Identifying School Climate Variables Associated with Students' Financial Literacy Outcomes

A Cross-Country Comparison Using PISA 2018 Data

Tony C. A. Tan

Thesis submitted for the degree of
Master in Assessment, Measurement and Evaluation
30 credits

Centre for Educational Measurement
Faculty of Educational Sciences

UNIVERSITY OF OSLO

Spring 2021

Identifying School Climate Variables Associated with Students' Financial Literacy Outcomes

A Cross-Country Comparison Using PISA 2018 Data

Tony C. A. Tan

Identifying School Climate Variables Associated with Students' Financial Literacy Outcomes

http://www.duo.uio.no/

Printed: Reprosentralen, University of Oslo

敬致父母

To my parents

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

Contents

List of Tables

List of Figures

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, 2020; 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; Cao-Alvira et al., 2020; 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; Endsley, 2020; Eniola & Entebang, 2016; Erner et al., 2016; Erylmaz et al., 2020; 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; Goodman, 1975; Goyal & Kumar, 2020; Gramaţki, 2017; Green, 1956; Grohmann, 2016; Grohmann et al., 2018; Grohmann et al., 2015; Grund et al., 2020; Gudmunson & Danes, 2011; Gudmunson et al., 2016; Guest & Brimble, 2018; Guttman, 1944; 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; Indefenso & Yazon, 2020; 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; Ozkale & Erdogan, 2020a, 2020b; 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; Runge & Hudson, 2020; Ruoss, 2020; Rust, 2014; Rustomfram & Robinson, 2015; Rutkowski et al., 2010; Savard et al., 2020; Savard, 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; Stride et al., 2015; 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; Warm, 1989; van Wee & Banister, 2016; Williams et al., 2020; Willis, 2008; World Bank, 2020; Wuttke et al., 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.

Table 2.1

Percentages of Missing Values

CNT	MALE	IMMI1GEN	IMMI2GEN	ESCS	FCFMLRTY	FLCONFIN	PERFEED	TEACHINT	FLSCHOOL	DISCRIM†	BELONG	BULLY	FLFAMILY	CURSUPP†	PASCHPOL†	STRATIO	EDUSHT	STAFFSHT
BGR	0	6	6	3	12	27	10	10	21	28	19	31	22	100	100	8	3	3
BRA	0	5	5	2	12	34	9	8	21	36	23	40	24	17	19	12	6	7
CAN†	0	7	7	5	11	15	100	100	13	100	8	14	14	100	100	100	2	2
CHL	0	4	4	3	10	24	5	4	13	30	15	34	15	9	8	18	9	9
ESP	0	3	3	2	5	21	3	2	7	25	9	29	8	100	100	11	5	6
EST	0	3	3	3	4	8	3	3	6	9	5	11	6	100	100	0	0	0
FIN	0	2	2	2	4	10	3	3	6	100	6	11	7	100	100	2	7	7
GEO	0	5	5	2	9	26	9	9	17	100	15	22	21	4	5	1	2	2
IDN	0	3	3	1	3	6	3	2	5	3	2	5	5	100	100	23	14	14
ITA	0	4	4	3	7	17	4	4	10	23	10	27	12	16	17	9	3	3
LTU	0	3	3	3	4	12	3	3	5	17	8	20	7	100	100	0	0	0
LVA	0	2	2	2	5	9	3	3	6	14	6	15	7	100	100	6	3	4
NLD	0	3	3	2	3	5	3	2	4	100	4	8	4	100	100	11	5	5
PER	0	2	2	1	2	11	5	4	4	56	31	65	5	100	100	2	0	0
POL	0	1	1	1	3	7	2	1	5	9	3	11	5	100	100	0	0	0
PRT	0	6	6	5	8	11	6	6	10	15	8	17	10	10	10	11	1	1
RUS	0	3	3	2	8	13	5	4	11	13	8	15	11	100	100	3	3	3
SRB	0	3	3	1	10	25	8	7	18	25	15	27	19	100	100	8	1	1
SVK	0	2	2	1	4	12	4	3	7	14	6	17	8	100	100	6	6	7
USA	0	3	3	2	3	6	2	1	4	100	4	6	4	100	100	16	10	10

Note. Using shades of red in addition to numbers (measured in %), this table visualises the missing percentages by variable and by country. Variables DISCRIM, CURSUPP and PASCHPOL are no longer pursued in the model because too many countries chose not to respond to these questions. Canada (CAN) is not included due to 100 percent missings on multiple variables. † marks the country and variables that are excluded from subsequent analyses.

Figure 2.1
Path Diagram: Country-level (L3)

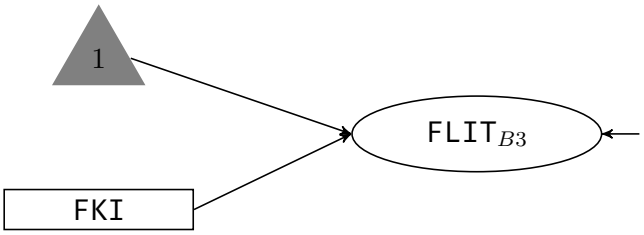
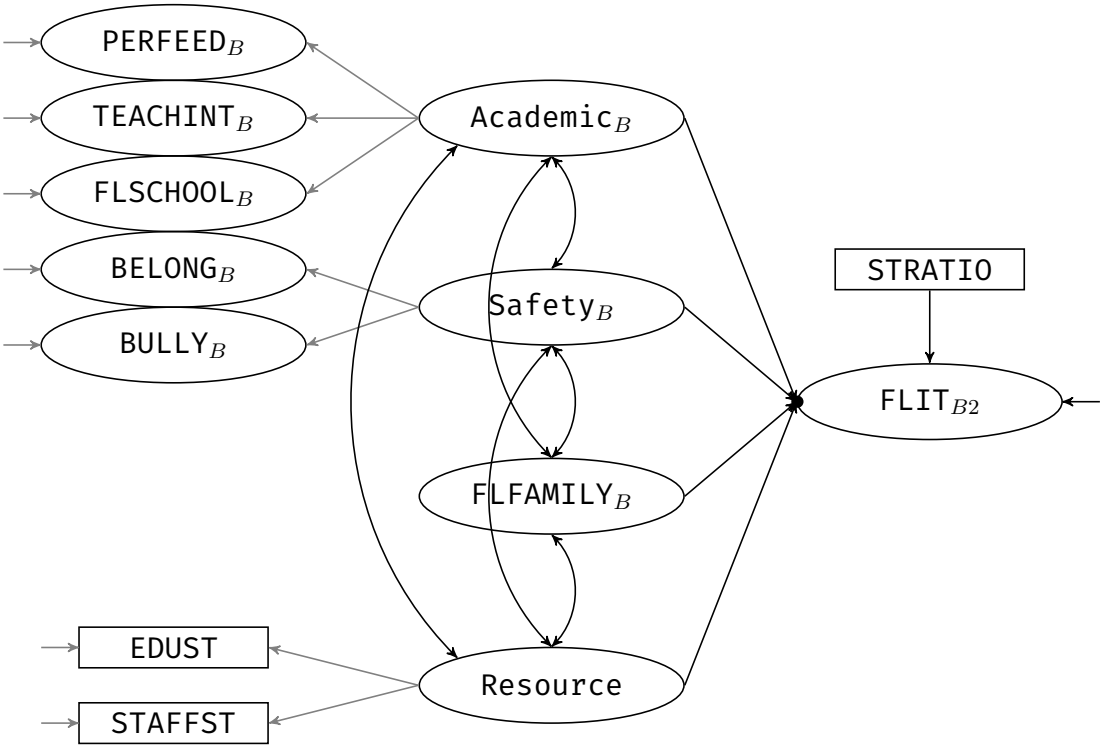


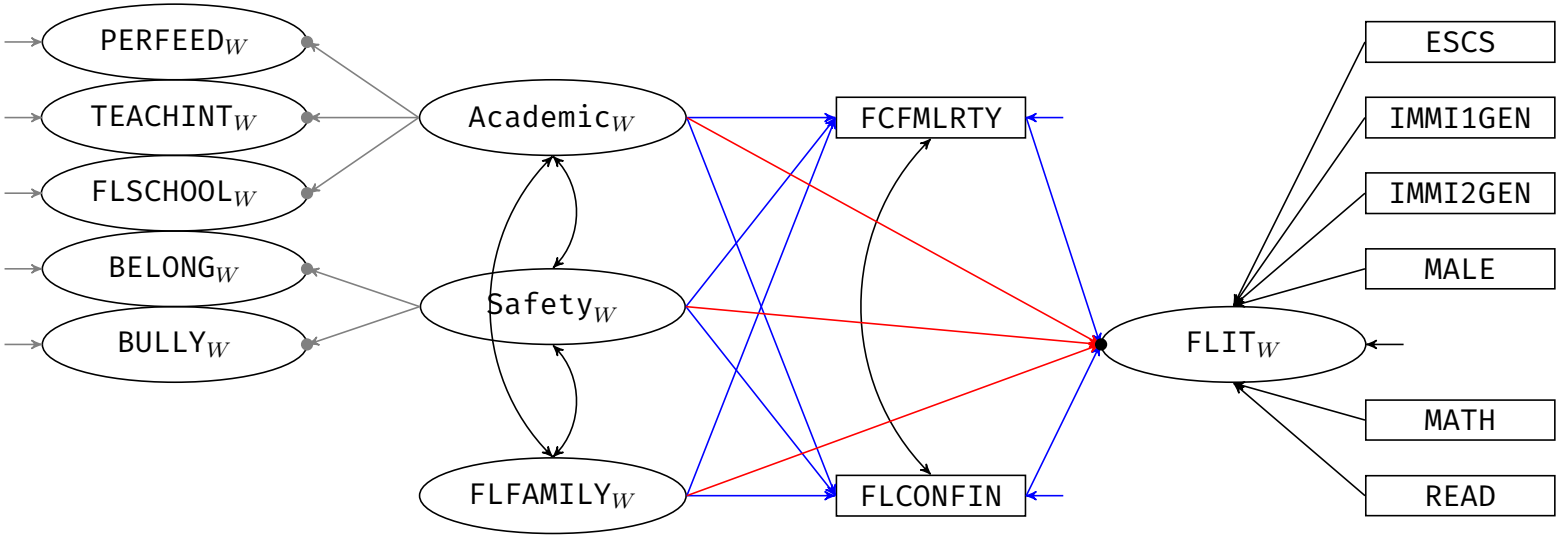
Figure 2.2
Path Diagram: School-level (L2)



