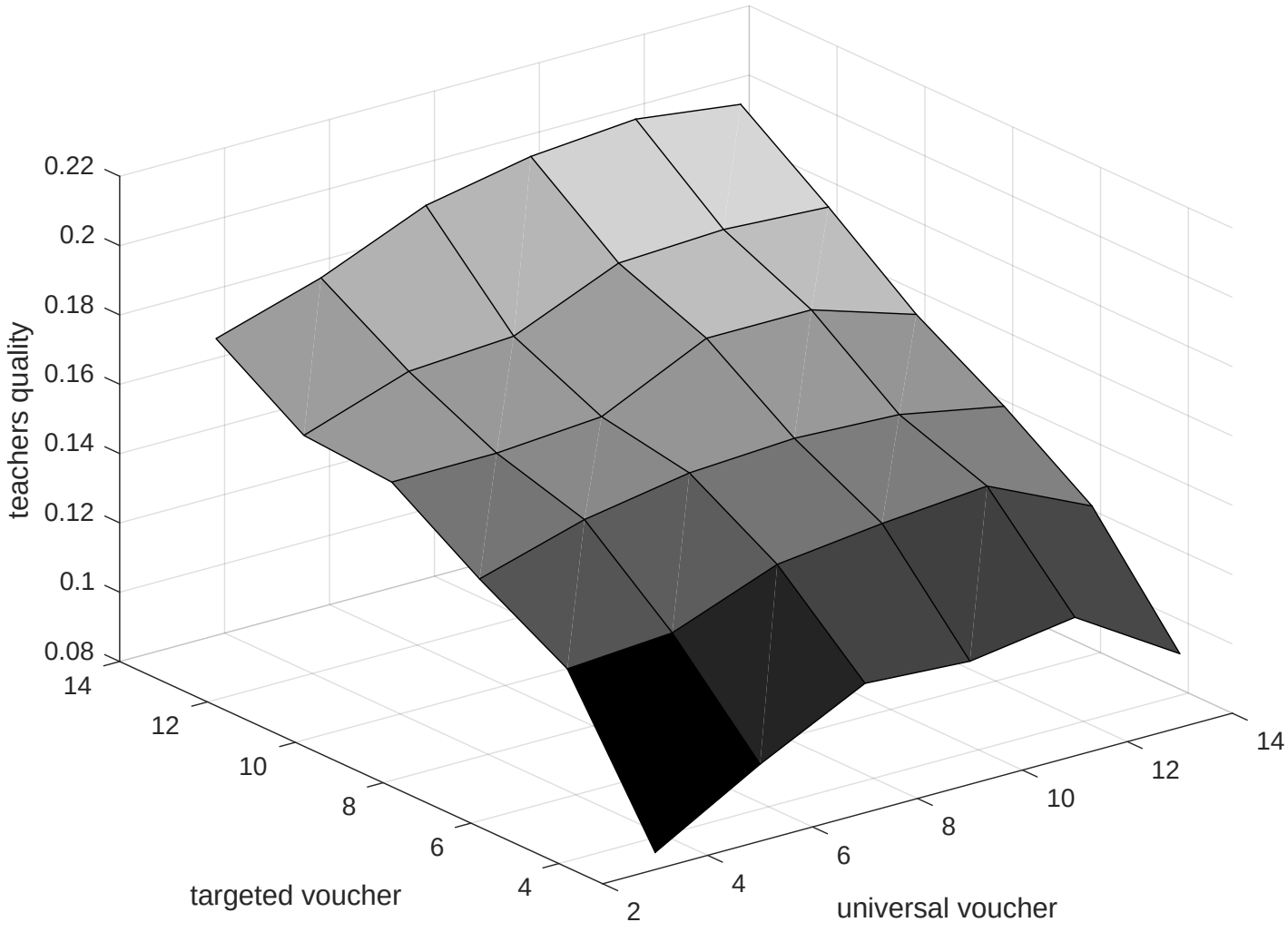
Policy Analysis and Counterfactuals

Policy Analysis and Counterfactuals

Exercise 1

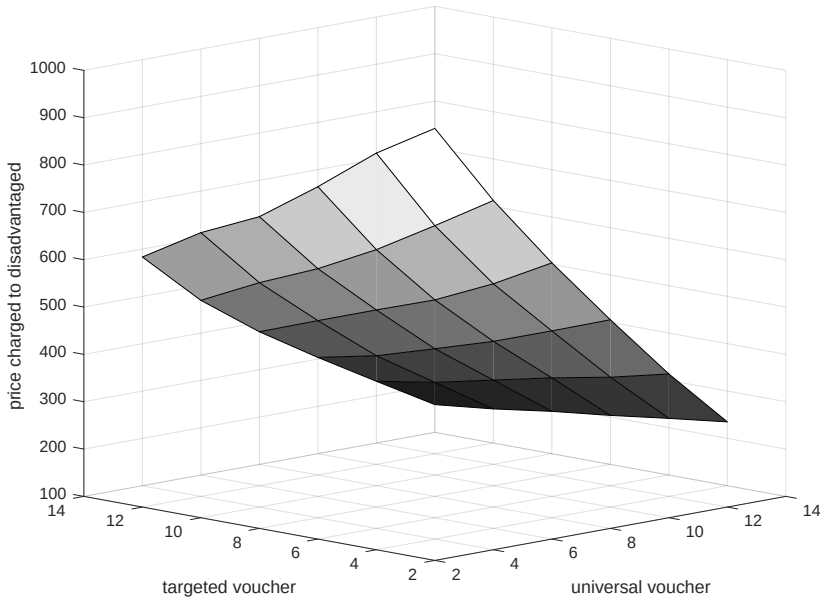
- I analyze markets' equilibria under various combinations of universal and targeted voucher amounts
  - Universal voucher: \$300, \$500, \$700, \$900, \$1100, \$1300
  - Targeted voucher: \$300, \$500, \$700, \$900, \$1100, \$1300
- I study:
  - Participation in targeted program
