Can Successful Schools Replicate? 
Scaling Up Boston’s Charter Sector

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Federal Reserve Bank of Minneapolis
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Can effective programs scale?

- The feasibility of scaling remains a key problem for social policy
- Recent large-scale studies have failed to replicate the impressive gains of smaller-scale studies
  - Early childhood programs
  - Class size reductions
  - Success for All (whole school reform model)
Why might replications miss the mark?

- Differences in inputs (i.e. quality, type)
- Changing counterfactuals
- Differences in population characteristics
- Implementation fidelity/quality control
- Increased samples size $\rightarrow$ closer to true mean
- Publication bias
Focus of this study: “No Excuses” charter schools

- “No Excuses” charters share a common set of practices
  - Longer school days and years
  - High academic and behavioral expectations
  - Frequent teacher feedback
  - High-intensity tutoring
  - Data-driven instruction
- Growing lottery-based evidence that “No Excuses” charter schools generate gains for low-income urban students
  - Boston, NYC, KIPP, Denver, NOLA
- No school district has adopted these “No Excuses” policies on a wide scale
- “No Excuses” charters generally serve small shares of students in the cities where they operate
In 2010, Massachusetts lifted restrictions on the number of charter schools in low-performing districts, including Boston.

The state chose “proven providers” – schools with track records of success — and allowed them to open new campuses.

Charter sector in Boston doubled from 2010 to 2014
- 16 → 32 charter schools
- 15% → 31% of Boston students enrolled in charter schools
Notes: This figure plots the share of Boston fourth, sixth, and ninth grade students enrolled in charter schools between 2002 and 2015.
Objective

- Use randomized charter middle school admission lotteries to study:
  - whether the new replication campuses produced similar test score gains to their parent campuses
  - what explains the success of the scaling
Sample schools

- 14 charter middle schools
  - Cover 94% of Boston middle school charter enrollment in 2014

- School types
  - Four proven providers
  - Seven expansion charters
  - Three “other charters”
Growing demand, changing demographics

<table>
<thead>
<tr>
<th></th>
<th>Before Expansion</th>
<th>After Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of Boston students applying</td>
<td>15%</td>
<td>35%</td>
</tr>
<tr>
<td>Selection on math scores?</td>
<td>$0.22\sigma$</td>
<td>$0.02\sigma$</td>
</tr>
<tr>
<td>Selection on ELA scores?</td>
<td>$0.30\sigma$</td>
<td>$0.02\sigma$</td>
</tr>
<tr>
<td>Free/reduced price lunch</td>
<td>69%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(on par with BPS)</td>
</tr>
<tr>
<td>ELLs</td>
<td>12%</td>
<td>36%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(slightly lower than BPS)</td>
</tr>
<tr>
<td>Special education</td>
<td>19%</td>
<td>20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(slightly lower than BPS)</td>
</tr>
</tbody>
</table>
Jointly estimate charter attendance at 5 charter types

<table>
<thead>
<tr>
<th>Before Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proven Providers</strong></td>
</tr>
<tr>
<td>charter schools designated by the state as proven providers after the change in the law, in 2010 and prior</td>
</tr>
<tr>
<td><strong>Other Charters</strong></td>
</tr>
<tr>
<td>charter schools never designated proven providers after the change in the law, in 2010 and prior</td>
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<tr>
<td>charter schools designated by the state as proven providers after the change in the law, in 2011 and following</td>
</tr>
<tr>
<td><strong>Expansion Charters</strong></td>
</tr>
<tr>
<td>new charter schools, in 2011 and following</td>
</tr>
<tr>
<td><strong>Other Charters</strong></td>
</tr>
<tr>
<td>charter schools never designated proven providers and that are also not replication campuses after the change in the law, in 2011 and following</td>
</tr>
</tbody>
</table>
Methods

- Use charter school lotteries as *instruments* for charter school attendance
- Estimate for each charter school type (something like):

\[
\text{Effect of 1 Year of Charter Attendance}_{\text{Charter Type } k} = \frac{\text{Test Score}_{\text{Offered Seat at } k} - \text{Test Score}_{\text{Not Offered Seat at } k}}{\text{Years Attended}_{\text{Offered Seat at } k} - \text{Years Attended}_{\text{Not Offered Seat at } k}}
\]

- Estimate 5 \((k)\) charter types jointly so we have the right counterfactual
- Many students apply to multiple charters, especially parent and replicates, so estimate using *risk sets*
Effect of 1 Year of Attendance on Math Scores

![Bar chart showing the effect of one year of attendance at a charter school (Math) for Proven Providers and Other Charters before and after charter expansion.]

