Dynamic Model for the Prediction of Teacher Needs

Miguel Tavares Aleluia
Introduction

Teachers

• Teacher quality is the most relevant factor under school control that affects student performance (Hanushek, 2011)

• Still, even in developed countries the profession is unstable
  • Japan
  • Korea
  • France
  
  Too many teachers - 20 % or less of new graduates are able to obtain a job

• The Netherlands
• England

  Unfilled vacancies

• Finland
• Sweden
• USA

  Unqualified Teachers

Source: OECD (2005)
How do countries monitor the balance in supply and demand?

Source: Eurydice (2013)
Methods used to estimate needs for teachers

- Committee on National Statistics (1992) - student to teacher ratios (constant or projected) is the most usual
  - Since these don’t predict changes in these ratios, they are not very useful to analyze policies

- Present date examples:
  - Teacher Supply Model (Department for Education, 2014)
  - Projections of Education Statistics to 2022 (National Center for Educational Statistics, 2014)
• Every year, teachers are hired for tenure at a national level
• Hiring the same number of teachers that leave the profession isn’t advisable, because there are changes in:
  • Birth rates
  • School organization
  • Population of each region
  • Legislation that determines school curriculum
• It is an occasion to reshape the teaching force for the future, and so propagating past unbalances should be avoided
We will then predict teacher needs by estimating:

- Number of students
  - Approval Rates
  - Movements between school paths
  - Movements between regions
- Periods required
  - Number of classes
  - Periods per class for each teacher group
- Number of tenured teachers
  - Retirement rates
- Periods provided
  - Periods per teacher (legislated)
Number of Students

For each Region:

\[
\text{Flow of Students, New Path Grades[Path Grade]} = \sum \text{matrix transfers between path grades[Path Grade, Path Grade!]} \\
* \text{Flow of Students Finishing a School Year[Path Grade!]} \\
* \left(1 - \text{Fraction of Students Leaving the System[Path Grade!]}\right)
\]

For each Path Grade

\[
\text{Flow of Students, New Path Grades, New Regions[Region]} = \sum \text{matrix transfers between regions[Region, Region!]} \\
* \text{Flow of Students, New Path Grades[Region!]} \\
\]

• For each Region:

• For each Path Grade
Number of classes

• To estimate the number of classes we divided the number of students by an average class size in public schools in the municipality

• An alternative approach would be to divide the number of students in each school for the legislated class size, rounding that number up
Number of Periods per Class

• The number of periods per class is mostly legislated (Decreto-Lei n.º 139/2012), leaving some options to be made by the students or schools

• Another cause of variability are the different paths that students can take

• We calculated the profile for each school of periods per class for each group of schools, and applied it to its classes

• The non teaching needs for periods were distributed by the teaching groups proportionally to the needs for periods for lessons
The Fraction of tenured Teachers that leave the system (function of the age group) was determined by optimization of the number of teachers in each age group for each group of schools.

The number of periods provided by teachers of each age group was also obtained from the legislation.
Results – 1st Cycle Teachers

- Birth rate uncertainty only starts showing around 2022
- Teachers retire faster than birth rates decline

• Regardless of the scenario, needs for teachers always increase in the absence of hirings
Results – 1st Cycle Teachers

- The % of needs hired determines the fraction of needs that are covered with tenure teachers.
- Fraction of Tenure Teacher decreases for all hiring scenarios.

- The hiring of high % of needs generates oscillations in the number of teachers hired.
Results – 2nd Cycle Visual and Technological Teachers

2nd Cycle Visual Education Teachers, No Teachers Hired (240)

- Birth rate uncertainty only starts showing around 2026
- Initial teacher excess that only stops around 2025

- Almost linear increase in needs

Graphs showing the number of teachers needed and the number of tenure teachers over time for different scenarios:

- Teachers Needed, High Births Scenario
- Teachers Needed, Central Scenario
- Teachers Needed, Low Births Scenario
- Tenure Teachers

Graphs also show the difference between the number of teachers needed and the number of tenure teachers over time for different birth rate scenarios.
Results – 2nd Cycle Visual and Technological Teachers

- Few teachers would be hired for tenure, in all scenarios

- Teachers are hired even though there are too many (due to different schools)
Results – 3rd Cycle and Secondary Math Teachers

- Almost linear increase in needs

- Birth rate uncertainty only starts showing around 2029
Results – 3rd Cycle and Secondary Math Teachers

- Few oscillations

- Fraction of tenure teachers decreases

3rd Cycle and Sec. Math Teachers, Central Scenario (500)

Teachers Needed
Tenure Teachers: 50% Needs Hired
Tenure Teachers: 25% Needs Hired
Tenure Teachers: 10% Needs Hired

Teachers Hired, Central Scenario (500)

10% Needs Hired each Year
25% Needs Hired each Year
50% Needs Hired each Year
Results – All Teacher Groups

- Almost linear increase in needs
- Birth rate uncertainty only starts showing around 2024
Stable number of teachers needed for tenure from 1000 to 1500 per year for 10% needs hired and up to 1700 for 50% of needs hired
• To obtain the stable fraction of tenure teachers lets consider that:

\[
\text{Number of Teachers}(n + 1) = \text{Number of Teachers}(n) - \frac{\text{Number of Teachers}(n)}{\text{Average Time Tenure Teacher Teaches}} \\
+ \text{Fraction of Needs Hired per Year}(\text{Number of Teachers Needed} - \text{Number of Teachers}(n))
\]

• By solving for a stable number of teachers:

\[
\frac{\text{Number of Teachers}}{\text{Number of Teachers Needed}} = \frac{\text{Fraction of Needs Hired per Year}}{1/\text{Average Time Tenure Teacher Teaches} + \text{Fraction of Needs Hired per Year}}
\]

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<th>0.1</th>
<th>0.25</th>
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<td>0.88</td>
<td>0.92</td>
<td>0.94</td>
<td>0.96</td>
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Conclusions

• Uncertainty in the number of births takes some years until it is noticed
• Higher fractions of needs being hired each year may cause large fluctuations in the number of teachers being hired each year
• Even small fractions being hired each year generate high percentages of tenure teachers
• The overall number of teachers that need to be hired for tenure each year is between 1000 and 1500 by hiring 10% of needs or up to 1700 in 2030 for 50% of needs


Hanushek, Eric A. *The Economics of School Quality*. German Economic Review 6, no. 3, August 2005