  - Tuition
  - Students' welfare
  - Government spending


Participation in Targeted Program
program participation
900
850
800
750
700
650
600
550
14
12
10
8
6
4
targeted voucher
2
4
6
8
10
12
14
universal voucher

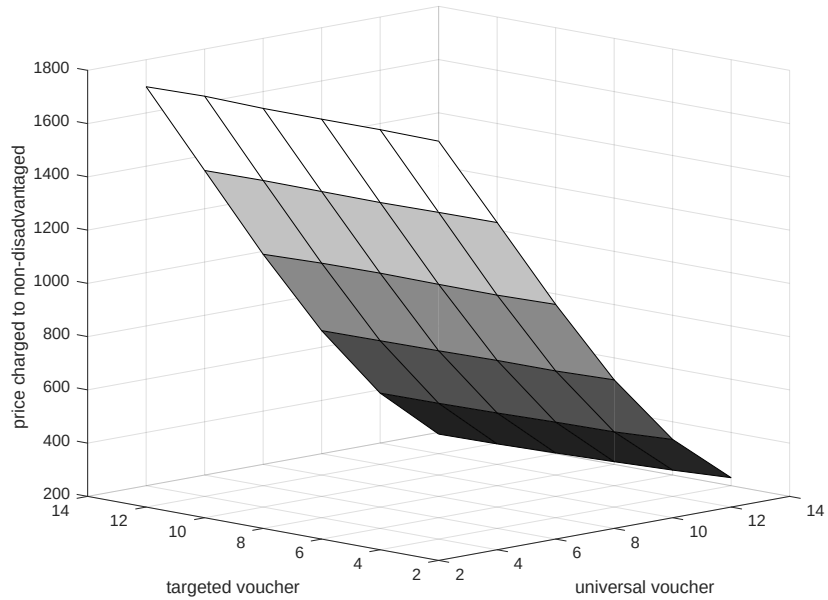

Quality of Schools Participating in Targeted Program
teachers quality
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
targeted voucher
14
12
10
8
6
4
universal voucher
2
4
6
8
10
12
14

