# Identifying School Climate Variables Associated with Students' Financial Literacy Outcomes

*A Cross-Country Comparison Using PISA 2018 Data*

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敬致父母

To my parents

*Study hard what interests you the most in the most undisciplined, irreverent and original manner possible.*

Richard P. Feynman

# Contents

# List of Tables

# List of Figures

# Acknowledgement

Thank-you goes to

# Popular Abstract

This is a press release style abstract.

# Abstract

Repeated economic crises in recent memory have exposed the harsh consequences of financial *illiteracy* shared by high proportions of the general population. Policy makers experienced little resistance when identifying youth as the most effective group for bringing about improvement in citizens' ability to engage with economic and financial matters, but opinions quickly diverge over the optimal approaches for achieving such targeted outcome. Existing literature frequently reports the importance of family environment in cultivating students' financial literacy through the process of "financial socialisation" – [definition goes here] (reference). Such practice, however, encounters interrogation by educators over equity concerns should families remain the main arena for financial literacy development. Schools play vital roles in alleviating inequality in accessing education and training in general but scarce research so far has been devoted into identifying the specific classroom factors that are most effective in advancing students' financial literacy outcomes. The current study therefore attempts to contribute to this enquiry by investigating the relationship between school climate variables and students' financial literacy achievement with an aim of stimulating policy debate about the levers and instruments available to education interventionists for the purpose of improving young people's financial literacy and preparedness as they step into an increasingly uncertain world. Using the 2018 PISA dataset, this paper employs a three-level hierarchical model to conduct cross-country comparisons to highlight school climate variables that are most strongly associated with high financial literacy outcomes.

# Chapter 1

# Introduction

This is a line that recently got added.

## 1.1 Broad motivations

As shown in ??, the world is not that bad.

## 1.2 Quick definitions of key terms

### 1.2.1 Financial literacy vs finance

### 1.2.2 Flow vs stock: teaching vs assessment of financial literacy

## 1.3 My topic(s)

## 1.4 Zooming out: Why this topic is important?

(Abu Bakar & Abu Bakar, 2020; Agarwal et al., 2015; Agnew & Cameron-Agnew, 2015; Agnew & Harrison, 2015; Agyei, 2018; Akben-Selcuk & Altiok-Yilmaz, 2014; Ali et al., 2014; Allgood & Walstad, 2016; Amagir et al., 2018; Aprea et al., 2015; Arceo-Gómez

& Villagómez, 2017; Arellano et al., 2014, 2018; Arthur, 2012; Atkinson & Messy, 2011; Bartholomae & Fox, 2016; Batsaikhan & Demertzis, 2018; Becchetti et al., 2013; De Beckker et al., 2019, 2020; Beckmann & Reiter, 2020; Behrman et al., 2012; Bel & Eberlein, 2015; Belás et al., 2016; Bernheim et al., 2001; Birbili & Kontopoulou, 2015; L. Blue & Brimble, 2014; L. Blue et al., 2014; L. E. Blue, 2020; L. E. Blue et al., 2018; L. E. Blue & Pinto, 2017; Boisclair et al., 2017; Bongini et al., 2012; Bottazzi & Lusardi, 2016; Bover et al., 2018, 2020; Bowen, 2002; Bray & Thomas, 1995; Breitbach & Walstad, 2016; Brimble & Blue, 2013; Brown & Graf, 2013; Brown et al., 2018; Brown et al., 2016; Bucciol et al., 2020; Bucher-Koenen et al., 2016; Caliendo & Findley, 2013; Cameron et al., 2013; Van Campenhout, 2015; Campioni et al., 2017; Carlin & Robinson, 2012a, 2012b; Caro & Biecek, 2017; Carvalho, 2020; Chambers & Asarta, 2018; Chambers et al., 2019; Chatfield, 1978; Chen & Garand, 2018; Chiang, 2020; Ciemleja et al., 2014a, 2014b; Cole et al., 2016; Cole et al., 2009; Collins, 2013; Connolly & Nicol, 2015; Cordero & Pedraja, 2019; Cude et al., 2016; Cupak et al., 2018a, 2018b; Cupák et al., 2018; Curugan et al., 2020; Danes & Haberman, 2007; von Davier, 2014; Davies et al., 2016; Davoli & Rodríguez-Planas, 2020; Driva et al., 2016; Eickelmann et al., 2016; Emmons, 2005; Eniola & Entebang, 2016; Erner et al., 2016; Fabris & Luburić, 2016; Farinella et al., 2017; Fernandes et al., 2014; Ferrari, 2019; Fonseca et al., 2012; Fornero & Lo Prete, 2019; Förster et al., 2017; Frączek & Klimontowicz, 2015; Frisancho, 2019; Garder, 1985; Garg & Singh, 2018; Geiger et al., 2016; Gomes, 2020; Goyal & Kumar, 2020; Gramaţki, 2017; Grohmann, 2016; Grohmann et al., 2018; Grohmann et al., 2015; Grund et al., 2020; Gudmunson & Danes, 2011; Gudmunson et al., 2016; Guest & Brimble, 2018; Hanushek & Woessmann, 2012a, 2012b; Happ et al., 2016; Hastings et al., 2013; Henderson et al., 2020; Hira, 2016; Ho & Lee, 2020; Holtsch & Eberle, 2016; Huston, 2010, 2012; Ibarra et al., 2019; Janssen et al., 2019; Jappelli, 2010; Jappelli & Padula, 2013, 2015; Jorgensen & Savla, 2010; Jüttler & Schumann, 2016; Kaiser & Menkhoff, 2020; Kalmi & Ruuskanen, 2018; Karakurum-Ozdemir et al., 2019; Kell, 2014; Kenayathula et al., 2020; Khalil, 2020; Khan et al., 2017; Khoirunnisaa & Johan, 2020; Kiliyanni & Sivaraman, 2016; Kim et al., 2020; Klapper & Lusardi, 2019; Klieme, 2020; Kosor et al., 2020; Kunovskaya et al., 2014; Laukaityte & Wiberg, 2018; Leumann et al., 2016; Li, 2020; Liaqat et al., 2020; Longobardi et al., 2017, 2018; Lusardi, 2012, 2015a, 2015b, 2019; Lusardi & Lopez, 2016; Lusardi et al., 2019; Lusardi & Mitchell, 2007, 2008, 2011, 2014; Lusardi et al., 2010; Lusardi et al., 2017; Lusardi & Wallace, 2013; Mancebón et al., 2015; Mancebón et al., 2019; Mandell & Klein, 2009; Mändmaa, 2020; Marsh et al., 2004; Marsh et al., 2012; Marsh et al., 2019; Matheson et al., 2020; Mitchell & Lusardi, 2015; Mohammadpour, 2013; Moreno-Herrero et al., 2018a, 2018b; Mountain et al., 2020; Norvilitis & MacLean, 2010; Norvilitis et al., 2006; Nurhasanah et al., 2020; Oberrauch & Kaiser, 2019; OECD, 2005, 2009, 2020; Oliver-Márquez et al., 2020; Opletalová, 2015; Page, 2020; Paolo Stella et al., 2020; Pesando, 2018; Peugh, 2010; L. Pinto & Couson, 2011; L. E. Pinto, 2012, 2013; Pokropek, 2016; Potrich et al., 2015; Potrich et al., 2016; Preston & Wright, 2019; Lo Prete, 2013; R Core Team, 2020; Remund, 2010; Riitsalu & Põder, 2016; Rinaldi & Todesco, 2012; Rodríguez et al., 2020; Rohatgi & Scherer, 2020; van Rooij et al., 2011; Rubin, 1987; Rust, 2014; Rustomfram & Robinson, 2015; Rutkowski et al., 2010; Savard et al., 2020; Sawatzki et al., 2020; Schmeiser & Seligman, 2013; Schuhen & Schürkmann, 2014; Schürkmann & Schuhen, 2013; Sellar & Lingard, 2013; Serido & Deenanath, 2016; Shadish et al., 2002; Shen et al., 2016; Shim et al., 2010; Shim et al., 2009; Siegfried, 2016; Silgoner et al., 2015; Skagerlund et al., 2018; Söderlund & Eriksson, 2020; Sole, 2014; Spataro & Corsini, 2017; Stanisavjević & Stojković, 2018; Stolper & Walter, 2017; Strahija et al., 2020; Strietholt & Scherer, 2018; Sun et al., 2012; Sutter et al., 2020; Taylor & Wagland, 2013; Tchatoka & Varvaris, 2020; Te'eni-Harari, 2016; Tezel, 2015; Thomas & Spataro, 2018; Thomson & De Bortoli, 2017; Titko, Ciemleja et al., 2015; Titko, Lace et al., 2015; Toosi et al., 2020; UiO, 2020; United Nations, 2020; Utkarsh et al., 2020; Vale et al., 2020; Vyvyan et al., 2014; Walstad et al., 2016; H. Wang & Xu, 2020; M.-T. Wang &