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 (`EC`), educational training (`ET`), existing practices in financial market (`Use`), and incentives (`Need`) to engage with financial products. The first sub-index `EC` is calculated using the logarithm of a country's GDP per capita in current international dollars (purchasing power parity adjusted). For the `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 `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

$$\texttt{Use} = (\text{GPEA} + \text{ICA})^{\text{IUS}}.$$

The final sub-index `Need` is compiled as

$$\texttt{Need} = (\text{PFA} + \text{AC})^{\text{AGEING}},$$

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

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

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	19	GDP per capita, PPP (current international $)	2018
		Educational Training	
WD-ed	19 \ 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	19	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	19	Individuals using the Internet (% of population)	2009–**2018**
		Need	
WB-fin	19 \ 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	19	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] "19" = the 19 participating countries in 2018 PISA financial literacy test: Brazil, Bulgaria, 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

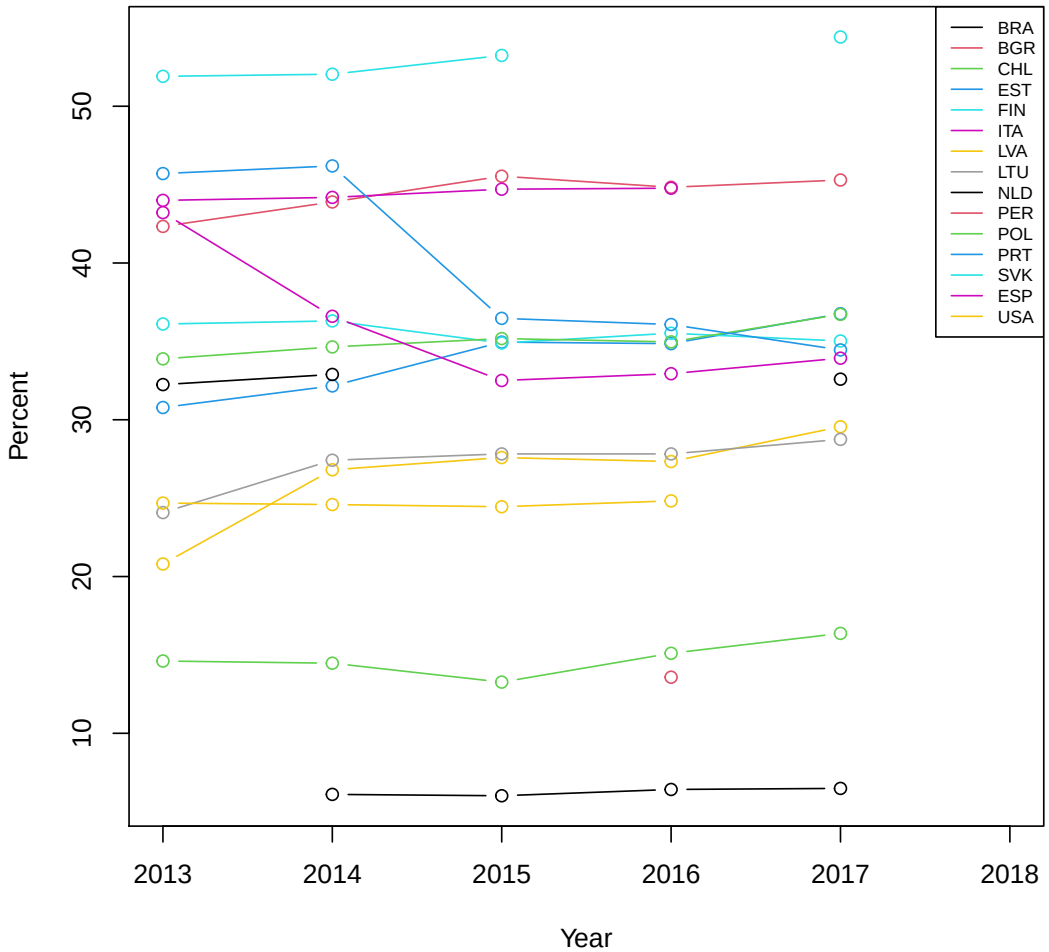
[*] Georgia started a new pension system on 1 January 2019. Since 2018 was a transitional period with scarce data, 2019 is used as the best approximation for Georgia's pension system for 2018.

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

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

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)

and suggests that this ratio is likely to be stable over time, especially between adjacent

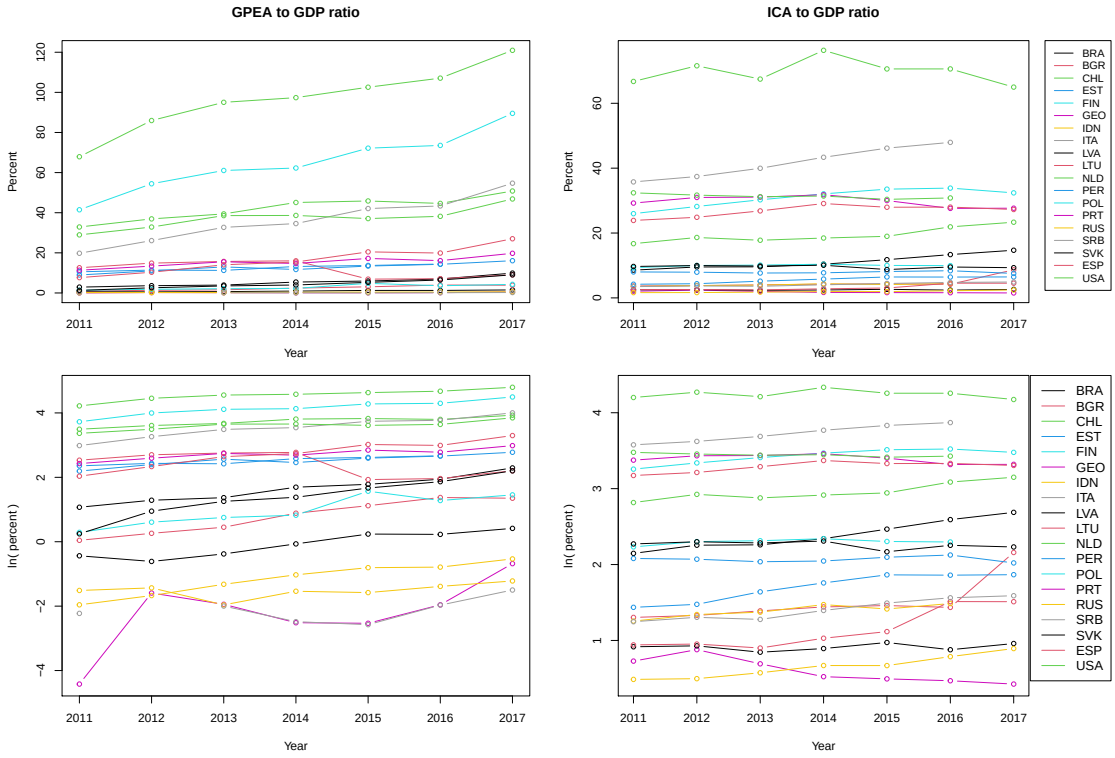
years. A "naive forecast", where the nearest available year's data are to be duplicated for 2018, is applied for SKILLED.

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.

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.

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

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	1.21	0.288
BGR	10.026	45.294	11.8	4.114	7.044	64.782	13.577	1.091	0.234
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	16.399	7.681	89.357	18.012	0.876	0.163
FIN	10.807	35.024	12.4	93.626	31.481	88.89	52.024	0.974	0.37
GEO	9.588	24.039	12.8	0.784	1.469	62.718	0.834	1.227	0.042
IDN	9.362	7.771	8	0.636	4.612	39.905	1.826	1.059	0.145
ITA	10.665	44.771	10.2	57.434	51.26	74.387	10.589	1.075	0.155
LVA	10.33	29.554	12.8	8.598	2.538	83.577	14.732	1.027	0.142
LTU	10.487	28.749	13	9.008	5.5	79.723	7.457	1.107	0.149
NLD	10.961	32.59	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	52.54	22.53	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	0.302	2.614	80.865	4.415	0.941	0.155
SRB	9.774	26.946	11.2	0.306	5.111	73.361	0.845	1.171	0.28
SVK	10.391	54.417	12.6	10.644	8.873	80.66	12.497	0.962	0.3
ESP	10.609	33.929	9.8	27.681	28.23	86.107	10.235	1.044	0.186
USA	11.048	24.825	13.4	55.505	30.183	84.881	150.04	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	0.957	0.939	0.640	1.967	1.000
USA	0.947	0.990	0.589	0.918	1.407
ITA	0.771	0.767	0.602	1.145	0.806
FIN	0.733	0.850	0.685	1.194	0.563
ESP	0.637	0.734	0.464	0.697	0.726
LTU	0.614	0.664	0.633	0.256	0.835
PRT	0.598	0.639	0.401	0.680	0.762
BGR	0.585	0.396	0.760	0.404	0.728
EST	0.579	0.672	0.747	0.282	0.574
SVK	0.562	0.608	0.924	0.322	0.440
POL	0.559	0.595	0.700	0.311	0.572
CHL	0.552	0.449	0.302	0.818	0.908
LVA	0.547	0.573	0.634	0.165	0.794
RUS	0.449	0.536	0.597	0.088	0.638
SRB	0.424	0.249	0.500	0.209	0.742
GEO	0.419	0.141	0.547	0.210	0.997
PER	0.309	0.078	0.194	0.701	0.877
BRA	0.145	0.155	0.010	0.472	0.832
IDN	0.122	0.010	0.040	0.974	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

References

Abu Bakar, M. Z. & Abu Bakar, S. (2020). Parental financial socialisation: Pathways to positive financial behaviour. *International Journal of Academic Research in Business & Social Sciences*, *10*(6), 55–62. https://doi.org/10.6007/IJARBSS/v10-i6/7260

Agarwal, S., Amromin, G., Ben-David, I., Chomsisengphet, S. & Evanoff, D. D. (2015). Financial literacy and financial planning: Evidence from India. *Journal of Housing Economics*, *27*, 4–21. https://doi.org/10.1016/j.jhe.2015.02.003

Agnew, S. & Cameron-Agnew, T. (2015). The influence of consumer socialisation in the home on gender differences in financial literacy. *International Journal of Consumer Studies*, *39*(6), 630–638. https://doi.org/10.1111/ijcs.12179

Agnew, S. & Harrison, N. (2015). Financial literacy and student attitudes to debt: A cross national study examining the influence of gender on personal finance concepts. *Journal of Retailing and Consumer Services*, *25*, 122–129. https://doi.org/10.1016/j.jretconser.2015.04.006

