System level factors influencing fourth grade students' science achievements in TIMSS

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ECER 2012, Cadiz

Objectives of the study

To find out:

- Impact of social, economic, political and demographic factors on average achievements in science of fourth grade students
- Best fitting indicators to forecast students' average achievements in science
- How to evaluate the achievements of the Latvian fourth grade students in the TIMSS 2007

Selected countries for analysis

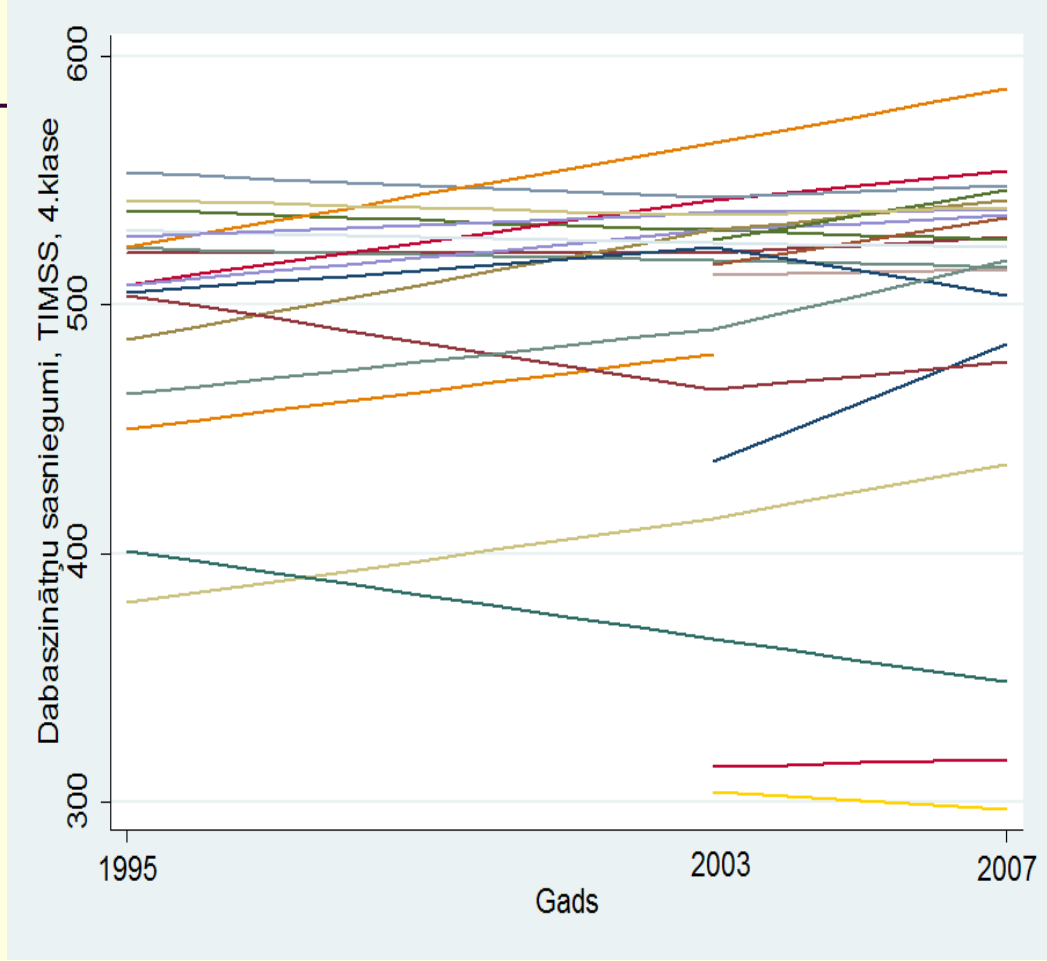
1. Countries participates in the TIMSS at least for two waves
2. Country presents reasonable economic, social and demographic indicators

United Kingdom TIMSS results – weighted average from England and Scotland

Nr.	Country
1	Armenia
2	Australia
3	Austria
4	Cyprus
5	Czech Republic
6	Hong Kong SAR
7	Hungaria
8	Iran, Islamic Rep.
9	Italia
10	Japan
11	Kuwait
12	Latvia
13	Lithuania
14	Morocco
15	Netherlands
16	New Zealand
17	Norway
18	Russian Federation
19	Singapore
20	Slovenia
21	Tunisia
22	United Kingdom
23	United States

Assumption

- Students' achievements have linear trend over the consecutive years
- Missing data have been interpolated linearly



Six factors are selected

- State economic situation, living standard
- Economic development
- Demography
- Fiscal policy regarding the distribution of expenditure
- State policy regarding the education spending
- Overall education level

State economic situation, living standard

1. GNI per capita, PPP current international $
2. Exports of goods and services, % of GDP
3. High-technology exports, % of manufactured exports
4. Employment to population ratio, 15+, total, %
5. Energy use, kg of oil equivalent per capita
6. Electric power consumption, kWh per capita

