A Quantitative Analysis of Turkish Private Education Reform

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Abstract

As of September 2015, Turkey plans to shut down all private supplementary education centers (SEC’s) which serve between 50% to 70% of high school students. This paper analyzes the effect of this policy change on the student achievement distribution after high school. To carry out the analysis, we use a political economy model of education at which households, heterogeneous with respect to income and child ability, choose the optimal amount of supplementary education spending for their child given their budget. Public education is mandatory and free of charge. Achievement of a child depends on its ability, supplementary education spending chosen by its parent and public education spending per pupil. Public education is financed by income tax revenue collected from all households. Income tax rate, constant among all households, is determined via majority voting. We calibrate the model so as to match certain targets from Turkish data. In the model, when the SEC’s are banned, achievement level of students decrease since supplementary education spending becomes zero. Even in the best case scenario at which public spending per pupil adjusts in the positive direction, we quantitatively show that mean achievement level after high school decreases by 17% with the reform. Moreover, variance of achievement decreases by 93% implying a mean-variance tradeoff.
A Quantitative Analysis of Turkish Private Education Reform

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Turkey gets ready to ban all supplementary education centers (SEC’s) in September 2015.

50%-70% of 12th grade students enroll in SEC’s.
How will banning SEC’s affect students’ achievement distribution right after high school?

Assume achievement depends on educational spending in (SEC’s + Public School).

Banning SEC’s will imply:
1. Lower achievement since educational spending in SEC=0
2. Higher achievement since educational spending in Public School ↑. (best case scenario)

Two opposing forces affecting the answer.

Question requires quantitative analysis.
Environment

- Static model.
- Continuum of households with measure one.
- Each household consists of one parent and one school age child.
- Households are heterogeneous w.r.t. income and ability of their child.
- One public school.
- Continuum of SEC’s.
- Our Model = Epple & Romano (1996 JPE) + Ability Heterogeneity
Household’s Preferences

- Households have identical preferences over \((c, a)\) pairs in \(\mathbb{R}^2_{++}\).
- Preferences are represented by a CRRA utility function:

\[
\frac{c^{1-\theta}}{1-\theta} + \delta \frac{a^{1-\theta}}{1-\theta} \quad \delta > 0, \theta > 1
\]

where
- \(c\): consumption of the numeraire good
- \(a\): achievement of household’s child
Households are heterogeneous w.r.t. exogenously specified annual income \((y)\) and child’s ability \((b)\).

\((y, b)\) is distributed with c.d.f. \(F(\cdot)\) over \(\mathbb{R}_+^2\).

Mean income is denoted with \(Y\).

We assume mean income is greater than median income consistently with empirical evidence.
Public school expenditure is financed through mandatory income taxes.

Budget of public school is:

\[ g = \tau Y \]

where:
- \( g \): Public education spending per pupil
- \( \tau \): Income tax rate
- \( Y \): Mean income
SEC’s

- Continuum of perfectly competitive SEC’s operating under constant marginal cost and zero profit.
- Each SEC supplies a different amount of supplementary education.
- They supply whatever is demanded by households.
Household’s Decision Problem

Given \( \tau \) and \((y, b)\), households solve:

\[
V(\tau, y, b) = \max_{c, s} \frac{c^{1-\theta}}{1-\theta} + \delta \frac{a^{1-\theta}}{1-\theta}
\]

subject to

\[
a = b(g + s) = b(\tau Y + s)
\]

\[
c + s = (1 - \tau)y
\]

\[
c \geq 0, \ s \geq 0
\]

where \( s \) is the amount of supplementary education.
Household’s Decision Problem

- Solving the household’s problem implies:

\[ s^*(\tau, y, b) = \begin{cases} 
\frac{(1-\tau)y - \kappa \tau Y}{1+\kappa} & \text{if } 0 \leq \tau < \frac{y}{y+\kappa Y}; \\
0 & \text{otherwise.}
\end{cases} \]

\[ V(\tau, y, b) = \begin{cases} 
\frac{(\kappa^{1-\theta} + \delta b^{1-\theta})[(1-\tau)y + \tau Y]^{1-\theta}}{(1-\theta)(1+\kappa)^{1-\theta}} & \text{if } 0 \leq \tau < \frac{y}{y+\kappa Y}; \\
\frac{[(1-\tau)y]^{1-\theta} + \delta b^{1-\theta} (\tau Y)^{1-\theta}}{1-\theta} & \text{otherwise.}
\end{cases} \]

where \( \kappa = (\delta b^{1-\theta})^{-\frac{1}{\theta}} \)
The optimal tax rate for household $(y, b)$ is determined by:

$$\tau^*(y, b) = \arg\max_{0 \leq \tau \leq 1} V(\tau, y, b)$$

Solving this problem implies:

$$\tau^*(y, b) = \begin{cases} 
\frac{y^{\theta-1}}{\theta} & \text{if } y \leq Y; \\
\frac{y^{\theta-1}}{\theta} + \kappa Y^{\theta-1} & \text{otherwise.}
\end{cases}$$

where $\kappa = (\delta b^{1-\theta})^{-\frac{1}{\theta}}$. 