Agyei, S. K. (2018). Culture, financial literacy, and SME performance in Ghana. *Cogent Economics & Finance*, *6*(1), 1–16. https://doi.org/10.1080/23322039.2018.1463813

Akben-Selcuk, E. & Altiok-Yilmaz, A. (2014). Financial literacy among Turkish college students: The role of formal education, learning approaches, and parental teaching. *Psychological Reports*, *115*(2), 351–371. https://doi.org/10.2466/31.11.pr0.115c18z3

Ali, P., Anderson, M. E., McRae, C. H. & Ramsay, I. (2014). The financial literacy of young Australians: An empirical study and implications for consumer protection and ASIC's National Financial Literacy Strategy. *Company and Securities Law Journal*, *32*(5), 334–352. https://ssrn.com/abstract=2490154

Allgood, S. & Walstad, W. B. (2016). The effects of perceived and actual financial literacy on financial behaviors. *Economic Inquiry*, *54*(1), 675–697. https://doi.org/10.1111/ecin.12255

Amagir, A., Groot, W., van den Brink, H. M. & Wilschut, A. (2018). A review of financial-literacy education programs for children and adolescents. *Citizenship, Social and Economics Education*, *17*(1), 56–80. https://doi.org/10.1177/2047173417719555

Aprea, C., Wuttke, E., Leumann, S. & Heumann, M. (2015). Kompetenzfacetten von Financial Literacy: Sichtweisen verschiedener Akteure [Competency facets of financial literacy: Perspectives of different actors]. In J. Seifried, S. Seeber & B. Ziegler (Eds.), *Jahrbuch der berufs- und wirtschaftspädagogischen Forschung 2015* (pp. 11–22). Verlag Barbara Budrich. https://library.oapen.org/bitstream/handle/20.500.12657/25649/1004444.pdf

Arceo-Gómez, E. O. & Villagómez, F. A. (2017). Financial literacy among Mexican high school teenagers. *International Review of Economics Education*, *24*, 1–17. https://doi.org/10.1016/j.iree.2016.10.001

Arellano, A., Cámara, N. & Tuesta, D. (2014). *The effect of self-confidence on financial literacy* (Working Paper No. 14/28). BBVA Research. https://www.bbvaresearch.com/wp-content/uploads/2014/10/WP14-28The-effect-of-self-confidence-on-financial-literacy1.pdf

Arellano, A., Cámara, N. & Tuesta, D. (2018). Explaining the gender gap in financial literacy: The role of non-cognitive skills. *Economic Notes*, *47*(2–3), 495–518. https://doi.org/10.1111/ecno.12113

Arthur, C. (2012). Consumers or critical citizens? Financial literacy education and freedom. *Critical Education*, *3*(6), 1–24. https://doi.org/10.14288/ce.v3i6.182350

Atkinson, A. & Messy, F.-A. (2011). Assessing financial literacy in 12 countries: An OECD/INFE international pilot exercise. *Journal of Pension Economics and Finance*, *10*(4), 657–665. https://doi.org/10.1017/s1474747211000539

Bartholomae, S. & Fox, J. J. (2016). Advancing financial literacy education using a framework for evaluation. In J. J. Xiao (Ed.), *Handbook of consumer finance research* (pp. 45–59). Springer. https://doi.org/10.1007/978-3-319-28887-1_4

Batsaikhan, U. & Demertzis, M. (2018). Financial literacy and inclusive growth in the European Union. *Bruegel Policy Contribution*, *2018*(8), 1–18. https://www.econstor.eu/bitstream/10419/208015/1/1028806345.pdf

Becchetti, L., Caiazza, S. & Coviello, D. (2013). Financial education and investment attitudes in high schools: Evidence from a randomized experiment. *Applied Financial Economics*, *23*(10), 817–836. https://doi.org/10.1080/09603107.2013.767977

De Beckker, K., De Witte, K. & Van Campenhout, G. (2019). Identifying financially illiterate groups: An international comparison. *International Journal of Consumer Studies*, *43*(5), 490–501. https://doi.org/10.1111/ijcs.12534

De Beckker, K., De Witte, K. & Van Campenhout, G. (2020). The role of national culture in financial literacy: Cross-country evidence. *Journal of Consumer Affairs*, 1–19. https://doi.org/10.1111/joca.12306

Beckmann, E. & Reiter, S. (2020). How financially literate is CESEE? Insights from the OeNB Euro Survey. *Focus on European Economic Integration*, *20*(Q3), 36–59. https://www.oenb.at/dam/jcr:578c0407-1d22-4094-a312-b7ce3e82ae76/03_feei_Q3_20_How-financially-literate-is-CESEE.pdf

Behrman, J. R., Mitchell, O. S., Soo, C. K. & Bravo, D. (2012). How financial literacy affects household wealth accumulation. *American Economic Review: Papers & Proceedings*, *102*(3), 300–304. https://doi.org/10.1257/aer.102.3.300

Bel, S. & Eberlein, J. (2015). Why financial literacy matters for development. *The OECD Observer*, *303*, 28–29. https://oecdobserver.org/news/fullstory.php/aid/4967/Why_financial_literacy_matters_for_development.html

Belás, J., Nguyen, A., Smrčka, L., Kolembus, J. & Cipovová, E. (2016). Financial literacy of secondary school students. Case study from the Czech Republic and Slovakia. *Economics & Sociology*, *9*(4), 191–206. https://doi.org/10.14254/2071-789x.2016/9-4/12

Bernheim, B., Garrett, D. M. & Maki, D. M. (2001). Education and saving: The long-term effects of high school financial curriculum mandates. *Journal of Public Economics*, *80*(3), 435–465. https://doi.org/10.1016/s0047-2727(00)00120-1

Birbili, M. & Kontopoulou, M. (2015). Financial education for preschoolers: Preparing young children for the 21st Century. *Childhood Education*, *91*(1), 46–53. https://doi.org/10.1080/00094056.2015.1001670

Blue, L. & Brimble, M. (2014). Reframing the expectations of financial literacy education: Bringing back the reality. *JASSA: The Finsia Journal of Applied Finance*, *1*, 37–41. https://research-repository.griffith.edu.au/bitstream/handle/10072/63062/94351_1.pdf

Blue, L., Grootenboer, P. & Brimble, M. (2014). Financial literacy education in the curriculum: Making the grade or missing the mark? *International Review of Economics Education*, *16*, 51–62. https://doi.org/10.1016/j.iree.2014.07.005

Blue, L. E. (2020). Financial literacy education: Toward reasonable, just, and sustainable practices. In W. L. Filho, A. M. Azul, L. Brandli, P. G. Özuyar & T. Wall (Eds.), *Quality education* (pp. 307–315). Springer. https://doi.org/10.1007/978-3-319-95870-5

Blue, L. E., O'Brien, M. & Makar, K. (2018). Exploring the classroom practices that may enable a compassionate approach to financial literacy education. *Mathematics Education Research Journal*, *30*(2), 143–164. https://doi.org/10.1007/s13394-017-0223-5

Blue, L. E. & Pinto, L. E. (2017). Other ways of being: Challenging dominant financial literacy discourses in Aboriginal context. *Australian Educational Researcher*, *44*(1), 55–70. https://doi.org/10.1007/s13384-017-0226-y

Boisclair, D., Lusardi, A. & Michaud, P.-C. (2017). Financial literacy and retirement planning in Canada. *Journal of Pension Economics and Finance*, *16*(3), 277–296. https://doi.org/10.1017/s1474747215000311

Bongini, P., Trivellato, P. & Zenga, M. (2012). Measuring financial literacy among students: An application of Rasch analysis. *Electronic Journal of Applied Statistical Analysis*, *5*(3), 425–430. https://doi.org/10.1285/i20705948v5n3p425

Bottazzi, L. & Lusardi, A. (2020). *Stereotypes in financial literacy: Evidence from PISA* (NBER Working Paper No. 28065). National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w28065/w28065.pdf

Bover, O., Hospido, L. & Villanueva, E. (2018). *The impact of high school financial education on financial knowledge and saving choices: Evidence from a randomized*

trial in Spain (Working paper No. 1801). Banco de España. https://doi.org/10.2139/ssrn.3116054

Bover, O., Hospido, L. & Villanueva, E. (2020). *The impact of high school financial education on financial knowledge and saving choices: Evidence from a randomized trial in Spain*. http://laurahospido.com/wp-content/uploads/2020/06/20200602_bhv_s.pdf

Bowen, C. F. (2002). Financial knowledge of teens and their parents. *Journal of Financial Counseling and Planning*, *13*(2), 93–102. https://afcpe.buckeyedev.com/wp-content/uploads/2018/10/vol1328.pdf

Bray, M. & Thomas, R. M. (1995). Levels of comparison in educational studies: Different insights from different literatures and the value of multilevel analyses. *Harvard Educational Review*, *65*(3), 472–491. https://doi.org/10.17763/haer.65.3.g3228437224v4877

Breitbach, E. & Walstad, W. B. (2016). Financial literacy and financial behavior among young adults in the United States. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 81–98). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.7

Brimble, M. & Blue, L. (2013). Tailored financial literacy education: An indigenous perspective. *Journal of Financial Services Marketing*, *18*(3), 207–219. https://doi.org/10.1057/fsm.2013.16

Brown, M. & Graf, R. (2013). Financial literacy and retirement planning in Switzerland. *Numeracy*, *6*(2), 1–21. https://doi.org/10.5038/1936-4660.6.2.6

Brown, M., Henchoz, C. & Spycher, T. (2018). Culture and financial literacy: Evidence from a within-country language border. *Journal of Economic Behavior & Organization*, *150*, 62–85. https://doi.org/10.1016/j.jebo.2018.03.011

Brown, M., Grigsby, J., van der Klaauw, W., Wen, J. & Zafar, B. (2016). Financial education and the debt behavior of the young. *Review of Financial Studies*, *29*(9), 2490–2522. https://doi.org/10.1093/rfs/hhw006

Bucciol, A., Quercia, S. & Sconti, A. (2020). *Promoting financial literacy among the elderly: Consequences on confidence* (Working Paper Series No. 12). Department of Economics, University of Verona. http://dse.univr.it/home/workingpapers/wp2020n12.pdf

Bucher-Koenen, T., Lusardi, A., Alessie, R. & van Rooij, M. (2016). How financially literate are women? An overview and new insights. *Journal of Consumer Affairs*, *51*(2), 255–283. https://doi.org/10.1111/joca.12121

Caliendo, F. N. & Findley, T. S. (2013). Time inconsistency and retirement planning. *Economics Letters*, *121*(1), 30–34. https://doi.org/10.1016/j.econlet.2013.06.041