- **Proven Providers**
  - Before Charter Expansion: 0.32
  - After Charter Expansion: 0.37

- **Other Charters**
  - Before Charter Expansion: 0.18
  - After Charter Expansion: 0.33
State selected more effective schools for expansion

Effect of One Year of Attendance at a Charter School (Math)

- Proven Providers
  - Before Charter Expansion: 0.32
  - After Charter Expansion: 0.37
- Other Charters
  - Before Charter Expansion: 0.18
  - After Charter Expansion: 0.33
- Expansion Charters
  - After Charter Expansion: 0.19

$p\text{-value}(\text{Proven Providers} = \text{Other Charters}) = 0.000$
Proven providers remained effective during expansion.
Proven providers successfully replicated their schools

Effect of One Year of Attendance at a Charter School (Math)

- Proven Providers
- Other Charters
- Expansion Charters

Before Charter Expansion

- Proven Providers: 0.32
- Other Charters: 0.18

After Charter Expansion

- Proven Providers: 0.37
- Expansion Charters: 0.33
- Other Charters: 0.19

$p$-value(Proven Providers $=$ Expansion Charters) $= 0.632$
Expansions more effective than long-running schools

Effect of One Year of Attendance at a Charter School (Math)

Before Charter Expansion
Proven Providers: 0.32
Other Charters: 0.18

After Charter Expansion
Proven Providers: 0.37
Expansion Charters: 0.33
Other Charters: 0.19

$p$-value(Expansion Charters = Other Charters) = 0.030
Similar pattern but smaller effects in English

Effect of One Year of Attendance at a Charter School (ELA)

<table>
<thead>
<tr>
<th></th>
<th>Before Charter Expansion</th>
<th>After Charter Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proven Providers</td>
<td>0.12</td>
<td>0.19</td>
</tr>
<tr>
<td>Other Charters</td>
<td>0.08</td>
<td>0.23</td>
</tr>
<tr>
<td>Proven Providers</td>
<td>0.12</td>
<td>0.19</td>
</tr>
<tr>
<td>Expansion Charters</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>Other Charters</td>
<td>0.13</td>
<td></td>
</tr>
</tbody>
</table>
Potential explanations for replication’s success

- **Human capital management**
  - Successful despite 2/3rd brand new teachers
  - School leadership trained in proven provider school

- **Counterfactual schools**
- **Changing demographics or heterogeneous treatment effects**
- **School model**
Teacher experience profile slightly flatter at charters

<table>
<thead>
<tr>
<th>Experience Profile</th>
<th>Math</th>
<th>P-value of Charter==BPS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Charter (1)</td>
<td>BPS (2)</td>
</tr>
<tr>
<td>1 - 4 Years of Experience</td>
<td>0.063***</td>
<td>0.093***</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.036)</td>
</tr>
<tr>
<td>5 or More Years of Experience</td>
<td>0.031</td>
<td>0.078**</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.038)</td>
</tr>
</tbody>
</table>
Teacher and classroom variation reduced at charters

<table>
<thead>
<tr>
<th></th>
<th>Math Chart</th>
<th>Math BPS</th>
<th>P-value of Charter==BPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Random Effects Parameters: SD</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School</td>
<td>0.133***</td>
<td>0.103***</td>
<td>0.362</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.016)</td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td>0.122***</td>
<td>0.185***</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.012)</td>
<td>(0.010)</td>
<td></td>
</tr>
<tr>
<td>Class X Year</td>
<td>0.075***</td>
<td>0.151***</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>(0.008)</td>
<td>(0.005)</td>
<td></td>
</tr>
</tbody>
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Potential explanations for replication’s success

- Human capital management
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- Counterfactual schools
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  - School model
Applicants’ outside options do not explain the results

<table>
<thead>
<tr>
<th></th>
<th>Before Charter Expansion</th>
<th>After Charter Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Proven Providers (1)</td>
<td>Other Charters (2)</td>
</tr>
<tr>
<td>Untreated Complier Mean</td>
<td>0.008 (0.010)</td>
<td>0.015 (0.009)</td>
</tr>
<tr>
<td>Math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>-0.015 (0.008)</td>
<td>-0.012 (0.008)</td>
</tr>
</tbody>
</table>

N: 7194

Notes: This table displays the mean school value added for untreated compliers. School value added estimates come from OLS regressions of test scores on a set of school indicator variables, controlling for baseline test scores and student demographics. The school value added estimates are centered to zero for the average value added of Boston Public Schools.
No relationship between charter effectiveness & outside option
Potential explanations for replication’s success

- Human capital management
  - Successful despite 2/3rd brand new teachers
  - School leadership trained in proven provider school

- Counterfactual schools

- Changing demographics or heterogeneous treatment effects

- School model
Decompose charter effect into two parts for each charter type:

- Average Treatment Effect at type k ($ATE_k$)
  - How effective is this charter school for the average Boston kid

- Match at type k ($Match_k$)
  - How effective is this charter school for the mix of kids it gets (e.g. particularly effective/ineffective for low-scoring students)
Proven providers and expansions are similarly effective for the average kid

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<tbody>
<tr>
<td></td>
<td>Proven Providers (1)</td>
<td>Other Charters (2)</td>
</tr>
<tr>
<td>TOT</td>
<td>0.333***</td>
<td>0.185***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.020)</td>
</tr>
<tr>
<td>ATE</td>
<td>0.320***</td>
<td>0.198***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Match</td>
<td>0.013</td>
<td>-0.013</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>N (scores)</td>
<td></td>
<td>15924</td>
</tr>
</tbody>
</table>
Expansions enroll students that are easier for charters to produce gains for, but this advantage is relatively small.