Economic development

- GDP growth, annual, %;
- Unemployment, total, % of total labor force
- Inflation, consumer prices, annual %

Demography

- Population total, milj
- Land area, sq km
- Population density, people per sq km
- Rural population, % of total population
- Population ages 0-14, % of total population
- Population growth, annual %.
- Fertility rate, total, births per woman

Fiscal policy regarding the distribution of expenditure

- Health expenditure per capita, current US $
- Health expenditure, total, % of GDP
- Public spending on education, total, % of government expenditure
- Military expenditure, % of GDP
- Research and development expenditure, % of GDP
- Researchers in R&D, per million people

State policy regarding the education spending

- Expenditure per student, primary, % of GDP per capita
- Expenditure per student, secondary, % of GDP per capita
- Expenditure per student, tertiary, % of GDP per capita
- Pupil-teacher ratio, primary

Overall education level

- Average years of total schooling, age 20-24, total
- Average years of secondary schooling, age 15+, total
- Average years of tertiary schooling, age 25+, total
- Literacy rate, adult total, % of people ages 15 and above
- Ratio of female to male tertiary enrollment, %
- Ratio of female to male secondary enrollment, %
- School enrollment, tertiary, % gross
- Internet users per 100 people
- Percentage of population by educational attainment, age 25+, total, completed tertiary

Data sources

- Main database – World Bank (data.worldbank.org)
- Other data base - Rapid Intelligence (NationMaster.com)
- Other sources

Data base used for the analyisis

- 23 countries
- 36 variables
- ~10000 data inputs

Data tratment

- Missing values – replaced with mean values
  - Russian Federation – Expenditure per student, primary, % of GDP per capita
  - Russian Federation – Expenditure per student, secondary, % of GDP per capita
  - Hong Kong SAR – Military expenditure, % of GDP
- Some indicators were logarithmically transformed (for example, GNI-Gross National Income)

Panel data linear regression models

Ordinary least square linear regression model – ORS

$$Y_{it} = \alpha + \beta X_{it} + U_{it}$$

i – country

t - year

Fixed effect linear regression model – FE

$$Y_{it} = \alpha_i + \beta X_{it} + U_{it}$$

i – country

t - year

Baltagi, 2005; Wooldridge, 2003; Wooldridge, 2009 ; Cameron and Trivedi; 2009; Hocko, 2005; Hsiao, 2003; Stata, 2011

STATA 12 software was used for the analysis

Results

Variable	Panel data fixed effect model			
	Coefficient β	SE β	t value	Significance p
gadimac	3,00	1,2	2,55	0,011
iedzl14	-1,79	0,58	-3,10	0,002
xelektr	28,30	9,1	3,12	0,002
strada	-1,98	0,55	-3,60	0,000
xizdpetn	22,40	3,3	6,74	0,000
xbezdarb	-14,60	2,8	-5,27	0,000
xizdmili	17,60	2,7	6,44	0,000
izdvespr	-5,37	0,86	-6,21	0,000
constant	412,7	88	4,66	0,000

gadimac	Average years of total schooling, age 20-24, total
iedzl14	Population ages 0-14, % of total population
xelektr	Electric power consumption, kWh per capita, log
strada	Employment to population ratio, 15+, total, %
xizdpetn	Research and development expenditure, % of GDP, log
xbezdarb	Unemployment, total, % of total labor force, log
xizdmil1	Military expenditure, % of GDP, log
izdvespr	Health expenditure, total, % of GDP