Cameron, M. P., Calderwood, R., Cox, A., Lim, S. & Yamaoka, M. (2013). Personal financial literacy among high school students in New Zealand, Japan and the USA. *Citizenship, Social and Economics Education*, *12*(3), 200–215. https://doi.org/10.2304/csee.2013.12.3.200

Van Campenhout, G. (2015). Revaluing the role of parents as financial socialization agents in youth financial literacy programs. *Journal of Consumer Affairs*, *49*(1), 186–222. https://doi.org/10.1111/joca.12064

Campioni, E., Larocca, V., Mirra, L. & Panaccione, L. (2017). *Financial literacy and bank runs: An experimental analysis* (CEIS Working Paper No. 402). Centre for Economic and International Studies, University of Rome Tor Vergata. https://doi.org/10.2139/ssrn.2955813

Cao-Alvira, J. J., Novoa-Hoyos, A. & Núñez-Torres, A. (2020). On the financial literacy, indebtedness, and wealth of Colombian households. *Review of Development Economics*, 1–16. https://doi.org/10.1111/rode.12739

Carlin, B. I. & Robinson, D. T. (2012a). Financial education and timely decision support: Lessons from junior achievement. *American Economic Review: Papers & Proceedings*, *102*(3), 305–308. https://doi.org/10.1257/aer.102.3.305

Carlin, B. I. & Robinson, D. T. (2012b). What does financial literacy training teach us? *Journal of Economic Education*, *43*(3), 235–247. https://doi.org/10.1080/00220485.2012.686385

Caro, D. H. & Biecek, P. (2017). intsvy: An R package for analyzing international large-scale assessment data. *Journal of Statistical Software*, *81*(7), 1–44. https://doi.org/10.18637/jss.v081.i07

Carvalho, L. M. (2020). Revisiting the fabrications of PISA. In G. Fan & T. S. Popkewitz (Eds.), *Handbook of education policy studies* (pp. 259–273). Springer. https://doi.org/10.1007/978-981-13-8343-4_14

Chambers, R. G. & Asarta, C. J. (2018). Gender, country-level variables, and financial knowledge. *Empirische Pädagogik*, *32*(3/4), 310–328. https://bit.ly/2Pw1HFs

Chambers, R. G., Asarta, C. J. & Farley-Ripple, E. N. (2019). Gender, parental characteristics, and financial knowledge of high school students: Evidence from multicountry data. *Journal of Financial Counseling and Planning*, *30*(1), 91–109. https://files.eric.ed.gov/fulltext/EJ1241100.pdf

Chatfield, C. (1978). The Holt-Winters forecasting procedure. *Journal of the Royal Statistical Society. Series C (Applied Statistics)*, *27*(3), 264–279. https://www.jstor.org/stable/pdf/2347162.pdf

Chen, Z. & Garand, J. C. (2018). On the gender gap in financial knowledge: Decomposing the effects of don't know and incorrect responses. *Social Science Quarterly*, *99*(5), 1551–1571. https://doi.org/10.1111/ssqu.12520

Chiang, T.-F. (2020). Financial capability and investment management of Chinese households: An application of hybrid item response theory. *Journal of Consumer Affairs*. https://doi.org/10.1111/joca.12319

Ciemleja, G., Lace, N. & Titko, J. (2014a). Financial literacy as a prerequisite for citizens' economic security: Development of a measurement instrument. *Journal of Security and Sustainability Issues*, *4*(1), 29–40. https://doi.org/10.9770/jssi.2014.4.1(3)

Ciemleja, G., Lace, N. & Titko, J. (2014b). Towards the practical evaluation of financial literacy: Latvian survey. *Procedia – Social and Behavioral Sciences*, *156*, 13–17. https://doi.org/10.1016/j.sbspro.2014.11.111

Cole, S., Paulson, A. & Shastry, G. K. (2016). High school curriculum and financial outcomes: The impact of mandated personal finance and mathematics courses. *Journal of Human Resources*, *51*(3), 656–698. https://doi.org/10.3368/jhr.51.3.0113-5410r1

Cole, S., Sampson, T. & Zia, B. (2009). *Financial literacy, financial decisions, and the demand for financial services: Evidence from India and Indonesia* (Working Paper 09-117). Harvard Business School. http://www1.worldbank.org/prem/poverty/ie/dime_papers/1107.pdf

Collins, J. M. (2013). The impacts of mandatory financial education: Evidence from a randomized field study. *Journal of Economic Behavior & Organization*, *95*, 146–158. https://doi.org/10.1016/j.jebo.2012.08.011

Connolly, M. & Nicol, C. (2015). Students and financial literacy: What do middle school students know? What do teachers want them to know. In K. Beswick, T. Muir & J. Wells (Eds.), *Proceedings of the 39th Psychology of Mathematics Education conference* (pp. 185–192). https://bit.ly/2CaVSKO

Cordero, J. M. & Pedraja, F. (2019). The effect of financial education training on the financial literacy of Spanish students in PISA. *Applied Economics*, *51*(16), 1679–1693. https://doi.org/10.1080/00036846.2018.1528336

Cude, B. J., Danes, D. & Kabaci, M. J. (2016). Financial knowledge and financial education of college students. In J. J. Xiao (Ed.), *Handbook of consumer finance research* (pp. 141–153). Springer. https://doi.org/10.1007/978-3-319-28887-1_12

Cupak, A., Fessler, P., Silgoner, M. & Ulbrich, E. (2018a). *Exploring differences in financial literacy across countries: The role of individual characteristics and institutions* (Working Paper 220). Oesterreichische Nationalbank. https://www.oenb.at/dam/jcr:c6506da3-61d3-4be8-abee-cf19468c13fa/WP220.pdf

Cupak, A., Fessler, P., Silgoner, M. & Ulbrich, E. (2018b). Financial literacy in Austria: A survey of recent research results. *Monetary Policy & the Economy*, *Q1*, 14–26. https://www.oenb.at/dam/jcr:a3752d2a-edf3-438f-9363-92e2c7f1d8a9/03_mop_2018_q1_Cupak_Fessler_Silgoner_Ulbrich.pdf

Cupák, A., Fessler, P., Silgoner, M. & Ulbrich, E. (2018). *Financial literacy gaps across countries: The role of individual characteristics and institutions* (Working Paper 2/2018). National Bank of Slovakia. https://www.nbs.sk/_img/Documents/PUBLIK/WP_2_2018_Cupak_Financial_Literacy_EN.pdf

Curugan, A. A. M., Masnan, A. H. & Norwani, N. M. (2020). The development of Kwartalino financial education program for kindergarten learners. *Southeast Asia Early Childhood Journal*, *9*(2), 11–38. https://ojs.upsi.edu.my/index.php/SAECJ/article/view/3332/2523

Danes, S. M. & Haberman, H. R. (2007). Teen financial knowledge, self-efficacy, and behavior: A gendered view. *Journal of Financial Counseling and Planning*, *18*(2), 48–60. https://files.eric.ed.gov/fulltext/EJ1104367.pdf

von Davier, M. (2014). Imputing proficiency data under planned missingness in population models. In L. Rutkowski, M. von Davier & D. Rutkowski (Eds.), *Handbook of international large-scale assessment: Background, technical issues, and methods of data analysis* (pp. 175–201). CRC Press. https://doi.org/10.1201/b16061-13

Davies, P., Syed, F. & Appleyard, L. (2016). Secondary school students' understanding of the financial system. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 41–62). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.5

Davoli, M. & Rodríguez-Planas, N. (2020). *Culture and adult financial literacy: Evidence from the United States* (Discussion Paper No. 13349). Forschungsinstitut zur Zukunft der Arbeit [IZA Institute of Labor Economics]. http://ftp.iza.org/dp13349.pdf

Driva, A., Lührmann, M. & Winter, J. (2016). Gender differences and stereotypes in financial literacy: Off to an early start. *Economics Letters*, *146*, 143–146. https://doi.org/10.1016/j.econlet.2016.07.029

Eickelmann, B., Gerick, J. & Koop, C. (2016). ICT use in mathematics lessons and the mathematics achievement of secondary school students by international comparison: Which role do school level factors play? *Education and Information Technologies*, *22*(4), 1527–1551. https://doi.org/10.1007/s10639-016-9498-5

Emmons, W. R. (2005). Consumer-finance myths and other obstacles to financial literacy. *Saint Louis University Public Law Review*, *24*(2), 335–362. https://heinonline.org/HOL/PDFsearchable?handle=hein.journals/stlpl24&collection=journals&section=25&id=&print=section&sectioncount=1&ext=.pdf&nocover=

Endsley, A. A. (2020). *Does experimential learning add value in a financial literacy program? A qualitative investigation* (Publication No. 27837591) [Doctoral dissertation, Eastern Kentucky University]. ProQuest Dissertations Publishing.

Eniola, A. A. & Entebang, H. (2016). Financial literacy and SME firm performance. *International Journal of Research Studies in Management*, *5*(1), 31–43. https://doi.org/10.5861/ijrsm.2015.1304

Erner, C., Goedde-Menke, M. & Oberste, M. (2016). Financial literacy of high school students: Evidence from Germany. *Journal of Economic Education*, *47*(2), 95–105. https://doi.org/10.1080/00220485.2016.1146102

Erylmaz, N., Rivera-Gutiérrez, M. & Sandoval-Hernández, A. (2020). Should different countries participating in PISA interpret socioeconomic background in the same way? A measurement invariance approach. *Revista Iberoamericana de Educación*, *84*(1), 109–133. https://doi.org/10.35362/rie8413981

Fabris, N. & Luburić, R. (2016). Financial education of children and youth. *Journal of Central Banking Theory and Practice*, *5*(2), 65–79. https://doi.org/10.1515/jcbtp-2016-0011

Farinella, J., Bland, J. & Franco, J. (2017). The impact of financial education on financial literacy and spending habits. *International Journal of Business, Accounting, and Finance*, *11*(1), 1–12. http://www.iabpad.com/the-impact-of-financial-education-on-financial-literacy-and-spending-habits/

Fernandes, D., Lynch, J. G. & Netemeyer, R. G. (2014). Financial literacy, financial education, and downstream financial behaviors. *Management Science*, *60*(8), 1861–1883. https://doi.org/10.1287/mnsc.2013.1849

Ferrari, I. (2019). The nativity wealth gap in Europe: A matching approach. *Journal of Population Economics*, *33*(1), 33–77. https://doi.org/10.1007/s00148-019-00735-8