Tuition Charged

A.To Disadvantaged

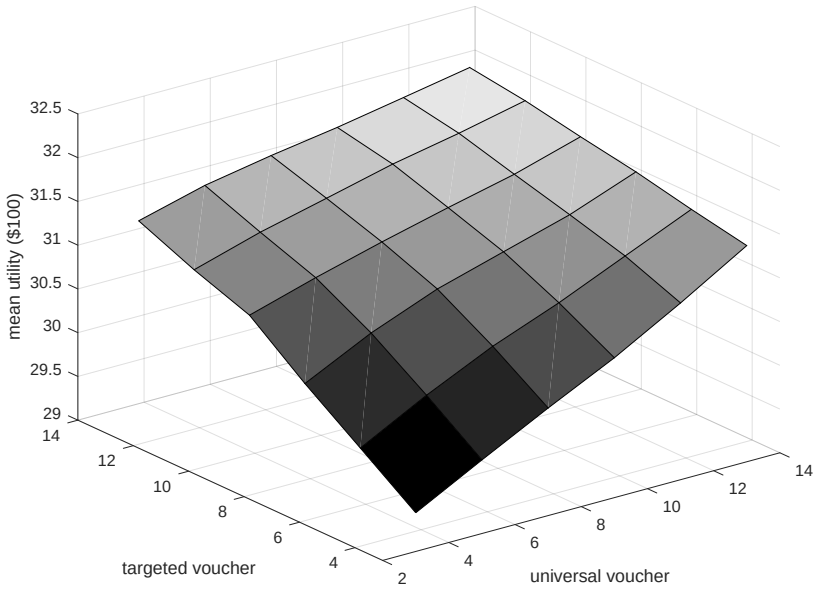


B. To Non-disadvantaged

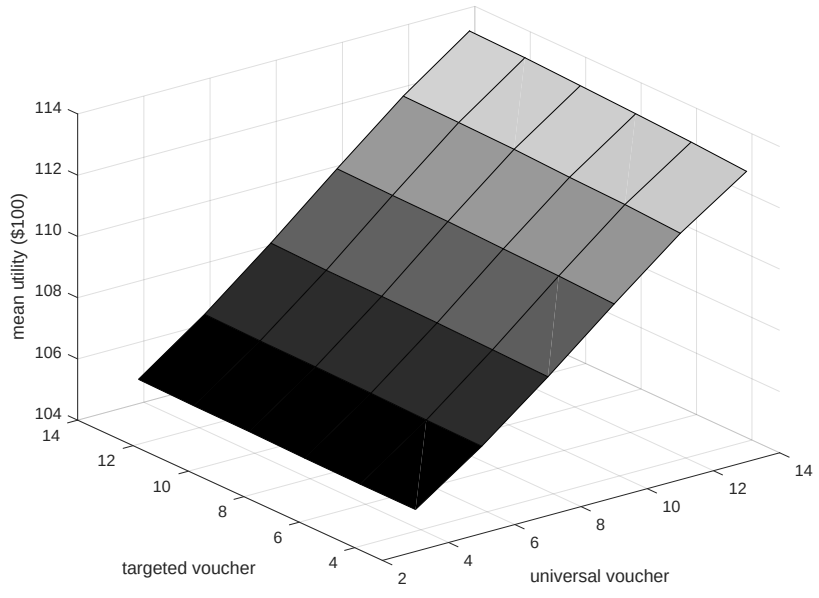


Students' Welfare

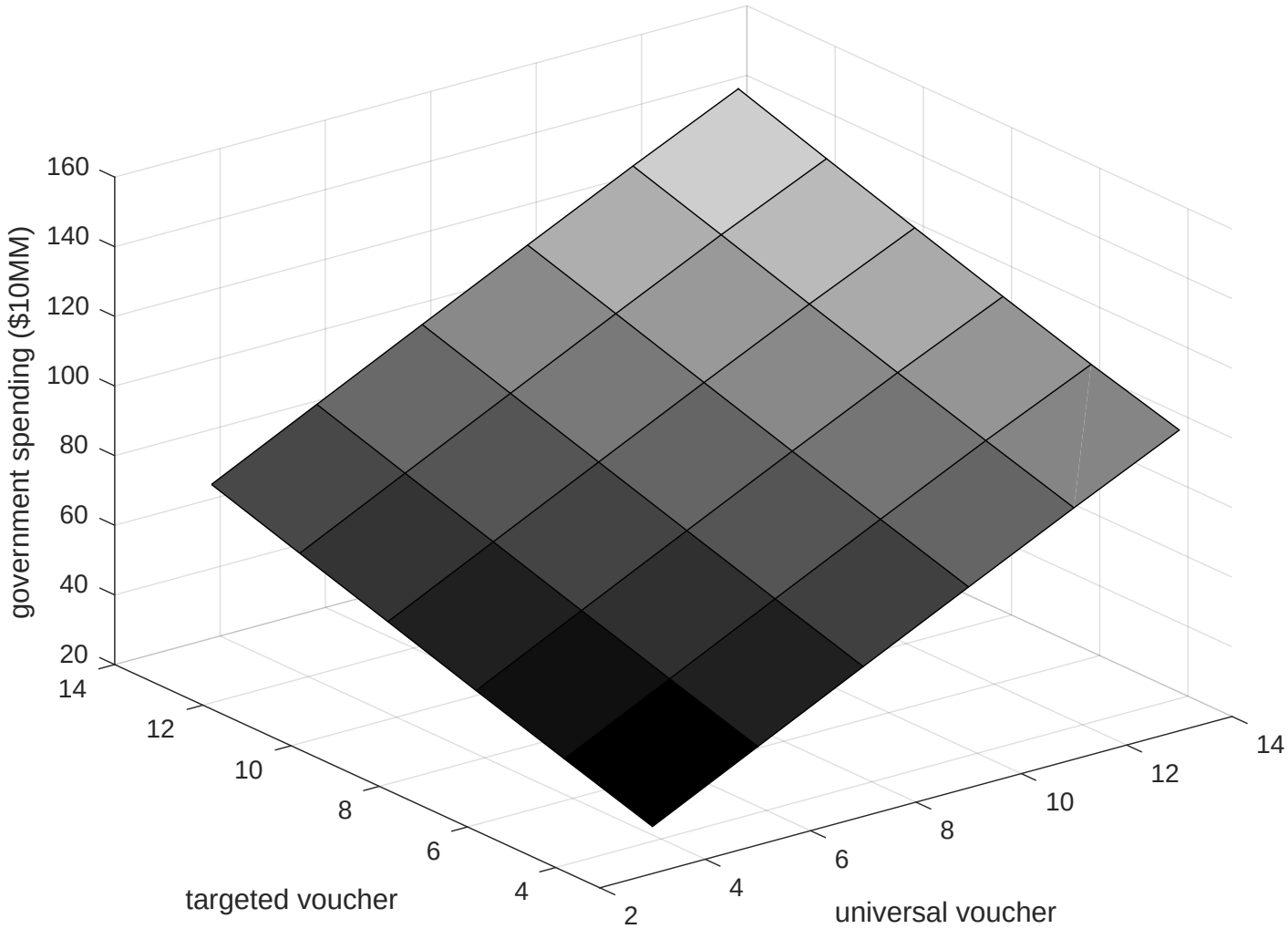
A. Disadvantaged



B. Non-disadvantaged



Government Spending



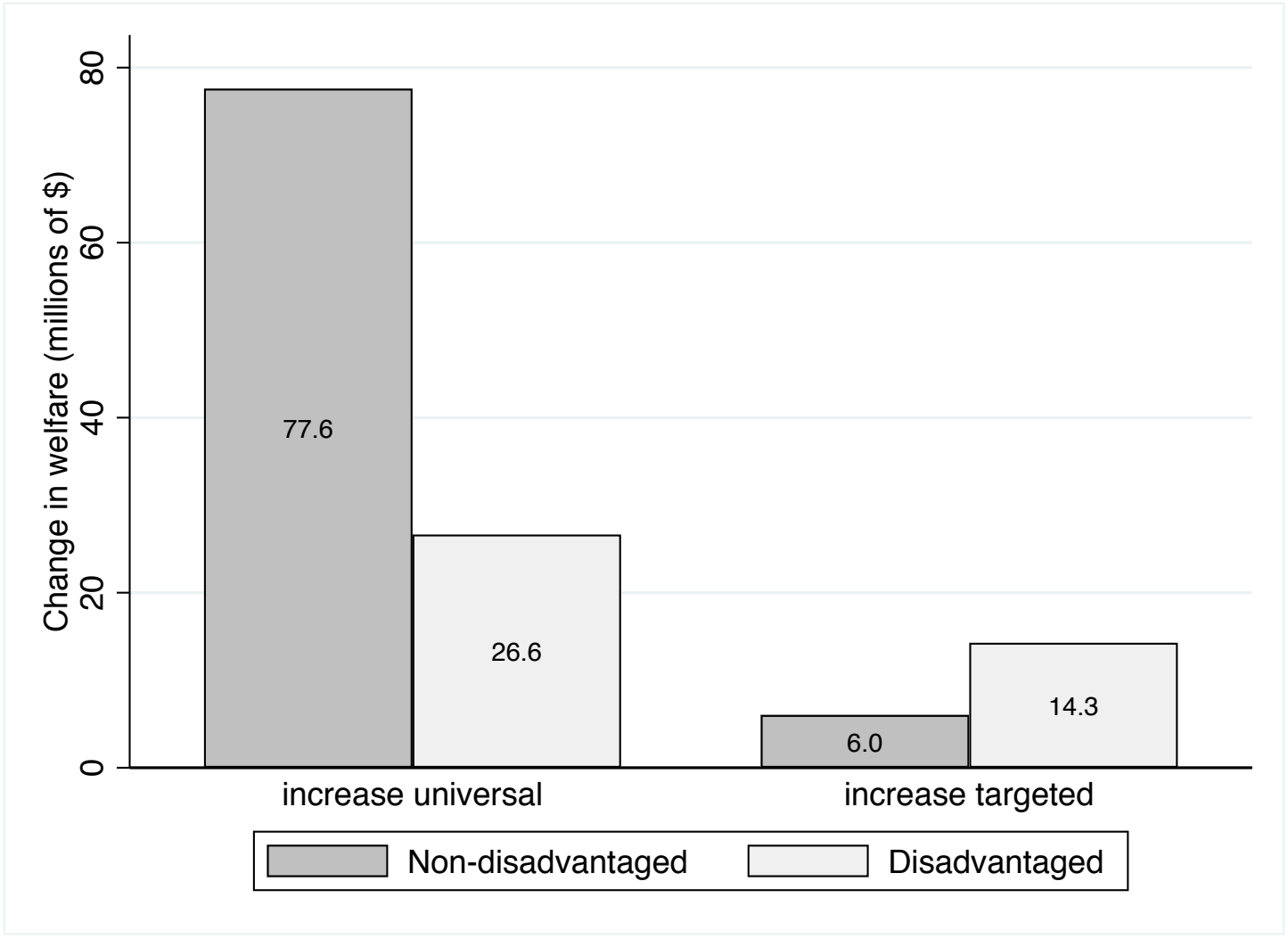
Policy Analysis and Counterfactuals

Exercise 2

- Two equally costly policies: 20% increase in government spending
  - Allocate extra funds to increase *universal* voucher
  - Allocate extra funds to increase *targeted* voucher

Voucher Amounts in Counterfactual Scenarios

	baseline	increase in universal voucher	increase in targeted voucher
universal voucher ($)	1,220	1,562	1,220
targeted voucher ($)	717	717	1,256


Change in Students' Welfare
Change in welfare (millions of $)
0
20
40
60
80
77.6
26.6
6.0
14.3
increase universal
increase targeted
Non-disadvantaged
Disadvantaged

Conclusions

- I study school competition under a general framework of vouchers
- A higher targeted voucher attracts program participation
- A higher universal voucher lowers tuition levels
- Higher voucher amounts increase students' welfare, and government spending
- Framework may help explain negative effects on test scores found elsewhere (Abdulkadiroglu et al., 2018)
- Analysis can be used by policymakers to guide the design of voucher programs

Appendix

Education Markets

Education Markets' Characterization

	mean	std. dev.	min	max
no. of students	23,651	13,810	10,082	59,316
% disadvantaged students	52	10	30	69
no. of schools	86	52	35	240
no. of public schools	38	19	14	87
no. of private-voucher schools	42	33	12	138
no. of private-non-voucher schools	6	7	0	35
% private-voucher schools in targeted program	62	17	21	86