Coefficient of determination– over 0,9

Results

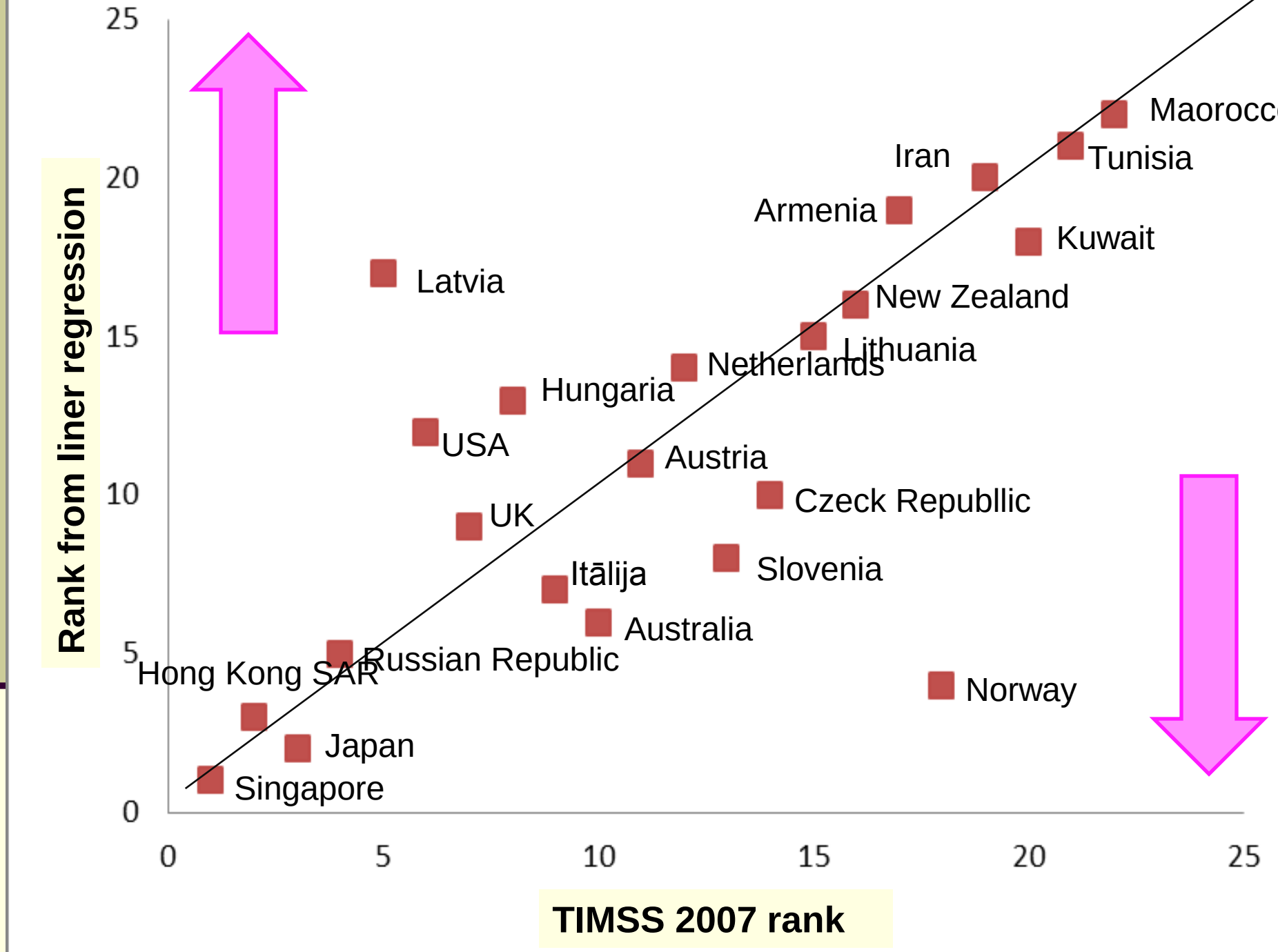
+	Average years of total schooling, age 20-24, total
-	Population ages 0-14, % of total population
+	Electric power consumption, kWh per capita, log
-	Employment to population ratio, 15+, total, %
+	Research and development expenditure, % of GDP, log
-	Unemployment, total, % of total labor force, log
+	Military expenditure, % of GDP, log
-	Health expenditure, total, % of GDP
	No any indicator from education funding

Results, grade 4, Math

+	Average years of total schooling, age 20-24, total
-	Employment to population ratio, 15+, total, %
+	Research and development expenditure, % of GDP, log
-	Unemployment, total, % of total labor force, log
+	Military expenditure, % of GDP, log
- p<.1	Health expenditure, total, % of GDP
	No any indicator from education funding

Ranks of Real TIMSS and by model forecasted achievements using the factors analyzed in the model (economic, social, political and demographical factors)

Country	Rank in TIMSS 2007	Rank in regression model	Differece
Latvia	5	17	12
USA	6	12	6
Hungary	8	13	5
UK	7	9	2
Netherlands	12	14	2
Armenia	17	19	2
Hong Kong	2	3	1
Russia	4	5	1
Iran	19	20	1
Singapoure	1	1	0
Austria	11	11	0
Lithuania	15	15	0
New Zealand	16	16	0
Tunisia	21	21	0
Morocco	22	22	0
Japan	3	2	-1
Italia	9	7	-2
Kuwait	20	18	-2
Australia	10	6	-4
Czech Republic	14	10	-4
Slovania	13	8	-5
Norway	18	4	-14


Rank from liner regression
TIMSS 2007 rank
0
5
10
15
20
25
Maorocco
Tunisia
Iran
Armenia
Kuwait
Latvia
New Zealand
Lithuania
Netherlands
Hungaria
USA
Austria
Czeck Republlic
UK
Slovenia
Itālija
Australia
Russian Republic
Hong Kong SAR
Norway
Japan
Singapore

Conclusions

- State economic, social and demographical factors influence strongly achievements in science for primary level students
- The achievements of Latvian primary students are higher than forecasted by the model
- We believe that high achievements of primary students in Latvia are determined by education system of Latvia
- Previous studies conclude that science textbooks in Latvia are definitely a factor that determines students' high achievements

Thank you!