Fonseca, R., Mullen, K. J., Zamarro, G. & Zissimopoulos, J. (2012). What explains the gender gap in financial literacy? The role of household decision making. *Journal of Consumer Affairs*, *46*(1), 90–106. https://doi.org/10.1111/j.1745-6606.2011.01221.x

Fornero, E. & Lo Prete, A. (2019). Voting in the aftermath of a pension reform: The role of financial literacy. *Journal of Pension Economics and Finance*, *18*(1), 1–30. https://doi.org/10.1017/s1474747218000185

Förster, M., Happ, R. & Molerov, D. (2017). Using the U.S. *Test of Financial Literacy* in Germany–Adaptation and validation. *Journal of Economic Education*, *48*(2), 123–135. https://doi.org/10.1080/00220485.2017.1285737

Frączek, B. & Klimontowicz, M. (2015). Financial literacy and its influence on young cutomers' decision factors. *Journal of Innovation Management*, *3*(1), 62–84. https://journalsojs3.fe.up.pt/index.php/jim/article/view/2183-0606_003.001_0007/166

Frisancho, V. (2019). The impact of financial education for youth. *Economics of Education Review*. https://doi.org/10.1016/j.econedurev.2019.101918

Garder, E., Jr. (1985). Exponential smoothing: The state of the art. *Journal of Forecasting*, *4*, 1–28. https://www.bauer.uh.edu/gardner/Exp-Sm-1985.pdf

Garg, N. & Singh, S. (2018). Financial literacy among youth. *International Journal of Social Economics*, *45*(1), 173–186. https://doi.org/10.1108/ijse-11-2016-0303

Geiger, J.-M., Meretz, U. & Liening, A. (2016). Systematisierung deutschsprachiger studien zur kompetenzerfassung von financial literacy [Systematization of German-language studies for the competence assessment of financial literacy]. *Zeitschrift für ökonomische Bildung*, *5*, 72–93. https://doi.org/10.7808/0504

Gomes, O. (2020). Hand-to-mouth consumers, rule-of-thumb savers, and optimal control. *Journal of Economic Interaction and Coordination*. https://doi.org/10.1007/s11403-020-00292-4

Goodman, L. A. (1975). A new model for scaling response patterns: An application of the quasi-independence concept. *Journal of the American Statistical Association*, *70*(352), 755–768. https://doi.org/10.2307/2285434

Goyal, K. & Kumar, S. (2020). Financial literacy: A systematic review and bibliometric analysis. *International Journal of Consumer Studies*, 1–26. https://doi.org/10.1111/ijcs.12605

Gramaţki, I. (2017). A comparison of financial literacy between native and immigrant school students. *Education Economics*, *25*(3), 304–322. https://doi.org/10.1080/09645292.2016.1266301

Green, B. F. (1956). A method of scalogram analysis using summary statistics. *Psychometrika*, *21*(1), 79–88. https://doi.org/10.1007/BF02289088

Grohmann, A. (2016). The gender gap in financial literacy: Income, education, and experience offer only partial explanations. *DIW Economic Bulletin*, *6*(46/47), 531–537. https://www.econstor.eu/bitstream/10419/148080/1/872886581.pdf

Grohmann, A., Klühs, T. & Menkhoff, L. (2018). Does financial literacy improve financial inclusion? Cross country evidence. *World Development*, *111*, 84–96. https://doi.org/10.1016/j.worlddev.2018.06.020

Grohmann, A., Kouwenberg, R. & Menkhoff, L. (2015). Childhood roots of financial literacy. *Journal of Economic Psychology*, *51*, 114–133. https://doi.org/10.1016/j.joep.2015.09.002

Grund, S., Lüdtke, O. & Robitzsch, A. (2020). On the treatment of missing data in background questionnaires in educational large-scale assessments: An evaluation of different procedures. *Journal of Educational and Behavioral Statistics*, 1–36. https://doi.org/10.3102/1076998620959058

Gudmunson, C. G. & Danes, S. M. (2011). Family financial socialization: Theory and critical review. *Journal of Family and Economic Issues*, *32*(4), 644–667. https://doi.org/10.1007/s10834-011-9275-y

Gudmunson, C. G., Ray, S. K. & Xiao, J. J. (2016). Financial socialization. In J. J. Xiao (Ed.), *Handbook of consumer finance research* (pp. 61–72). Springer. https://doi.org/10.1007/978-3-319-28887-1_5

Guest, R. & Brimble, M. (2018). Financial literacy 101. *Policy: A Journal of Public Policy and Ideas*, *34*(1), 3–7. https://www.cis.org.au/app/uploads/2018/03/34-1-guest-brimble.pdf

Guttman, L. (1944). A basis for scaling qualitative data. *American Sociological Review*, *9*(2), 139–150. https://doi.org/10.2307/2086306

Hanushek, E. A. & Woessmann, L. (2012a). Do better schools lead to more growth? Cognitive skills, economic outcomes, and causation. *Journal of Economic Growth*, *17*(4), 267–321. https://doi.org/10.1007/s10887-012-9081-x

Hanushek, E. A. & Woessmann, L. (2012b). Schooling, educational achievement, and the Latin American growth puzzle. *Journal of Development Economics*, *99*(2), 497–512. https://doi.org/10.1016/j.jdeveco.2012.06.004

Happ, R., Zlatkin-Troitschanskaia, O., Beck, K. & Förster, M. (2016). Increasing heterogeneity in students' prior economic content knowledge–Impact on and implications for teaching in higher education. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 193–210). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.12

Hastings, J. S., Madrian, B. C. & Skimmyhorn, W. L. (2013). Financial literacy, financial education, and economic outcomes. *Annual Review of Economics*, *5*(1), 347–373. https://doi.org/10.1146/annurev-economics-082312-125807

Henderson, G. E., Beach, P., Sun, L. & McConnel. (2020). Does the content of financial literacy education resources vary based on who made or paid for them? *Citizenship, Social and Economics Education*, 204717342096103. https://doi.org/10.1177/2047173420961031

Hira, T. K. (2016). Financial sustainability and personal finance education. In J. J. Xiao (Ed.), *Handbook of consumer finance research* (pp. 357–366). Springer. https://doi.org/10.1007/978-3-319-28887-1_29

Ho, C. S. M. & Lee, H. L. D. (2020). Integrating positive financial attitudes to nurture students' identity as informed financial decision-makers in high power distance Chinese contexts. *Journal of Educational Change*, 1–24. https://doi.org/10.1007/s10833-020-09396-x

Holtsch, D. & Eberle, F. (2016). Learners' economic competence in Switzerland: Conceptual foundations and considerations for measurement. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 101–120). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.8

Huston, S. J. (2010). Measuring financial literacy. *Journal of Consumer Affairs*, *44*(2), 296–316. https://doi.org/10.1111/j.1745-6606.2010.01170.x

Huston, S. J. (2012). Financial literacy and the cost of borrowing. *International Journal of Consumer Studies*, *36*(5), 566–572. https://doi.org/10.1111/j.1470-6431.2012.01122.x

Ibarra, G. L., McKenzie, D. & Ruiz-Ortega, C. (2019). Estimating treatment effects with big data when take-up is low: An application to financial education. *World Bank Economic Review*, 1–28. https://doi.org/10.1093/wber/lhz045

Indefenso, E. E. & Yazon, A. D. (2020). Numeracy level, mathematics problem skills, and financial literacy. *Universal Journal of Educational Research*, *8*(10), 4393–4399. https://doi.org/10.13189/ujer.2020.081005

Janssen, J. H. M., van Laar, S., de Rooij, M. J., Kuha, J. & Bakk, Z. (2019). The detection and modeling of direct effects in latent class analysis. *Structural Equation Modeling: A Multidisciplinary Journal*, *26*, 280–290. https://doi.org/10.1080/10705511.2018.1541745

Jappelli, T. (2010). Economic literacy: An international comparison. *The Economic Journal*, *120*(548), F429–F451. https://doi.org/10.1111/j.1468-0297.2010.02397.x

Jappelli, T. & Padula, M. (2013). Investment in financial literacy and saving decisions. *Journal of Banking & Finance*, *37*(8), 2779–2792. https://doi.org/10.1016/j.jbankfin.2013.03.019

Jappelli, T. & Padula, M. (2015). Investment in financial literacy, social security, and portfolio choice. *Journal of Pension Economics and Finance*, *14*(4), 369–411. https://doi.org/10.1017/s1474747214000377

Jorgensen, B. L. & Savla, J. (2010). Financial literacy of young adults: The importance of parental socialization. *Family Relations*, *59*(4), 465–478. https://doi.org/10.1111/j.1741-3729.2010.00616.x

Jüttler, A. & Schumann, S. (2016). Effects of students sociocultural background on economic competencies in upper secondary education. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 121–148). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.9

Kaiser, T. & Menkhoff, L. (2020). Financial education in schools: A meta-analysis of experimental studies. *Economics of Education Review*, *78*, 1–15. https://doi.org/10.1016/j.econedurev.2019.101930

Kalmi, P. & Ruuskanen, O.-P. (2018). Financial literacy and retirement planning in Finland. *Journal of Pension Economics and Finance*, *17*(3), 335–362. https://doi.org/10.1017/s1474747217000270

Karakurum-Ozdemir, K., Kokkizil, M. & Uysal, G. (2019). Financial literacy in developing countries. *Social Indicators Research*, *143*(1), 325–353. https://doi.org/10.1007/s11205-018-1952-x

Kell, P. (2014). Early financial literacy education key to informed financial decisions. *Governance Directions*, *66*(11), 685–688. https://search.informit.com.au/documentSummary;dn=791221674677151;res=IELAPA

Kenayathula, H. B., Nair, S., Rahman, M. N. A. & Radzi, N. M. (2020). Financial literacy of undergraduate students in selected Malaysian high education institutions: A way forward to policy recommendations. *Malaysian Online Journal of Educational Management*, *8*(3), 82–102. https://mojem.um.edu.my/article/view/24711/11801

Khalil, M. (2020). Financial citizenship as a broader democratic context of financial literacy. *Citizenship, Social and Economics Education*, 1–14. https://doi.org/10.1177/2047173420948411

Khan, M. N., Rothwell, D. W., Cherney, K. & Sussman, T. (2017). Understanding the financial knowledge gap: A new dimension of inequality in later life. *Journal of Gerontological Social Work*, *60*(6-7), 487–503. https://doi.org/10.1080/01634372.2017.1317311

Khoirunnisaa, J. & Johan, I. R. (2020). The effects of financial literacy and self-control towards financial behavior among high school students in Bogor. *Journal of Consumer Sciences*, *5*(2), 73–86. https://doi.org/10.29244/jcs.5.2.73-86