Back

Demand: *Maximum Likelihood - 2SLS*

- Two-step procedure (Goolsbee and Petrin, 2004; Hackmann, 2015).
- In the first step, I estimate preference for proximity, taste heterogeneity in mother's education level, and mean utilities,

$$\delta_j = \beta_1 p_j + \beta_3^{'} X_j + \xi_j$$

- The corresponding log-likelihood function is:

$$LL(\beta) = \sum_i \sum_j e_{ij} \ln \left(\frac{\exp\left(\beta_{1i} p_j + \beta_2 d_{ij} + \delta_j\right)}{\sum_k \exp\left(\beta_{1i} p_k + \beta_2 d_{ik} + \delta_k\right)} \right),$$

- In the second step, I estimate the remaining mean preference parameters in a linear regression of the form:

$$\hat{\delta}_j = \beta_1 p_j + \beta_3^{'} X_j + \xi_j.$$

- p_j is potentially endogenous. I use IV methods for estimation.
- Instruments: non-price attributes of all other schools in the market (BLP).

Back

Supply:

- I back up c_j from schools' FOC, and parameterize $c_j = X_j\omega_1 + \epsilon_j$.
- p_j is corner solution for some schools, so I use a Tobit model, where

$$p_j^* = c_j(\omega) - v^u - m_j(\hat{\beta}; d_j) + \epsilon_j,$$

where $m_j(\hat{\beta}; d_j)$ is the estimated markup term, and $\epsilon_j \sim N(0, \omega)$. Observed tuition is,

$$p_j = \begin{cases} p_j^* & \text{if } p_j^* > 0 \\ 0 & \text{if } p_j^* \leq 0. \end{cases}$$

- I parameterize $\kappa_j = W_j\lambda + \nu_j$, with $\nu_j \sim N(0, 1)$
- GMM - NFXP

Back

Summary Statistics - Student Level

	mean	std. dev.	median
distance to school of choice (km.)	3.05	9.49	1.39
disadvantaged	0.53	0.50	1.00
male	0.51	0.50	1.00
computer at home	0.64	0.48	1.00
internet at home	0.49	0.50	0.00
no. of books at home: 0	0.03	0.17	0.00
no. of books at home: 1–9	0.25	0.43	0.00
no. of books at home: 10–50	0.39	0.49	0.00
no. of books at home: 51–100	0.10	0.30	0.00
no. of books at home: 100 or more	0.05	0.21	0.00
no. of books at home: missing	0.18	0.39	0.00
attended day care	0.13	0.34	0.00
attended pre-kindergarten level 1	0.53	0.50	1.00
attended pre-kindergarten level 2	0.73	0.44	1.00
attended kindergarten	0.82	0.39	1.00
mother's education: none	0.08	0.26	0.00
mother's education: primary	0.20	0.40	0.00
mother's education: secondary	0.39	0.49	0.00
mother's education: college	0.16	0.36	0.00
mother's education: missing	0.18	0.38	0.00
father's education: none	0.07	0.26	0.00
father's education: primary	0.20	0.40	0.00
father's education: secondary	0.36	0.48	0.00
father's education: college	0.15	0.35	0.00
father's education: missing	0.22	0.41	0.00
household's monthly income: $317.15 or less	0.23	0.42	0.00
household's monthly income: $317.15–$740.02	0.31	0.46	0.00
household's monthly income: $740.02–$1,902.91	0.22	0.41	0.00
household's monthly income: $1,902.91 or more	0.07	0.25	0.00
household's monthly income: missing	0.18	0.38	0.00

Summary Statistics - School Level

	mean	std. dev.	median
annual tuition (private schools)	943.15	1805.32	182.24
participates in targeted voucher program (private-voucher schools)	0.66	0.47	1.00
public	0.43	0.50	0.00
private-voucher	0.50	0.50	0.00
private-non-voucher	0.07	0.25	0.00
rural	0.20	0.40	0.00
secular	0.50	0.50	0.00
average teachers' experience	12.69	5.67	12.35
% teachers with a degree not in education	0.03	0.06	0.00
% teachers with a college degree	0.92	0.11	0.94
% teachers with a long-term contract	0.51	0.25	0.50
% teachers with specialization	0.48	0.20	0.47
% teachers with a 10+ semesters degree	0.38	0.29	0.33
% female teachers	0.75	0.16	0.76