Degol, 2015; Willis, 2008; World Bank, 2020; Yoshino et al., 2015; J. H. Young, 2013; R. Young & Johnson, 2015; Zhu, 2012; Zhu et al., 2015; Zokaityte, 2016)

# Chapter 2

# Conceptual Framework

## 2.1 In-depth definitions of “financial literacy”

### 2.1.1 Every term my readers need in order to understand my research question

### 2.1.2 Survey not only PISA but also alternative definitions, even critiques of such definitions

### 2.1.3 Any practices that are common in maths/literature but uncommon in financial literacy? Meaning? Implies?

## 2.2 Country-level Financial Knowledge Index

PISA 2018 financial literacy dataset (OECD, 2020) provides rich information about students and schools. For the purpose of cross-country comparison, however, the country-level financial literacy information must be addressed separately by the researchers. Earlier attempts such as Moreno-Herrero et al. (2018a) approximated this information using a variable "quality of math and science education" to control for country-level differences since consensus is yet to emerge about the most appropriate measure for countries' financial knowledge. Inspired by the UN's approach to forming Human Development Indices, a recent publication by Oliver-Márquez et al. (2020) proposed a macroeconomic measure for countries' general financial knowledge levels by examining their economic capability, educational training, existing practices in the financial markets as well as incentives to interact with financial products. More specifically, the authors considered a country's economic capability, represented by its GDP per capita, to be a key dimension in bringing about its financial knowledge index (FKI). Secondly, literature converges on the importance of educational training for a country's financial knowledge capability (OECD, 2005). Thirdly, countries with regular engagement with sophisticated financial products and financial markets should possess higher FKI. Lastly, countries with higher aggregate consumption levels and with ageing populations are likely to possess higher FKI due to more frequent exposure and pressure in retirement provision, respetively. Macroeconomic data needed for these computations can be sourced from the World Bank (World Bank, 2020) and the United Nations' *Human Development Reports* (United Nations, 2020).

Combining individual and institutional data cources can be a productive approach in international large-scale assessment (ILSA) research. According to the framework for comparative education analyses (Bray & Thomas, 1995), this project extends education outcome measures to a country level, addresses the aspect of society and labour market, and relates countries' entire populations to ILSA research (Strietholt & Scherer, 2018). By combining education outcome data with countries' economic performance indicators, this project remains most comparable to Hanushek and Woessmann (2012a)—while these authors looked into the relationship between countries' education achievement and their GDP growth, the current investigation highlights how countries' GDP, along with other macroeconomic practices, in turn systematically impacts on their youth's educational performance.

**Figure 2.1**

*Path Diagram: Country-level (L3)*

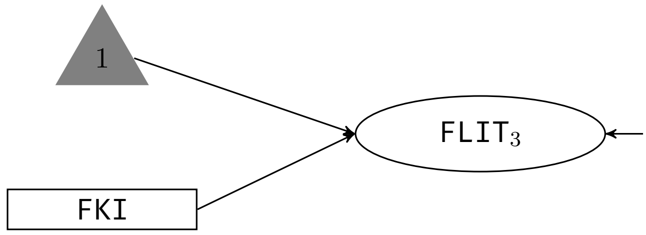
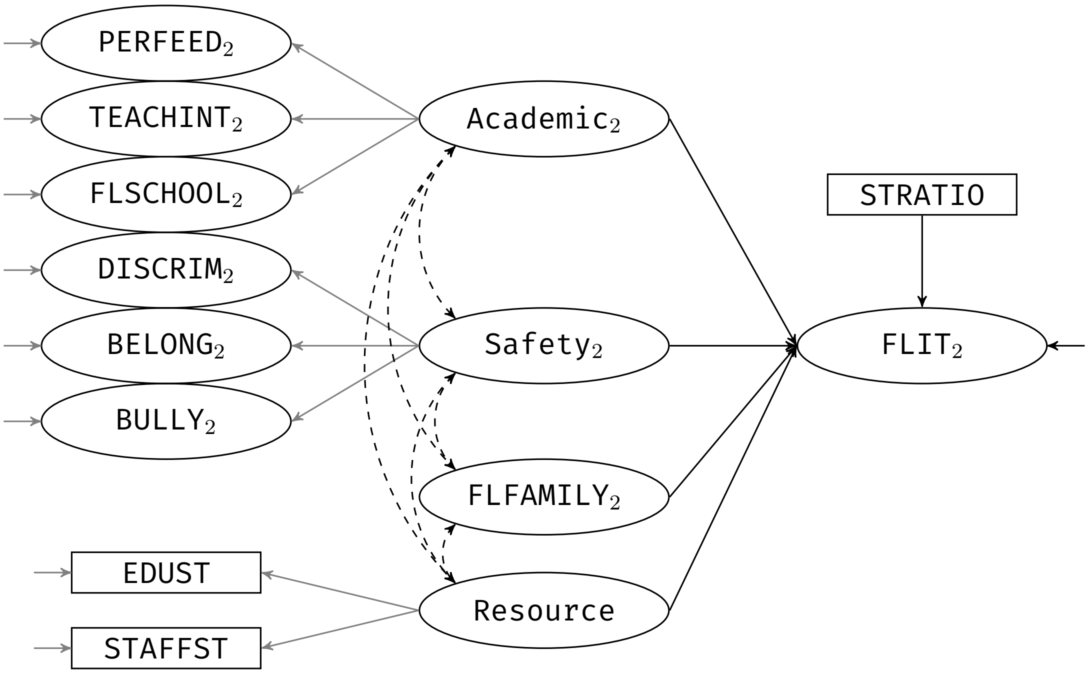