Kiliyanni, A. L. & Sivaraman, S. (2016). The perception-reality gap in financial literacy: Evidence from the most literate state in India. *International Review of Economics Education*, *23*, 47–64. https://doi.org/10.1016/j.iree.2016.07.001

Kim, K. T., Lee, J. & Hanna, S. D. (2020). The effects of financial literacy overconfidence on the mortgage delinquency of US households. *Journal of Consumer Affairs*, *54*(2), 517–540. https://doi.org/10.1111/joca.12287

Klapper, L. & Lusardi, A. (2019). Financial literacy and financial resilience: Evidence from around the world. *Financial Management*, 1–26. https://doi.org/10.1111/fima.12283

Klieme, E. (2020). Policies and practices of assessment: A showcase for the use (and misuse) of international large scale assessments in educational effectiveness research. In J. Hal, A. indorff & P. Sammons (Eds.), *International perspectives in*

educational effectiveness research (pp. 147–181). Springer. https://doi.org/10.1007/978-3-030-44810-3_7

Kosor, M. M., Pavičić, J. & Alfirević, N. (2020). The role of international benchmarking in the convergence/divergence of European education. In L. Moos, N. Alfirević, J. Pavičić, A. Koren & L. N. Čačija (Eds.), *Educational leadership, improvement and change: Discourse and systems in Europe* (pp. 89–102). Springer. https://doi.org/10.1007/978-3-030-47020-3_7

Kunovskaya, I. A., Cude, B. J. & Alexeev, N. (2014). Evaluation of a financial literacy test using classical test theory and item response theory. *Journal of Family and Economic Issues*, *35*(4), 516–531. https://doi.org/10.1007/s10834-013-9386-8

Laukaityte, I. & Wiberg, M. (2018). Importance of sampling weights in multilevel modeling of international large-scale assessment data. *Communications in Statistics—Theory and Methods*, *47*(20), 4991–5012. https://doi.org/10.1080/03610926.2017.1383429

Leumann, S., Heumann, M., Syed, F. & Aprea, C. (2016). Towards a comprehensive financial literacy framework: Voices from stakeholders in European vocational education and training. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 19–40). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.4

Li, X. (2020). When financial literacy meets textual analysis: A conceptual review. *Journal of Behavioral and Experimental Finance*, 100402. https://doi.org/10.1016/j.jbef.2020.100402

Liaqat, F., Mahmood, K. & Ali, F. H. (2020). Demographic and socio-economic differences in financial information literacy among university students. *Information Development*, 1–13. https://doi.org/10.1177/0266666920939601

Longobardi, S., Pagliuca, M. M. & Regoli, A. (2017). Family background and financial literacy of Italian students: The mediating role of attitudes and motivations. *Economics Bulletin*, *37*(4), 2585–2594. http://www.accessecon.com/Pubs/EB/2017/Volume37/EB-17-V37-I4-P232.pdf

Longobardi, S., Pagliuca, M. M. & Regoli, A. (2018). Can problem-solving attitudes explain the gender gap in financial literacy? Evidence from Italian students' data. *Quality & Quantity*, *52*(4), 1677–1705. https://doi.org/10.1007/s11135-017-0545-0

Lusardi, A. (2012). Numeracy, financial literacy, and financial decision-making. *Numeracy*, *5*(1), 1–12. https://doi.org/10.5038/1936-4660.5.1.2

Lusardi, A. (2015a). Financial literacy skills for the 21st Century: Evidence from PISA. *Journal of Consumer Affairs*, *49*(3), 639–659. https://doi.org/10.1111/joca.12099

Lusardi, A. (2015b). Risk literacy. *Italian Economic Journal*, *1*(1), 5–23. https://doi.org/10.1007/s40797-015-0011-x

Lusardi, A. (2019). Financial literacy and the need for financial education: Evidence and implications. *Swiss Journal of Economics and Statistics*, *155*(1), 1–8. https://doi.org/10.1186/s41937-019-0027-5

Lusardi, A. & Lopez, A. (2016). *Financial literacy among high school students in the United States: Evidence from the 2012 Programme for International Student Assessment (PISA)* (Working Paper). European Investment Bank Institute. https://institute.eib.org/wp-content/uploads/2016/10/2012-pisa.pdf

Lusardi, A., Michaud, P.-C. & Mitchell, O. S. (2019). Assessing the impact of financial education programs: A quantitative model. *Economics of Education Review*, 101899. https://doi.org/10.1016/j.econedurev.2019.05.006

Lusardi, A. & Mitchell, O. S. (2007). Baby Boomer retirement security: The roles of planning, financial literacy, and housing wealth. *Journal of Monetary Economics*, *54*(1), 205–224. https://doi.org/10.1016/j.jmoneco.2006.12.001

Lusardi, A. & Mitchell, O. S. (2008). Planning and financial literacy: How do women fare? *American Economic Review: Papers & Proceedings*, *98*(2), 413–417. https://doi.org/10.1257/aer.98.2.413

Lusardi, A. & Mitchell, O. S. (2011). Financial literacy around the world: An overview. *Journal of Pension Economics and Finance*, *10*(4), 497–508. https://doi.org/10.1017/s1474747211000448

Lusardi, A. & Mitchell, O. S. (2014). The economic importance of financial literacy: Theory and evidence. *Journal of Economic Literature*, *52*(1), 5–44. https://doi.org/10.1257/jel.52.1.5

Lusardi, A., Mitchell, O. S. & Curto, V. (2010). Financial literacy among the young. *Journal of Consumer Affairs*, *44*(2), 358–380. https://doi.org/10.1111/j.1745-6606.2010.01173.x

Lusardi, A., Samek, A., Kapteyn, A., Glinert, L., Hung, A. & Heinberg, A. (2017). Visual tools and narratives: New ways to improve financial literacy. *Journal of Pension Economics and Finance*, *16*(3), 297–323. https://doi.org/10.1017/S1474747215000323

Lusardi, A. & Wallace, D. (2013). Financial literacy and quantitative reasoning in the high school and college classroom. *Numeracy*, *6*(2), 1–5. https://doi.org/10.5038/1936-4660.6.2.1

Mancebón, M.-J., Ximénez-de-Embún, D. P. & Gómez-Sancho, J.-M. (2015). What determines the financial literacy of young people? An analysis from PISA 2012. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2612606

Mancebón, M.-J., Ximénez-de-Embún, D. P., Mediavilla, M. & Gómez-Sancho, J.-M. (2019). Factors that influence the financial literacy of young Spanish consumers. *International Journal of Consumer Studies*, *43*(2), 227–235. https://doi.org/10.1111/ijcs.12502

Mandell, L. & Klein, L. S. (2009). The impact of financial literacy education on subsequent financial behavior. *Journal of Financial Counseling and Planning*, *20*(1), 15–24. https://files.eric.ed.gov/fulltext/EJ859556.pdf

Mändmaa, S. (2020). Personal financial literacy among university students studying engineering. *International Journal for Innovation Education and Research*, *8*(8), 669–692. https://doi.org/10.31686/ijier.vol8.iss8.2575

Marsh, H. W., Dowson, M., Pietsch, J. & Walker, R. (2004). Why multicollinearity matters: A reexamination of relations between self-efficacy, self-concept, and achievement. *Journal of Educational Psychology*, *96*(3), 518–522. https://doi.org/10.1037/0022-0663.96.3.518

Marsh, H. W., Lüdtke, O., Nagengast, B., Trautwein, U., Morin, A. J. S., Abduljabbar, A. S. & Köller, O. (2012). Classroom climate and contextual effects: Conceptual and methodological issues in the evaluation of group-level effects. *Educational Psychologist*, *47*(2), 106–124. https://doi.org/10.1080/00461520.2012.670488

Marsh, H. W., Pekrun, R., Parker, P. D., Murayama, K., Guo, J., Dicke, T. & Arens, A. K. (2019). The murky distinction between self-concept and self-efficacy: Beware of lurking Jingle-Jangle fallacies. *Journal of Educational Psychology*, *111*(2), 331–353. https://doi.org/10.1037/edu0000281

Matheson, M. N., DeLuca, C. & Matheson, I. A. (2020). An assessment of personal financial literacy teaching and learning in Ontario high schools. *Citizenship, Social and Economics Education*, 1–15. https://doi.org/10.1177/2047173420927665

Mitchell, O. S. & Lusardi, A. (2015). Financial literacy and economic outcomes: Evidence and policy implications. *Journal of Retirement*, *3*(1), 107–114. https://doi.org/10.3905/jor.2015.3.1.107

Mohammadpour, E. (2013). A three-level multilevel analysis of Singaporean eighth-graders science achievement. *Learning and Individual Differences*, *26*, 212–220. https://doi.org/10.1016/j.lindif.2012.12.005

Moreno-Herrero, D., Salas-Velasco, M. & Sánchez-Campillo, J. (2018a). Factors that influence the level of financial literacy among young people: The role of parental engagement and students' experiences with money matters. *Children and Youth Services Review*, *95*, 334–351. https://doi.org/10.1016/j.childyouth.2018.10.042

Moreno-Herrero, D., Salas-Velasco, M. & Sánchez-Campillo, J. (2018b). The knowledge and skills that are essential to make financial decisions: First results from PISA 2012. *FinanzArchiv: Public Finance Analysis*, *74*(3), 293–339. https://doi.org/10.1628/fa-2018-0009

Mountain, T. P., Kim, N., Serido, J. & Shim, S. (2020). Does type of financial learning matter for young adults' objective financial knowledge and financial behaviors? A longitudinal and mediation analysis. *Journal of Family and Economic Issues*, 1–20. https://doi.org/10.1007/s10834-020-09689-6

Norvilitis, J. M. & MacLean, M. G. (2010). The role of parents in college students' financial behaviors and attitudes. *Journal of Economic Psychology*, *31*(1), 55–63. https://doi.org/10.1016/j.joep.2009.10.003

Norvilitis, J. M., Merwin, M. M., Osberg, T. M., Roehling, P. V., Young, P. & Kamas, M. M. (2006). Personality factors, money attitudes, financial knowledge, and credit-card debt in college students. *Journal of Applied Social Psychology*, *36*(6), 1395–1413. https://doi.org/10.1111/j.0021-9029.2006.00065.x

Nurhasanah, I., Widjaja, S. U. M. & Haryono, A. (2020). Financial literacy of economic education students. *International Journal of Business, Economics and*

Law, *21*(5), 199–205. https://www.ijbel.com/wp-content/uploads/2020/07/IJBEL21_283.pdf

Oberrauch, L. & Kaiser, T. (2019). Economic competence in early secondary school: Evidence from a large-scale assessment in Germany. *International Review of Economics Education*. https://doi.org/10.1016/j.iree.2019.100172