Back

Shools' quality: *Linear regression*

- I follow Arcidiacono et al. (2016), and estimate the following regression model:

$$y_{ij} = \alpha_1' x_i + \alpha_2' X_j + q_j + \upsilon_{ij},$$

- I estimate in two steps:
  1. $y_{ij} = \alpha_1' x_i + \rho_j + \upsilon_{ij}$
  2. $\hat{\rho}_j = \alpha_2' X_j + q_j$

Back Estimates

Results: Test Scores - Step 1

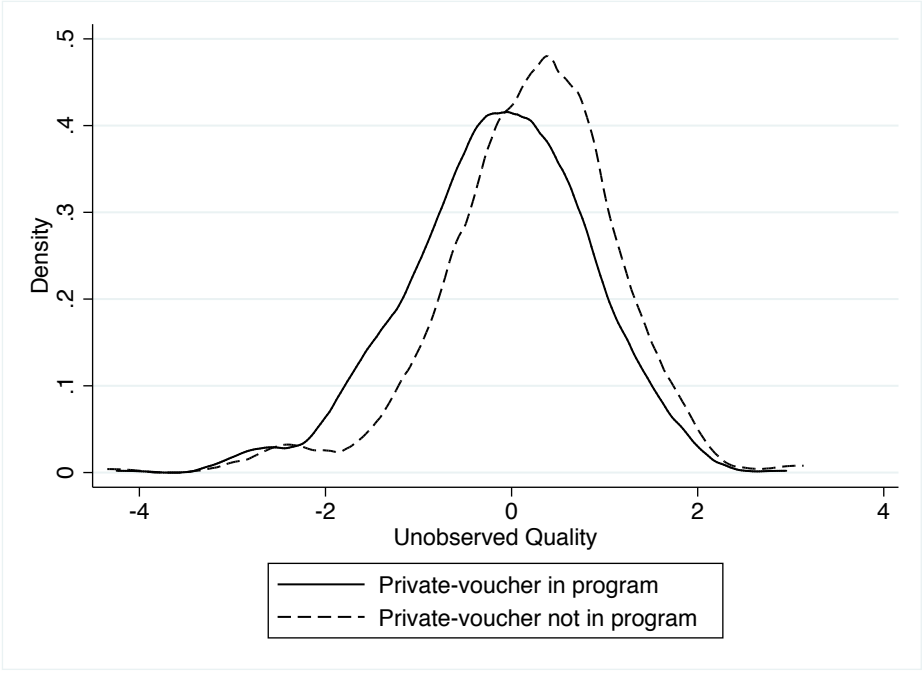
variable	coef.	std. err.
male	-0.057***	0.005
disadvantaged	-0.053***	0.005
computer at home	0.024***	0.008
computer at home: missing	-0.052***	0.017
internet at home	-0.006	0.007
no. books at home: 0	0.044***	0.014
no. books at home: 10–50	0.111***	0.014
no. books at home: 51–100	0.180***	0.016
no. books at home: more than 100	0.253***	0.017
attended day care	-0.018***	0.007
attended prekindergarten level 1	-0.049***	0.005
attended prekindergarten level 2	0.002	0.008
attended kindergarten	0.047*	0.026
mother's education: primary	0.029***	0.010
mother's education: secondary	0.129***	0.010
mother's education: college	0.151***	0.012
mother's education: missing	0.040*	0.021
father's education: primary	0.039***	0.010
father's education: secondary	0.098***	0.010
father's education: college	0.145***	0.012
father's education: missing	0.091***	0.014
household's monthly income: $317–$740	0.025***	0.007
household's monthly income: $740–$1,903	0.051***	0.008
household's monthly income: $1,903 or more	0.082***	0.012
household's monthly income: missing	0.097***	0.023
constant	-0.305***	0.030
R-squared	0.272	