**Figure 2.2**

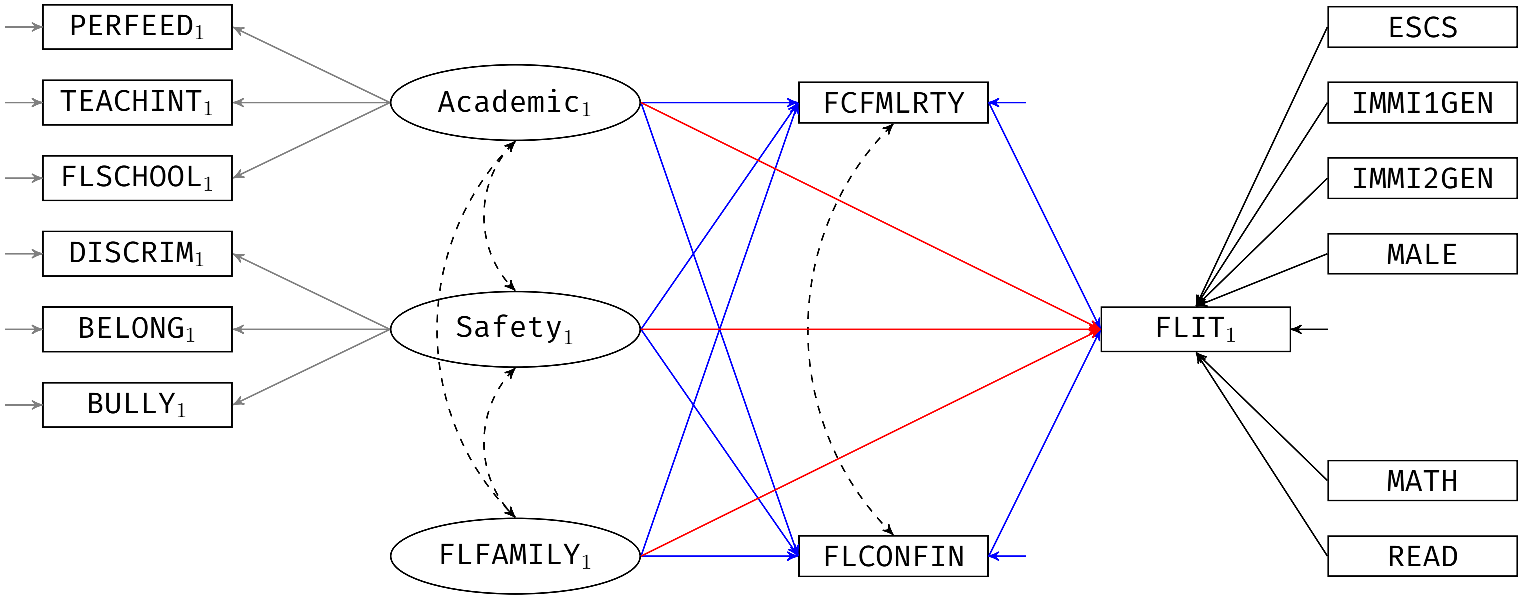
*Path Diagram: School-level (L2)*




*Note.* Manifest variables are surrounded by rectangles and latent variables by ovals. Covariances between variables are represented by dashed arcs. Error variances are shown as short arrows.

**Figure 2.3**

*Path Diagram: Student-level (L1)*




*Note.* Measurement models are coloured in gray. The direct and indirect paths of the structural component are represented in red and blue respectively.

# Chapter 3

# Methods

## 3.1 Data / Sample / Participants

This study drew its primary data soruce from PISA 2018 database (OECD, 2020) containing 107,174 observations spanning 20 countries, in which students were asked about their demographic background, family lives and school experiences. For the financial literacy section, in particular, students responded to qustions about their confidence about financial matters, familiarity with concepts of finance, their parental involvement in matters of fianncial literacy. Ten plausible values were subsequently generated by PISA organisers as measures of students' financial literacy outcomes and were used as the dependent variable.

Student-level independent variables are

School-level independent variables are

Country-level independent variables are

Missing data are handled using Mplus's multiple imputation procedure with ten imputations generated and pooled subsequently following Rubin's Rule (Rubin, 1976).

A three-level multigroup structural equation model was employed to account for the hiearchical structure of the PISA design, with private versus public school as the grouping variable.