OECD. (2005). *Improving financial literacy: Analysis of issues and policies*. OECD Publishing. https://www.oecd-ilibrary.org/docserver/9789264012578-en.pdf

OECD. (2009). *Financial education and the crisis: Policy paper and guidance*. OECD Publisher. https://www.oecd.org/finance/financial-education/50264221.pdf

OECD. (2020). *Financial literacy data file* (Data set). Organisation for Economic Cooperation and Development. https://webfs.oecd.org/pisa2018/SPSS_STU_FLT.zip

Oliver-Márquez, F. J., Guarnido-Rueda, A. & Amate-Fortes, I. (2020). Measuring financial knowledge: A macroeconomic perspective. *International Economics and Economic Policy*, 1–46. https://doi.org/10.1007/s10368-020-00482-2

Opletalová, A. (2015). Financial education and financial literacy in the Czech education system. *Procedia – Social and Behavioral Sciences*, *171*, 1176–1184. https://doi.org/10.1016/j.sbspro.2015.01.229

Ozkale, A. & Erdogan, E. O. (2020a). An analysis of the interaction between mathematical literacy and financial literacy in PISA. *International Journal of Mathematical Education in Science and Technology*, 1–21. https://doi.org/10.1080/0020739x.2020.1842526

Ozkale, A. & Erdogan, E. O. (2020b). A conceptual model for the interaction of mathematical and financial literacies. *International Journal of Progressive Education*, *16*(5), 288–304. https://doi.org/10.29329/ijpe.2020.277.18

Page, P. M. (2020). *Parents' perceptions of financial technology to support financial socialization and literacy levels* [Doctoral dissertation, Walden University]. Walden Dissertations and Doctoral Studies Collection. https://scholarworks.waldenu.edu/cgi/viewcontent.cgi?article=10487&context=dissertations

Paolo Stella, G., Filotto, U. & Cervellati, E. M. (2020). A proposal for a new financial literacy questionnaire. *International Journal of Business and Management*, *15*(2), 34. https://doi.org/10.5539/ijbm.v15n2p34

Pesando, L. M. (2018). Does financial literacy increase students' perceived value of schooling? *Education Economics*, *26*(5), 488–515. https://doi.org/10.1080/09645292.2018.1468872

Peugh, J. L. (2010). A practical guide to multilevel modeling. *Journal of School Psychology*, *48*(1), 85–112. https://doi.org/10.1016/j.jsp.2009.09.002

Pinto, L. & Couson, E. (2011). Social justice and the gender politics of financial literacy education. *Journal of the Canadian Association for Curriculum Studies*, *9*(2), 54–85. https://jcacs.journals.yorku.ca/index.php/jcacs/article/download/34299/31544

Pinto, L. E. (2012). One size does not fit all: Conceptual concerns and moral imperatives surrounding gender-inclusive financial literacy education. *Citizenship, Social and*

Economics Education, *11*(3), 177–188. https://doi.org/10.2304/csee.2012.11.3.177

Pinto, L. E. (2013). When politics trump evidence: Financial literacy education narratives following the global financial crisis. *Journal of Education Policy*, *28*(1), 95–120. https://doi.org/10.1080/02680939.2012.690163

Pokropek, A. (2016). Introduction to instrumental variables and their application to large-scale assessment data. *Large-scale Assessments in Education*, *4*(4), 1–20. https://doi.org/10.1186/s40536-016-0018-2

Potrich, A. C. G., Vieira, K. M., Coronel, D. A. & Bender Filho, R. (2015). Financial literacy in Southern Brazil: Modeling and invariance between genders. *Journal of Behavioral and Experimental Finance*, *6*, 1–12. https://doi.org/10.1016/j.jbef.2015.03.002

Potrich, A. C. G., Vieira, K. M. & Mendes-Da-Silva, W. (2016). Development of a financial literacy model for university students. *Management Research Review*, *39*(3), 356–376. https://doi.org/10.1108/mrr-06-2014-0143

Preston, A. C. & Wright, R. E. (2019). Understanding the gender gap in financial literacy: Evidence from Australia. *Economic Record*, *95*(S1), 1–29. https://doi.org/10.1111/1475-4932.12472

Lo Prete, A. (2013). Economic literacy, inequality, and financial development. *Economics Letters*, *118*(1), 74–76. https://doi.org/10.1016/j.econlet.2012.09.029

R Core Team. (2020). *R: A language and environment for statistical computing* (Version 4.0.3). R Foundation for Statistical Computing. Vienna, Austria. https://www.R-project.org/

Remund, D. L. (2010). Financial literacy explicated: The case for a clearer definition in an increasingly complex economy. *Journal of Consumer Affairs*, *44*(2), 276–295. https://doi.org/10.1111/j.1745-6606.2010.01169.x

Riitsalu, L. & Põder, K. (2016). A glimpse of the complexity of factors that influence financial literacy. *International Journal of Consumer Studies*, *40*(6), 722–731. https://doi.org/10.1111/ijcs.12291

Rinaldi, E. & Todesco, L. (2012). Financial literacy and money attitudes: Do boys and girls really differ? A study among Italian preadolescents. *Italian Journal of Sociology of Education*, *4*(2), 143–165. https://doi.org/10.14658/pupj-ijse-2012-2-9

Rodríguez, S., Valle, A., Gironelli, L. M., Guerrero, E., Regueiro, B. & Estévez, I. (2020). Performance and well-being of native and immigrant students. comparative analysis based on PISA 2018. *Journal of Adolescence*, *85*, 96–105. https://doi.org/10.1016/j.adolescence.2020.10.001

Rohatgi, A. & Scherer, R. (2020). Identifying profiles of students' school climate perceptions using PISA 2015 data. *Large-scale Assessments in Education*, *8*(4), 1–25. https://doi.org/10.1186/s40536-020-00083-0

van Rooij, M., Lusardi, A. & Alessie, R. (2011). Financial literacy and stock market participation. *Journal of Financial Economics*, *101*(2), 449–472. https://doi.org/10.1016/j.jfineco.2011.03.006

Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys*. John Wiley & Sons. https://doi.org/10.1002/9780470316696

Runge, J. & Hudson, N. (2020). *Public understanding of economics and economic statistics* (ESCoE Occasional Paper 03). Economic Statistics Centre of Excellence and Office for National Statistics. https://escoe-website.s3.amazonaws.com/wp-content/uploads/2020/11/24191147/ESCoE-OP03-Public-Understanding-of-Economics-and-Economic-Statistics.pdf

Ruoss, T. (2020). *When banking met education: The International Savings Banks Institute as a hub for the circulation of economic knowledge in the 20th Century* (Research Paper 1196). The World Savings and Retail Banking Institute and The European Savings and Retail Banking Group. https://www.wsbi-esbg.org/SiteCollectionDocuments/1196_ESBG_BRO_RESEARCH%20PAPER.pdf

Rust, K. (2014). Samping, weighting, and variance estimation in international large-scale assessments. In L. Rutkowski, M. von Davier & D. Rutkowski (Eds.), *Handbook of international large-sclae assessment: Background, technical issues, and methods of data analysis* (pp. 117–153). CRC Press. https://doi.org/10.1201/b16061-11

Rustomfram, P. & Robinson, B. (2015). Online government resources for financial literacy. *Journal of Business & Finance Librarianship*, *20*(1-2), 95–115. https://doi.org/10.1080/08963568.2015.977083

Rutkowski, L., Gonzalez, E., Joncas, M. & von Davier, M. (2010). International large-scale assessment data: Issues in secondary analysis and reporting. *Educational Researcher*, *39*(2), 142–151. https://doi.org/10.3102/0013189x10363170

Savard, A., Cavalcante, A. & Căprioară, D. (2020). The representations of financial education among elementary teachers in Romania: Between cognition and citizenship. *Bulletin of the Transilvania University of Braşov. Series VII: Social Sciences and Law*, *13*(62), 47–56. https://www.ceeol.com/search/viewpdf?id=908309

Savard, A. (2020). What did they have to say about money and finance? Grade 4 students' representations about financial concepts when learning mathematics. *Education 3-13*, 1–13. https://doi.org/10.1080/03004279.2020.1850826

Sawatzki, C., Zmood, S. & Davidson, A. (2020). Using financial modelling to decide "Should I tap into my superannuation?" *Australian Mathematics Education Journal*, *2*(2), 22–27. https://www.researchgate.net/profile/Aylie_Davidson/publication/343417084_Using_financial_modelling_to_decide_Should_I_tap_into_my_superannuation/links/5f29f5b792851cd302dbff12/Using-financial-modelling-to-decide-Should-I-tap-into-my-superannuation.pdf

Schmeiser, M. D. & Seligman, J. S. (2013). Using the right yardstick: Assessing financial literacy measures by way of financial well-being. *Journal of Consumer Affairs*, *47*(2), 243–262. https://doi.org/10.1111/joca.12010

Schuhen, M. & Schürkmann, S. (2014). Construct validity of financial literacy. *International Review of Economics Education*, *16*, 1–11. https://doi.org/10.1016/j.iree.2014.07.004

Schürkmann, S. & Schuhen, M. (2013). Kompetenzmessung im Bereich financial literacy: Ergebnisse zum Umgang mit Online-Rechnern aus der FILS-Studie [Com-

petence measurement in the area of financial literacy: Results on handling online computers from the FILS study]. *Zeitschrift für ökonomische Bildung*, *1*, 73–89. https://zfoeb.de/2013_1/schuerkmann_schuhen.pdf

Sellar, S. & Lingard, B. (2013). The OECD and the expansion of PISA: New global modes of governance in education. *British Educational Research Journal*, *40*(6), 917–936. https://doi.org/10.1002/berj.3120

Serido, J. & Deenanath, V. (2016). Financial parenting: Promoting financial self-reliance of young consumers. In J. J. Xiao (Ed.), *Handbook of consumer finance research* (pp. 291–300). Springer. https://doi.org/10.1007/978-3-319-28887-1_24

Shadish, W. R., Cook, T. D. & Campbell, D. T. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Wadsworth Cengage Learning.