Results: Test Scores - Step 2

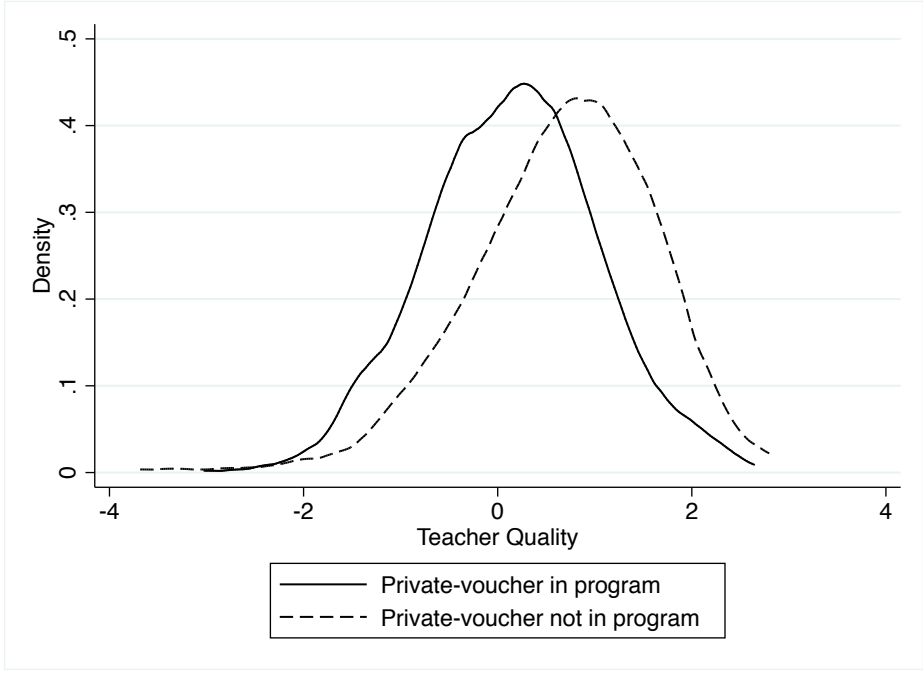
variable	coef.	std. err.
rural	0.014	0.025
public	-0.551***	0.032
private-voucher	-0.437***	0.027
secular	-0.023	0.015
average teachers' experience	-0.003*	0.002
% teachers with a degree not in education	-0.264*	0.145
% teachers with a college degree	0.218***	0.076
% teachers with a long-term contract	0.338***	0.041
% teachers with specialization	0.192***	0.041
% teachers with a 10+ semesters degree	0.182***	0.029
% female teachers	0.253***	0.049
constant	-0.430***	0.107
R-squared	0.245	

Results: Private-voucher Schools' Quality Distribution

A. Unobserved Quality



B. Teachers Quality



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Results: Demand Estimates

	non-disadvantaged		disadvantaged	
	coef.	std. err.	coef.	std. err.
annual tuition/100	-0.177	0.004	-0.055	0.007
annual tuition/100 × mother's education: primary	-0.095	0.011	-0.196	0.008
annual tuition/100 × mother's education: secondary	0.083	0.010	-0.037	0.002
annual tuition/100 × mother's education: college	0.138	0.010	0.003	0.002
annual tuition/100 × mother's education: missing	0.164	0.010	-0.062	0.004
distance to school/10	-5.023	0.051	-5.267	0.048
distance to school squared/10	0.026	0.002	0.050	0.001
public	-0.631	0.055	-0.073	0.071
rural	-0.657	0.068	-0.988	0.124
secular	0.096	0.046	0.116	0.060
unobserved quality	0.790	0.059	0.336	0.075
teachers quality	3.529	0.285	1.544	0.331
constant	-2.102	0.212	-1.025	0.235

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Results: Supply Estimates

	coef.	std. err.
marginal cost ($100):		
unobserved quality	0.279	0.056
teachers quality	0.296	0.062
secular	0.128	0.103
rural	-1.699	0.284
participates in targeted program	-3.158	0.106
constant	6.123	0.225
participation cost ($1,000):		
unobserved quality	9.271	6.980
teachers quality	40.578	7.089
secular	36.337	13.005
constant	-146.977	12.241
no. of schools	1,110	

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Results: Goodness of Fit

	mean		std. dev	
	actual	model	actual	model
all private-voucher schools:				
in targeted program	0.66	0.68	0.47	0.47
full tuition	305.9	332.2	409.8	452.6
schools in targeted program:				
unobserved quality	-0.15	-0.14	0.97	0.98
teachers quality	0.14	0.15	0.88	0.92
secular	0.41	0.39	0.49	0.49
rural	0.14	0.12	0.34	0.32

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