## 3.2 Measurement of financial literacy

### 3.2.1 Background questions

### 3.2.2 Students' motivation of spending money

### 3.2.3 Four-point Likert scale

### 3.2.4 Averages

## 3.3 Country-level Financial Knowledge Index

This project closely follows Oliver-Márquez et al.'s (2020) procedure in developing country-level financial kowledge indices using four sub-indices: economic capability ($\mathtt{EC}$), educational training ($\mathtt{ET}$), existing practices in financial market ($\mathtt{Use}$), and incentives ($\mathtt{Need}$) to engage with financial products. The first sub-index $\mathtt{EC}$ is calculated using the logarithm of a country's GDP per capita in current international dollars (purchasing power parity adjusted). For the $\mathtt{ET}$ sub-index, a country's highly skilled workforce is represented by its postgraduate to total tertiary graduation ratio, and the mean years of schooling is used to measure its general education level. For the $\mathtt{Use}$ sub-index, gross portfolio equity assets (GPEA) and insurance company assets (ICA) are considered sophisticated financial products a country engages in. Additionally, in order to capture the central role of technology in amplifying the proliferation and use of financial assets, the proportion of a country's Internet users (IUS) enters the definition via

$$\mathtt{Use} = (\mathrm{GPEA} + \mathrm{ICA})^{\mathrm{IUS}}.$$

The final sub-index $\mathtt{Need}$ is compiled as

$$\mathtt{Need} = (\mathrm{PFA} + \mathrm{AC})^{\mathrm{AGEING}},$$

where PFA is the pension fund assets to GDP ratio. Aggregate consumption is defined as:

$$\mathrm{AC} = \frac{2\% \times \text{household final consumption expenditure}}{\mathrm{GDP}},$$

with the “2% rule” being drawn from Caliendo and Findley’s (2013) derivation, and the proportion of ageing population is computed as

$$\text{AGEING} = \frac{\left[\frac{\text{population}(>65)}{\text{population}(20\sim64)}\right]_{2018} - \left[\frac{\text{population}(>65)}{\text{population}(20\sim64)}\right]_{2009}}{\left[\frac{\text{population}(>65)}{\text{population}(20\sim64)}\right]_{2009}}.$$

### 3.3.1 Data Collection and Missing Data Treatment

The data sources for FKI computation are documented in Table 3.1 and its associated notes. Sub-indices `ET` and `Use` both contain missing observations for the year 2018. Majority of such missing data appear to be the result of administrative delay, with historic observations available until 2017. It is therefore feasible to conduct time-series forecasts using prior year observations to best approximate 2018 values.

**Table 3.1**

*Data Sources for FKI Computation*

| Database[a] | Country[b] | Series | Time |
|---|---|---|---|
| | | Economic Capacity | |
| WB-dev | 20 | GDP per capita, PPP (current international $) | 2018 |
| | | Educational Training | |
| WD-ed | 20 \ Russia | Graduates from ISCED 7 programmes in tertiary education, both sexes (number) | 2013–**2018** |
| | | Graduates from ISCED 8 programmes in tertiary education, both sexes (number) | 2013–**2018** |
| | | Graduates from tertiary education, both sexes (number) | 2013–**2018** |
| RS | Russia | PhD (Type 1)[c], PhD (Type 2)[d] | 2018 |
| RE | Russia | Master (Type 1)[e], Master (Type 2)[f], total tertiary *excluding* PhD[g] | 2018 |
| HDR | 20 | Dimension = Education; Education = Mean years of schooling (years) | 2018 |
| | | Use | |
| WB-fin | 20 | Gross portfolio equity assets to GDP (%) | 2011–**2018** |
| | | Insurance company assets to GDP (%) | 2011–**2018** |
| WB-dev | 20 | Individuals using the Internet (% of population) | 2009–**2018** |
| | | Need | |
| WB-fin | 20 \ Georgia | Pension fund assets to GDP (%) | 2008–**2018** |
| GP | Georgia | Minutes of the meeting of the investment board of the Pension Agency[h] | 2019* |
| GS | Georgia | GDP at current prices, billion GEL[i] | 2018 |
| WB-dev | 20 | Household and NPISHs final consumption expenditure, PPP (current international $) | 2018 |
| | | GDP, PPP (current international $) | 2018 |
| | | Population ages 0–14, male | 2009, 2018 |
| | | Population ages 0–14, female | 2009, 2018 |
| | | Population ages 15–64, male | 2009, 2018 |
| | | Population ages 15–64, female | 2009, 2018 |
| | | Population ages 65 and above, male | 2009, 2018 |
| | | Population ages 65 and above, female | 2009, 2018 |
| | | Population ages 15–19, male (% of male population) | 2009, 2018 |
| | | Population ages 15–19, female (% of female population) | 2009, 2018 |

*Note.* Sub-indices are shaded in gray. Bold font signifies this year contains missing data.

[a] WB-dev = World Bank – World development indicators
WB-ed = World Bank – Education statistics – All indicators
WB-fin = World Bank – Global financial development
HDR = Human Development Reports – Data
RS = Russian Federal State Statistic Service
RE = Russian Ministry of Education and Science
GP = Pension Agency of Georgia
GS = National Statistics Office of Georgia

[b] "20" = the 20 participanting countries in 2018 PISA financial literacy test: Brazil, Bulgaria, Canada, Chile, Estonia, Finland, Georgia, Indonesia, Italy, Latvia, Lithuania, the Netherlands, Peru, Poland, Portugal, Russian Federation, Serbia, Slovak Republic, Spain, and the USA. "\" = exluding or except

[c] https://rosstat.gov.ru/storage/mediabank/asp-2(1).xls, Sheet "по направлениям подготовки", Cell C7 = number of PhD graduates (Type 1)

[d] https://rosstat.gov.ru/storage/mediabank/asp-3.xls, Sheet "по научным специальностям", Cell B7 = number of PhD graduates (Type 2)

[e–g] https://minobrnauki.gov.ru/common/upload/download/VPO_1_2018.rar contains a spreadsheet СВОД_ВПО1_ВСЕГО.xls, Sheet "P2_1_3(1)", Cell E198 = number of master graduates (Type 1)[e], Cell E410 = number of master graduates (Type 2)[f], Cell E592 = total tertiary graduates *excluding* PhD[g]

[h] Minutes of the meeting of the investment board of the Pension Agency, p. 4, no. 3

[i] Gross domestic product (GDP), row = GDP at current prices, billion GEL, column = 2018

[*] Georgia started a new pension system on 1 January 2019. Since 2018 was a transitional period with scarce data, 2019 is used as the best approximation for Georgia's pension system for 2018.

### Sub-index **ET**

The 2018 archive for the number of master (ISCED 7), PhD (ISCED 8), and total tertiary graduates are incomplete for all participating countries except Georgia, Indonesia and Serbia. Figure 3.1 presents a time series plot of

$$\text{SKILLED} = \frac{\text{number of masters} + \text{number of PhDs}}{\text{total number of tertiary graduates}}$$

and suggests that this ratio is likely to be stable over time, especially between adjacent years. A "naive forecast", where the nearest available year's data are to be duplicated for 2018, is applied for SKILLED.