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A majority voting equilibrium is a set of allocations \((c^*, s^*)\) for each household, public spending per pupil \(g^e\) and an income tax rate \(\tau^e\) such that:

1. \((c^*, s^*)\) solves household’s problem given \(g^e\), income and child’s ability.
2. \(g^e\) is determined by:
   \[ g^e = \tau^e Y \]
3. \(\tau^e\) wins at least 50\% of the votes in any binary election against some other \(\tilde{\tau} \neq \tau^e\).
Model Calibration

- Joint distribution of income and ability is assumed to be lognormal.
- Parameters of the distribution are $\mu_y$, $\sigma_y$, $\mu_b$, $\sigma_b$ and $\rho$.
- Two preference parameters ($\delta$, $\theta$).
- Seven parameters in total.
- We use Turkish data.
For 2013, mean disposable income = 29.479 TL and median disposable income = 22.650 TL.

We need to convert these into gross income.

From OECD data, we know ratio of tax revenue to GDP is 29.3%.

Mean Gross Income = 29.479(1 + 0.293) = 38.116 TL

Median Gross Income = 22.650(1 + 0.293) = 29.286 TL
To find $\mu_y$ and $\sigma_y$ solve:

$$\exp\left(\mu_y + \frac{\sigma_y^2}{2}\right) = 38.116$$

$$\exp(\mu_y) = 29.286$$

Implies $\mu_y = 3.37$ and $\sigma_y = 0.72$. 
We use 2005 High School Entrance Exam (OKS) score distribution data to find $\mu_b$ and $\sigma_b$.

In data, normalized mean score = 0.62 and normalized median score = 0.60.

To find $\mu_b$ and $\sigma_b$ solve:

\[
\exp \left( \mu_b + \frac{\sigma_b^2}{2} \right) = 0.62
\]

\[
\exp(\mu_b) = 0.60
\]

Implies $\mu_b = -0.49$ and $\sigma_b = 0.25$. 
Following Solon (1992) and Zimmerman (1992), we set $\rho = 0.4$.
Using these parameters, we generate joint distribution of income and ability.
We pick 10,000 different incomes and 100 different abilities for each income level.
In total $10,000 \times 100 = 1,000,000$ different households.
Preference Parameters

To estimate $\delta$ and $\theta$, minimize the model’s squared error deviation from the following targets in 2013 data:

1. Ratio of total public school spending to GDP: 4.3% (T1)
2. Coefficient of variation of the math score distribution in nationwide university entrance exam: 0.78 (T2)
Preference Parameters

- The above procedure yields $\delta = 0.002$ and $\theta = 2.1$
- The performance of the model w.r.t. targets:

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T1$</td>
<td>0.0398</td>
<td>0.043</td>
</tr>
<tr>
<td>$T2$</td>
<td>0.7246</td>
<td>0.78</td>
</tr>
</tbody>
</table>

- Although not targeted, model implies 65% enrollment in SEC’s which lies in the interval $[50\%, 70\%]$ as reported in data.
What if all SEC’s are banned by government?

How would the achievement distribution be affected from this policy?

To answer this, we solve the model once more given the estimated parameters by setting $s = 0$. 
Benchmark vs. Counterfactual

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>Counterfactual</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>$g^e$</td>
<td>1.5064</td>
<td>2.1181</td>
<td>40%</td>
</tr>
<tr>
<td>$\tau^e$</td>
<td>0.0398</td>
<td>0.056</td>
<td>40%</td>
</tr>
<tr>
<td>Mean Ach.</td>
<td>1.6027</td>
<td>1.3295</td>
<td>-17%</td>
</tr>
<tr>
<td>Variance of Ach.</td>
<td>1.3488</td>
<td>0.0857</td>
<td>-93%</td>
</tr>
</tbody>
</table>

Mean and variance of achievement declines by 17% and 93% when SEC’s are banned.
We quantitatively analyzed the upcoming Turkish SEC reform.

Found a 17% decline in mean achievement after high school as a result of the policy.

Variance also decreases by 93%. (mean-variance tradeoff)

Future research aims to include private schools in the model as well.