<table>
<thead>
<tr>
<th></th>
<th>Proven Providers</th>
<th>Other Charters</th>
<th>Proven Providers</th>
<th>Expansion Charters</th>
<th>Other Charters</th>
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<td>(0.038)</td>
</tr>
<tr>
<td>Match</td>
<td>0.013</td>
<td>-0.013</td>
<td>-0.002</td>
<td>0.014***</td>
<td>-0.011**</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.008)</td>
<td>(0.005)</td>
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<td></td>
<td>15924</td>
<td></td>
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Panel A: IV Results

Math
Potential explanations for replication’s success

- Human capital management
  - Successful despite 2/3rd brand new teachers
  - School leadership trained in proven provider school

- Counterfactual schools

- Changing demographics or heterogeneous treatment effects

- School model
Focus on “fit” of teachers - select heavily on commitment to school model

Utilize scale for curriculum planning and professional development
  - Chose best lesson plans/practices
  - Quality control

Support for new teachers and school leaders
  - Regular visits/observations/feedback

Expand 1-2 grades at a time

Tension between autonomy and centralization
  - Give leaders and teachers good resources and autonomy
Potential explanations for replication’s success

- **Human capital management**
  - Successful despite 2/3rd brand new teachers
  - School leadership trained in proven provider school

- **Counterfactual schools**

- **Changing demographics or heterogeneous treatment effects**

- **School model**
Boston’s “No Excuses” charter schools reproduced their effectiveness at new campuses.

New expansion schools generate test score gains similar to those of their parent campuses, despite a doubling of charter market share.

Applicants’ outside options, heterogeneous treatment effects, and changing demographics do not explain the effects.

Human capital management and faithfulness to the model might explain their success.
Thank you!

Questions or comments: cohodes@tc.columbia.edu
Two lottery instruments per charter type $k$ indicate if a student is admitted

- Initial offer ($Z_{ik1}$) indicates admission on lottery day at that charter type $k$
- Ever offer ($Z_{ik2}$) indicates admission on lottery day or later at that charter type $k$

Risk sets: Admission is random only after conditioning on the set of schools to which a student applied

- The charter risk set is the set of schools to which a student applied
- For example, 3 schools generate 7 risk sets
- We include a set of risk-set dummies (interacted with year of application) in all regressions

Check for potential threats to validity

- Covariate balance
- Attrition
2SLS Specification

K First Stages:

\[ C_{ig}^k = \mu_g^k + \sum_{\ell=1}^{K} \left( \pi_{\ell 1}^k Z_{i1}^\ell + \pi_{\ell 2}^k Z_{i2}^\ell \right) + \sum_{j=1}^{J} \lambda_j^k d_{ij} + X_i' \theta^k + \eta_{ig}^k, \quad k = 1...K \]

Second Stage:

\[ y_{ig} = \alpha_g + \sum_{k=1}^{K} \beta_k C_{ig}^k + \sum_{j=1}^{J} \delta_j d_{ij} + X_i' \gamma + \epsilon_{ig} \]

where \( y_{ig} \) is an outcome for student \( i \) in grade \( g \)

\( d_{ij} \) are risk sets

\( C_{ig}^k \) is years of charter attendance at a \( k^{th} \) type of charter

\( X_i \) is a vector of demographics

\( \mu_g^k \) and \( \alpha_g \) are grade fixed effects
Expand 2SLS strategy to include offers as well as offers interacted with student characteristics:

\[ Y_{ig} = \alpha_g + \sum_{k=1}^{K} (\beta_0^k + X_i' \beta^x) C^k_{ig} + \sum_{j=1}^{J} \delta_j R_{ij} + X_i' \gamma + \varepsilon_{ig} \]

Then: Decompose the $TOT_k$ into $ATE_k$ (average effect for Boston population) and $Match_k$ (deviation due to characteristics at charter type k):

\[
TOT_k = \beta_0^k + \bar{X}_k' \beta^x
\]

\[
= (\beta_0^k + \mu^{x'} \beta^x) + (\bar{X}_k - \mu^x)' \beta^x
\]

\[ \begin{align*}
\text{ATE}_k & = (\beta_0^k + \mu^{x'} \beta^x) \\
\text{Match}_k & = (\bar{X}_k - \mu^x)' \beta^x
\end{align*} \]