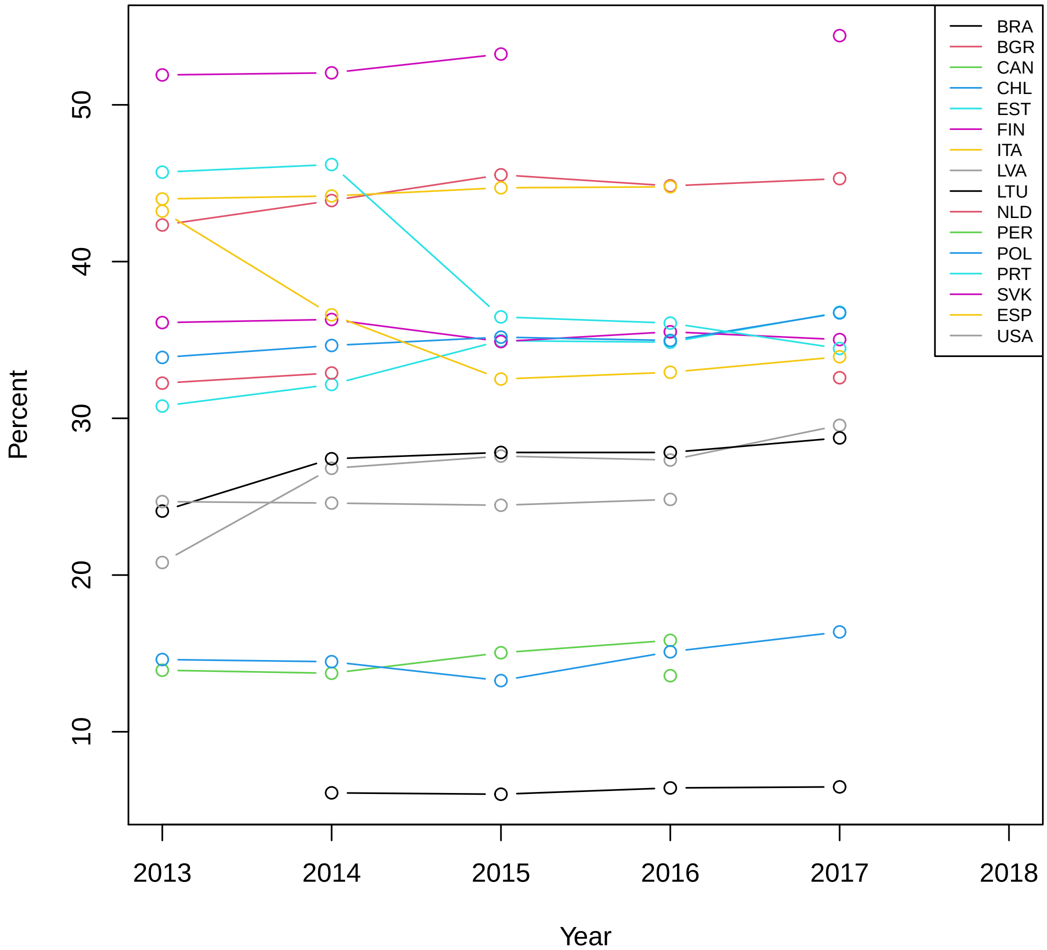
### Sub-index **Use**

All series involved in calculating this sub-index, GPEA, ICA and IUS, contain missing data. When time series data contain only exponential growth but no underlying trend, a simple exponential smoothing would suffice (Garder, 1985); if trend is present, Holt-Winters method is superior (Chatfield, 1978). Figure 3.2 facilitates this decision making by plotting both the original and log-transformed versions of GPEA and ICA series. Since curves after log-transformations have slopes, it is prudent to apply the Holt-Winters forecasting method in order to account for possible trends contained in the original series.

The IUS series contains missing data for Canada, Chile and the United States. Similar Holt-Winters procedure is applied to recover 2018 IUS data.

**Figure 3.1**

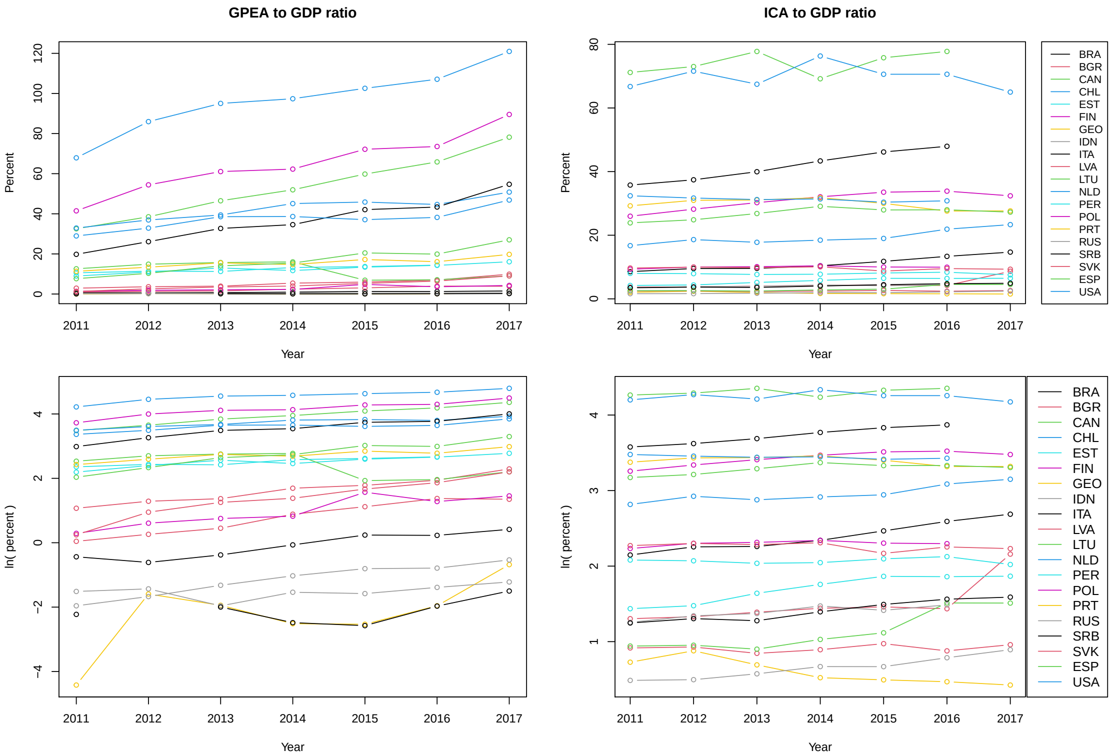
*Proportion of Postgraduates to Total Tertiary Graduations*




*Note.* “Postgraduate” is defined as master (ISCED 7) and PhD (ISCED 8) graduates. Countries not shown: GEO, IDN and SRB (2018 data available) and RUS (consult other sources)

**Figure 3.2**

*Time Series Trend Test*




*Note.* The time series plots after natural logarithm transformations (bottom panels) are not flat, suggesting the original series (top panels) contain trends. Holt-Winters method therefore is preferred over simple exponential smoothing for 2018 forecasts.

**Table 3.2**

*Data Utilised for Computing FKI*

| | Economic Capacity | Educational Training | | Use | | | Need | | |
|---|---|---|---|---|---|---|---|---|---|
| | GDP per capita | Skilled | Schooling | GPEA | ICA | IUS | PFA | AC | AGEING |
| BRA | 9.612 | 6.484 | 7.8 | 1.683 | 16.259 | 70.434 | 11.827 | 1.210 | 0.288 |
| BGR | 10.026 | 45.294 | 11.8 | 4.114 | 7.044 | 64.782 | 13.577 | 1.091 | 0.234 |
| CAN | 10.821 | 15.832 | 13.3 | 84.010 | 77.728 | 93.588 | 96.205 | 1.068 | 0.271 |
| CHL | 10.117 | 16.371 | 10.4 | 51.755 | 25.591 | 89.531 | 73.225 | 1.073 | 0.214 |
| EST | 10.501 | 36.765 | 13.0 | 16.399 | 7.681 | 89.357 | 18.012 | 0.876 | 0.163 |
| FIN | 10.807 | 35.024 | 12.4 | 93.626 | 31.481 | 88.890 | 0.834 | 0.974 | 0.370 |
| GEO | 9.588 | 24.039 | 12.8 | 0.784 | 1.469 | 62.718 | 52.024 | 1.227 | 0.042 |
| IDN | 9.362 | 7.771 | 8.0 | 0.636 | 4.612 | 39.905 | 1.826 | 1.059 | 0.145 |
| ITA | 10.665 | 44.771 | 10.2 | 57.434 | 51.260 | 74.387 | 10.589 | 1.075 | 0.155 |
| LVA | 10.330 | 29.554 | 12.8 | 8.598 | 2.538 | 83.577 | 14.732 | 1.027 | 0.142 |
| LTU | 10.487 | 28.749 | 13.0 | 9.008 | 5.500 | 79.723 | 7.457 | 1.107 | 0.149 |
| NLD | 10.961 | 32.590 | 12.2 | 124.171 | 64.956 | 94.712 | 207.938 | 0.805 | 0.326 |
| PER | 9.479 | 13.577 | 9.2 | 16.027 | 6.505 | 52.540 | 22.530 | 1.187 | 0.227 |
| POL | 10.368 | 36.725 | 12.3 | 4.853 | 9.535 | 77.542 | 9.838 | 1.085 | 0.355 |
| PRT | 10.444 | 34.454 | 9.2 | 19.353 | 25.579 | 74.661 | 8.761 | 1.133 | 0.237 |
| RUS | 10.267 | 30.349 | 12.0 | 0.302 | 2.614 | 80.865 | 4.415 | 0.941 | 0.155 |
| SRB | 9.774 | 28.076 | 11.2 | 0.306 | 5.111 | 73.361 | 0.845 | 1.171 | 0.280 |
| SVK | 10.391 | 54.417 | 12.6 | 10.644 | 8.873 | 80.660 | 12.497 | 0.962 | 0.300 |
| ESP | 10.609 | 33.929 | 9.8 | 27.681 | 28.230 | 86.107 | 10.235 | 1.044 | 0.186 |
| USA | 11.048 | 24.825 | 13.4 | 55.505 | 30.183 | 84.881 | 150.040 | 1.364 | 0.252 |

*Note.* Full variable names: Skilled = Postgraduate to total tertiary ratio; Schooling = Mean year of schooling; GPEA = Gross portfolio to GDP ratio; ICA = Insurance company assets to GDP ratio; IUS = Number of Internet users per 100 population; PFA = Pension fund assets to GDP ratio; AC = 2% of household final consumption expenditure to GDP ratio; AGEING = Aged-to-productive-population ratio (% change between 2009 and 2018)

#### Other Items with Data Concerns

Russia reported 67.96% and 61.01% of its total university degree receipients to be post-graduates for the year 2013 and 2015 respectively (2014 missing). This figure rapidly declines to 41.6% in 2016 and further down to 25.69% in 2017. Such volatility goes against the stable patterns shared by most countries in Figure 3.1, casting doubt on data reliability. Separate investigation is therefore conducted using Russian government archive (Notes c to g in Table 3.1).

Georgia underwent pension reform in 2018 with fund balance gradually transitioning to State Pension Agency for its official resumption of duty on 1 January 2019. Resultantly, 2018 pension balance for this country is unavailable but to be best appoximated using 2019 official data (Notes h, i and * of Table 3.1).

Table 3.2 documents the results of the abovementioned data recovery process.

### 3.3.2 Standardisation, Weights and FKI

Following Oliver-Márquez et al. (2020)'s procedure, all series in Table 3.2 undergo min-max normalisation such that the smallest entry receives a new score of 0.01 and the biggest number is re-coded to 0.99. This slight deviation from the original paper (where the min-max normalisation yields 0 to 1) is to avoid multiplying a series by zero or raising a base to the power of zero.

Variable weights are calculated following Oliver-Márquez et al. (2020)'s recipe to be the inverses of each series' standard deviations. Whereas a sub-index combines more than one series, each weight is further divided by the sum of the constituent weights so that total weights add to one.

FKI is finally computed by taking the geometric mean of all four sub-indices, subject to sub-index-weights similar to variable weights above, as presented in Table 3.3.

**Table 3.3**

*FKI and Sub-indices*

| | FKI | EC | ET | Use | Need |
|---|---|---|---|---|---|
| NLD | 0.939 | 0.939 | 0.640 | 1.805 | 1.000 |
| USA | 0.925 | 0.990 | 0.589 | 0.856 | 1.407 |
| CAN | 0.780 | 0.858 | 0.409 | 1.637 | 0.953 |
| ITA | 0.760 | 0.767 | 0.602 | 1.069 | 0.806 |
| ESP | 0.624 | 0.734 | 0.464 | 0.635 | 0.726 |
| FIN | 0.613 | 0.850 | 0.685 | 1.127 | 0.321 |
| LTU | 0.607 | 0.664 | 0.632 | 0.243 | 0.835 |
| PRT | 0.586 | 0.639 | 0.401 | 0.630 | 0.762 |
| BGR | 0.579 | 0.396 | 0.760 | 0.384 | 0.728 |
| EST | 0.577 | 0.672 | 0.746 | 0.266 | 0.574 |
| SVK | 0.563 | 0.608 | 0.924 | 0.301 | 0.440 |
| POL | 0.554 | 0.595 | 0.699 | 0.286 | 0.572 |
| LVA | 0.543 | 0.573 | 0.633 | 0.161 | 0.794 |
| CHL | 0.536 | 0.449 | 0.302 | 0.761 | 0.908 |
| RUS | 0.445 | 0.536 | 0.597 | 0.082 | 0.638 |
| SRB | 0.419 | 0.249 | 0.515 | 0.193 | 0.742 |
| GEO | 0.413 | 0.141 | 0.547 | 0.210 | 1.000 |
| PER | 0.299 | 0.078 | 0.194 | 0.691 | 0.877 |
| BRA | 0.133 | 0.155 | 0.010 | 0.432 | 0.832 |
| IDN | 0.115 | 0.010 | 0.040 | 0.973 | 0.787 |

*Note.* Table sorted in descending order by countries' FKI. FKI = financial knowledge index, EC = Economic Capability, ET = Educational Training.

## 3.4 What exactly I was using to address my research question

### 3.4.1 Sum score? Averages? One particular question?

### 3.4.2 Factor loading? Latent variables?

### 3.4.3 Motivation for choosing these measures

## 3.5 Software and version

## 3.6 My models

### 3.6.1 Motivation for choosing this particular model

### 3.6.2 Refer to my research question

## 3.7 Estimators I obtained

### 3.7.1 Motivation why these estimators rather than others

## 3.8 Weights? Plausible values?

## 3.9 Missing data and how I treated missing data

## 3.10 Model comparison

## 3.11 Guidelines and indices

# Chapter 4

# Results

## 4.1 Descriptive statistics

## 4.2 Correlation matrices

### 4.2.1 Across countries

### 4.2.2 Across levels: Country | School | Students

## 4.3 Examination of measurement models

## 4.4 Address the research question

**Table 4.1**

*Parameter Estimate*

| | Model 0 | | Model 1 | | Model 2 | |
|---|---|---|---|---|---|---|
| | Par. | S.E. | Par. | S.E. | Par. | S.E. |
| **FIXED EFFECTS** | | | | | | |
| Intercept | 481.17 | (10.50) | 376.22 | (13.47) | 27.80 | (4.61) |
| **Student-level Predictors** | | | | | | |
| Academic | | | | | | |
| Safety | | | | | | |
| Financial Socialisation | | | | | | |
| Familiarity | | | | | | |
| Confidence | | | | | | |
| SES | | | | | $0.30^{\dagger}$ | (0.53) |
| Male | | | | | 7.30 | (1.40) |
| 1st Generation Migrant | | | | | $0.05^{\dagger}$ | (3.65) |
| 2nd Generation Migrant | | | | | $-1.25^{\dagger}$ | (2.17) |
| Numeracy | | | | | 0.57 | (0.01) |
| Literacy | | | | | 0.38 | (0.02) |
| **School-level Predictors** | | | | | | |
| Academic | | | | | | |
| Safety | | | | | | |
| Resource shortage | | | | | | |
| Student-teacher ratio | | | | | | |
| **Country-level Predictors** | | | | | | |
| Financial Knowledge Index | | | 151.91 | (21.42) | 0.55 | (0.05) |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* |
| **RANDOM EFFECTS** | | | | | | |
| Student-level | 6034.80 | (317.12) | 6004.72 | (313.32) | 1645.19 | (52.95) |
| School-level | 2775.10 | (328.71) | 2882.72 | (356.54) | 56.89 | (12.27) |
| Country-level | 5163.06 | | 5158.35 | | 110.97 | (36.57) |
| **MODEL FIT INDICES** | | | | | | |
| Log-likelihood | −0.63 | (189.96) | −0.63 | (190.95) | −0.53 | (373.04) |
| AIC | 1.25 | (379.91) | 1.25 | (381.89) | 1.06 | (746.08) |
| BIC | 1.25 | (379.91) | 1.25 | (381.89) | 1.06 | (746.08) |
| SABIC | 1.25 | (379.91) | 1.25 | (381.89) | 1.06 | (746.08) |
| $\chi^2$ Test of Model Fit | | | 25.00 | (3.52) | 0.55 | (0.14) |
| RMSEA | | | | | | |
| CFI | | | 0.40 | (0.35) | | |
| TLI | | | | | | |
| SRMR L1 | | | 0.00 | (0.00) | | |
| SRMR L2 | | | 0.06 | (0.01) | | |
| SRMR L3 | | | 0.20 | (0.01) | 0.08 | (0.01) |

*Note.* Par. = parameter estimate, S.E. = standard error, $^{\dagger}$ = estimate that failed to reach 0.05 significance level, $M$ = mean estimate over ten plausible values, pooled using Rubin's Rule, $SD$ = standard deviation of estimates over ten plausible values. Mean estimates for log-likelihood, AIC, BIC and SABIC are recorded in $\times 10^6$ (i.e., millions), whose standard deviations are in original scale.

# Chapter 5

# Discussion

## 5.1 Brief summary

### 5.1.1 Remind readers what my research questions are

## 5.2 The implication of this study

## 5.3 Limitation and future directions

### 5.3.1 Word in positive form

## 5.4 Bird-eye view

### 5.4.1 What conclusion I can draw from this paper/study

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# Appendices

# Appendix A

# GDPR Documentation and Ethical Approval

This research project discharges its duty imposed by EEA's general data protection regulation (GDPR) by following Norwegian Centre for Research Data (NSD)'s notification test on Friday, 11 September 2020. Both PISA 2018 Database and the World Bank Open Data contain only aggregated and de-personalised datasets with no possibility of back-tracing to any particular participant. Resultantly, no identifiable personal data were collected or used at any stage of this research. The NSD's assessment letter outlines the agency's decision of not subjecting this project to the GDPR notification. The NSD decision letter also satisfies University of Oslo's ethical approval requirement and concludes the approval process.

About us (/personvernombud/en/about_us.html)
Norwegian (/personvernombud/meld_prosjekt/meldeplikttest.html)

NSD (/) > Personverntjenester (/personvernombud/) > Data Protection Services (/personvernombud/en/) > Notify project (/personvernombud/en/notify/) > Notification Test

Denne siden på norsk (/personvernombud/meld_prosjekt/meldeplikttest.html)

# Will you be processing personal data?

Are you unsure whether your project is subject to notification? Feel free to try our informal Notification test. Note that the test is intended as a guidance and is not a formal assessment.

**Will you be collecting/processing directly identifiable personal data?** ○Yes ◉No

A person will be directly identifiable through name, social security number, or other uniquely personal characteristics.

Read more about personal data (/personvernombud/en/help/vocabulary.html?id=8) and notification (/personvernombud/en/notify/index.html).

NB! Even though information is to be anonymized in the final thesis/report, check the box if identifying personal data is to be collected/processed in connection with the project.

**Will directly identifiable personal information be linked to the data (e.g. through a reference number which refers to a separate list of names/scrambling key)?** ○Yes ◉No

Note that the project will be subject to notification even if you cannot access the scrambling key (/personvernombud/en/help/vocabulary.html?id=11), as the procedure often is when using a data processor (/personvernombud/en/help/vocabulary.html?id=3), or in register-based studies (/personvernombud/en/help/research_methods/register_studies.html).

**Will you be collecting/processing background information that may identify individuals (indirectly identifiable personal data)?** ○Yes ◉No

A person will be indirectly identifiable if it is possible to identify him/her through a combination of background information (such as place of residence or workplace/school, combined with information such as age, gender, occupation, etc.).

**Will there be registered personal data (directly/indirectly/via IP or email address, etc.) using online surveys?** ○Yes ◉No

Please note that the project will be subject to notification even if you as a student/researcher cannot access the link to the IP or email address, as the procedure often is when using a data processor.

Read more about online surveys (/personvernombud/en/help/research_methods/online_surveys.html).

**Will there be registered personal data using digital photo or video files?** ○Yes ◉No

Photo/video recordings of faces will be regarded as identifiable personal data. In order for a voice to be considered as identifiable, it must be registered in combination with other background information, in such a way that people can be recognized.

Show results

## Notify project

Do I have to notify my project? (/personvernombud/en/notify/index.html)

Notification Form (/personvernombud/en/notify/meldeskjema_link)

Notifying changes (/personvernombud/en/notify/notifying_changes.html)

## Get help notifying your project

Processing the notification (/personvernombud/en/help/index.html)

Frequently asked questions (/personvernombud/en/help/faq.html)

Vocabulary (/personvernombud/en/help/vocabulary.html)

Research topics (/personvernombud/en/help/research_topics/)

Research methods (/personvernombud/en/help/research_methods/)

Information and consent (/personvernombud/en/help/information_consent/)

Other approvals (/personvernombud/en/help/other_approvals/)

## Result of Notification Test: Not Subject to Notification

You have indicated that neither directly or indirectly identifiable personal data will be registered in the project.

If no personal data is to be registered, the project will not be subject to notification, and you will not have to submit a notification form.

Please note that this is a guidance based on information that you have given in the notification test and not a formal confirmation.

For your information: *In order for a project not to be subject to notification, we presuppose that all information processed using electronic equipment in the project remains anonymous.*

*Anonymous information is defined as information that cannot identify individuals in the data set in any of the following ways:*

- *directly, through uniquely identifiable characteristic (such as name, social security number, email address, etc.)*
- *indirectly, through a combination of background variables (such as residence/institution, gender, age, etc.)*
- *through a list of names referring to an encryption formula or code, or*
- *through recognizable faces on photographs or video recordings.*

*Furthermore, we presuppose that names/consent forms are not linked to sensitive personal data.*

Kind regards,
NSD Data Protection

NSD – Norsk senter for forskningsdata AS    Harald Hårfagres gate 29    Tel: +47-55 58 21 17    nsd@nsd.no    Org.nr. 985 321 884
NSD – Norwegian Centre for Research Data    NO-5007 Bergen, NORWAY    Faks: +47-55 58 96 50    www.nsd.no

# Appendix B

# Data Management and Analysis Code

## Chapter 1

There are no R codes in .

## Chapter 2

### Data import

```
# Housekeeping
library(Orcs)
setwdOS(lin = "~/", win = "C:/Users/Tony/")


########################  Extract variable names
    ↪ ################################

#install.packages("intsvy")     # Install intsvy package if not yet
    ↪  done so
library(intsvy)

## Only need to extract variable names once
#pisa.var.label(
```

```
#     student.file="CY07_MSU_FLT_QQQ.SAV",
#     name="QQQ"      # File name of the .txt output file
#)    # Close pisa.var.lable

#pisa.var.label(
#     student.file="CY07_MSU_FLT_QQQ.SAV",
#     school.file="CY07_MSU_FLT_COG.SAV",
#     name="COG"      # File name of the .txt output file
#)    # Close pisa.var.lable

#pisa.var.label(
#     student.file="CY07_MSU_FLT_QQQ.SAV",
#     parent.file="CY07_MSU_FLT_TIM.SAV",
#     name="TIM"      # File name of the .txt output file
#)    # Close pisa.var.lable

## When importing data to Excel from CSV, use "--Fixed Width--" and type "0,13"

## In Excel, use formula D4=trim(clean(A4)) and drag down, in order to delete leading and trailing white spaces.

## Copy D4 into F4 but use "text only" option to strip off the formula.


library(data.table); setDTthreads(0) # 0 means all the availabe cores

var.names <- fread("Var_lab.txt", header=T, nThread=4)
var.names <- as.character(unlist(var.names[which(var.names$Source=="QQQ_student")][ , 2]))
country <- c("BGR", "BRA", "CAN", "CHL", "ESP", "EST", "FIN", "GEO", "IDN", "ITA", "LTU", "LVA", "NLD", "PER", "POL", "PRT", "QMR", "QRT", "RUS", "SRB", "SVK", "USA")

#########################  Stitch datasets together ################################

# Only in Windows: Double the memory allocated to R
# Turn it off in Linux
#memory.limit(size=64988)

# Import SPSS file into R
FL <- pisa.select.merge(
    student.file="CY07_MSU_FLT_QQQ.SAV",
    student=var.names,
    countries=country
)   # Close pisa2015.select.merge
```

```r

# Intsvy automatically re-generate country code, plausible values, etc.
# They are identical to the original dataset. Delete the newly generated variables (those end with .1)
FL <- FL[ , -grep("\\.1$", names(FL))]

# Export data into a CSV file for faster import next time
fwrite(FL, file="FL.csv", na="NA", row.names=F, col.names=T)


# Calculate mean achievement scores using 10 plausible values
pisa.tab <- pisa2015.mean.pv(pvlabel=subject, by=c("CNT", sex), data=pisa)
# Plots
plot(na.omit(pisa.tab))

# Produce frequency tables
for(.i in 1:length(unfair)){
    print(pisa2015.table(variable=unfair[.i], by=c("CNT", sex), data=pisa))
}

# Proficiency levels
pisa2015.ben.pv(
    pvlabel=subject,
#     cutoff=c(),     # If you want different cutoff points
    by=sex,
    data=pisa
)   # Close pisa2015.ben.pv

# Regression analysis
pisa2015.reg.pv(pvlabel=subject, x=unfair, by=c("CNT", sex), data=pisa)
```