Shen, C.-H., Lin, S.-J., Tang, D.-P. & Hsiao, Y.-J. (2016). The relationship between financial disputes and financial literacy. *Pacific-Basin Finance Journal*, *36*, 46–65. https://doi.org/10.1016/j.pacfin.2015.11.002

Shim, S., Barber, B. L., Card, N. A., Xiao, J. J. & Serido, J. (2010). Financial socialization of first-year college students: The roles of parents, work, and education. *Journal of Youth and Adolescence*, *39*(12), 1457–1470. https://doi.org/10.1007/s10964-009-9432-x

Shim, S., Xiao, J. J., Barber, B. L. & Lyons, A. C. (2009). Pathways to life success: A conceptual model of financial well-being for young adults. *Journal of Applied Developmental Psychology*, *30*(6), 708–723. https://doi.org/10.1016/j.appdev.2009.02.003

Siegfried, C. (2016). The necessity for well-founded teacher education in economics–Findings from curriculum analyses. In E. Wuttke, J. Seifried & S. Schumann (Eds.), *Economic competence and financial literacy of young adults* (pp. 211–232). Verlag Barbara Budrich. https://doi.org/10.2307/j.ctvbkk29d.13

Silgoner, M., Greimel-Fuhrmann, B. & Weber, R. (2015). Financial literacy gaps of the Austrian population. *Monetary Policy & the Economy*, *Q2*, 35–51. https://www.oenb.at/dam/jcr:a23bbdba-3696-4ed8-a4d5-656bbf09e0e0/mop_2015_q2_analyses02.pdf

Skagerlund, K., Lind, T., Strömbäck, C., Tinghög, G. & Västfjäll, D. (2018). Financial literacy and the role of numeracy–How individuals' attitude and affinity with numbers influence financial literacy. *Journal of Behavioral and Experimental Economics*, *74*, 18–25. https://doi.org/10.1016/j.socec.2018.03.004

Söderlund, A. & Eriksson, J. (2020). *Financial literacy & rational financial decision: A study of university students in Sweden* [Degree project, Umeå University]. Digitala Vetenskapliga Arkivet. https://www.diva-portal.org/smash/get/diva2:1447966/FULLTEXT01.pdf

Sole, M. A. (2014). Financial literacy: An essential component of mathematics literacy and numeracy. *Journal of Mathematics Education at Teachers College*, *5*(2), 55–62. https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1011&context=nc_pubs

Spataro, L. & Corsini, L. (2017). Endogenous financial literacy, saving, and stock market participation. *FinanzArchiv: Public Finance Analysis*, *73*(2), 135. https://doi.org/10.1628/001522117x14877521353555

Stanisavjević, M. & Stojković, M. (2018). Financial literacy of engineering students–Waiting for PISA 2018 results in Serbia. *Proceedings of the 7th International Scientific Conference Technics and Informatics in Education, (Session 3: Engineering Education and Practice)*, 257–262. http://www.ftn.kg.ac.rs/konferencije/tie2018/Radovi%20TIE%202018/EN/4)%20Session%203%20-%20Engineering%20Education%20and%20Practice/S301_050.pdf

Stolper, O. A. & Walter, A. (2017). Financial literacy, financial advice, and financial behavior. *Journal of Business Economics*, *87*(5), 581–643. https://doi.org/10.1007/s11573-017-0853-9

Strahija, K., Calopa, M. K. & Kokotec, I. D. (2020). Research on the financial literacy on capital market among students. In L. Komlosi, P. Kelle & D. Kjukec (Eds.), *Economic and social development: Proceedings of the 58th International Scientific Conference on Economic and Social Development Development* (pp. 34–43). Budapest, Hungary, 4–5 September 2020. https://www.esd-conference.com/upload/book_of_proceedings/Book_of_Proceedings_esdBudapest2020_Online.pdf#page=40

Stride, C. B., Gardner, S., Catley, N. & Thomas, F. (2015). *Mplus code for the mediation, moderation, and modeated mediation model templates from Andrew Hayes' PROCESS analysis examples*. http://offbeat.group.shef.ac.uk/FIO/model17.htm

Strietholt, R. & Scherer, R. (2018). The contribution of international large-scale assessments to educational research: Combining individual and institutional data sources. *Scandinavian Journal of Educational Research*, *62*(3), 368–385. https://doi.org/10.1080/00313831.2016.1258729

Sun, L., Bradley, K. D. & Akers, K. (2012). A multilevel modelling approach to investigating factors impacting science achievement for secondary school students: PISA Hong Kong sample. *International Journal of Science Education*, *34*(14), 2107–2125. https://doi.org/10.1080/09500693.2012.708063

Sutter, M., Weyand, M., Untertrifaller, A. & Froitzheim, M. (2020). *Financial literacy, risk and time preferences–Results from a randomized educational intervention* (Discussion Paper 2020/17). Max Planck Institute for Research on Collective Goods. https://homepage.coll.mpg.de/pdf_dat/2020_17online.pdf

Taylor, S. M. & Wagland, S. (2013). The solution to the financial literacy problem: What is the answer? *Australasian Accounting, Business and Finance Journal*, *7*(3), 69–90. https://doi.org/10.14453/aabfj.v7i3.5

Tchatoka, F. D. & Varvaris, V. (2020). *Neighbourhood, school zoning and the housing market: Evidence from New South Wales* (Working Paper No. 2020-07). School of Economics, University of Adelaide. https://media.adelaide.edu.au/economics/papers/doc/wp2020-07.pdf

Te'eni-Harari, T. (2016). Financial literacy among children: The role of involvement in saving money. *Young Consumers*, *17*(2), 197–208. https://doi.org/10.1108/yc-01-2016-00579

Tezel, Z. (2015). Financial education for children and youth. In Z. Copur (Ed.), *Handbook of research on behavioral finance and investment strategies: Decision making in the financial industry* (pp. 69–92). IGI Global. https://doi.org/10.4018/978-1-4666-7484-4.ch005

Thomas, A. & Spataro, L. (2018). Financial literacy, human capital and stock market participation in Europe. *Journal of Family and Economic Issues*, *39*(4), 532–550. https://doi.org/10.1007/s10834-018-9576-5

Thomson, S. & De Bortoli, L. (2017). *PISA 2015: Financial literacy in Australia*. Australian Council for Educational Research. https://research.acer.edu.au/cgi/viewcontent.cgi?article=1028&context=ozpisa

Titko, J., Ciemleja, G. & Lace, N. (2015). Financial literacy of Latvian citizens: Preliminary survey results. *Procedia – Social and Behavioral Sciences*, *213*, 12–17. https://doi.org/10.1016/j.sbspro.2015.11.396

Titko, J., Lace, N. & Polajeva, T. (2015). Financial issues perceived by youth: Preliminary survey for financial literacy evaluation in the Baltics. *Oeconomia Copernicana*, *6*(1), 75–98. https://doi.org/10.12775/oec.2015.004

Toosi, N. R., Voegeli, E. N., Antolin, A., Babbitt, L. G. & Brown, D. K. (2020). Do financial literacy training and clarifying pay calculations reduce abuse at work? *Journal of Social Issues*, 1–40. https://doi.org/10.1111/josi.12388

UiO. (2020). *Research ethics and data management*. University of Oslo. https://www.uio.no/english/for-employees/support/research/funding/units/hf/imv/data-ethics/

United Nations. (2020). *Human development reports* (Data set). The United Nations. http://hdr.undp.org/en/data

Utkarsh, B., Pandey, A., Ashta, A., Spiegelman, E. & Sutan, A. (2020). Catch them young: Impact of financial socialization, financial literacy and attitude towards money on financial well-being of young adults. *International Journal of Consumer Studies*, *44*(6), 531–541. https://doi.org/10.1111/ijcs.12583

Vale, C., Averill, R., Hall, J., Forgasz, H. & Leder, G. (2020). Equity, social justice, and ethics. In J. Way, C. Attard, J. Anderson, J. Bobis, H. McMaster & K. Cartwright (Eds.), *Research in mathematics education in Australasia 2016–2019* (pp. 177–208). Springer. https://doi.org/10.1007/978-981-15-4269-5_8

Vyvyan, V., Blue, L. & Brimble, M. (2014). Factors that influence financial capability and effectiveness: Exploring financial counsellors' perspectives. *Australasian Accounting, Business and Finance Journal*, *8*(4), 3–22. https://doi.org/10.14453/aabfj.v8i4.2

Walstad, W. B., Tharayil, A. & Wagner, J. (2016). Financial literacy and financial education in high school. In J. J. Xiao (Ed.), *Handbook of consumer finance research* (pp. 131–140). Springer. https://doi.org/10.1007/978-3-319-28887-1_11

Wang, H. & Xu, J. (2020). Efforts to break the "score determinism" and transfer college enrolment from recruiting "scores" to "people": The exploration and practice of comprehensive quality evaluation of general high school students in Shanghai. *Educational Philosophy and Theory*, 1–13. https://doi.org/10.1080/00131857.2020.1794152

Wang, M.-T. & Degol, J. L. (2015). School climate: A review of the construct, measurement, and impact on student outcomes. *Educational Psychology Review*, *28*(2), 315–352. https://doi.org/10.1007/s10648-015-9319-1

Warm, T. A. (1989). Weighted likelihood estimation of ability in item response theory. *Psychometrika*, *54*(3), 427–450. https://doi.org/10.1007/bf02294627

van Wee, B. & Banister, D. (2016). How to write a literature review paper? *Transport Reviews*, *36*(2), 278–288. https://doi.org/10.1080/01441647.2015.1065456

Williams, P., Morton, J. K. & Christian, B. J. (2020). Enhancing financial literacy in children 5–12 years old using authentic learning within a school market garden programme. *Education 3-13*, 1–14. https://doi.org/10.1080/03004279.2020.1851741

Willis, L. E. (2008). Against financial-literacy education. *Iowa Law Review*, *94*(1), 197–286. https://heinonline.org/HOL/PDFsearchable?handle=hein.journals/ilr94&collection=journals&section=7&id=&print=section&sectioncount=1&ext=.pdf&nocover=

World Bank. (2020). *World Bank DataBank* (Data set). The World Bank. https://databank.worldbank.org/home.aspx

Wuttke, E., Siegfried, C. & Aprea, C. (2020). Measuring financial literacy with a Situational Judgement Test: Do some groups really perform worse or is it the measuring instrument? *Empirical Research in Vocational Education and Training*, *12*(1), 1–21. https://doi.org/10.1186/s40461-020-00103-x

Yoshino, N., Morgan, P. J. & Wignaraja, G. (2015). *Financial education in Asia: Assessment and recommendations* (Working Paper Series No. 534). Asian Development Bank Institute. https://www.adb.org/sites/default/files/publication/161053/adbi-wp534.pdf

Young, J. H. (2013). Financial literacy: Age and experience as the determinants. *Washington Business Research Journal*, *3*(1), 36–46. https://6e33f114-376a-4c6d-b37d-beeda2590165.filesusr.com/ugd/62d798_edc32918d7e54915938abae24ee6bb70.pdf

Young, R. & Johnson, D. R. (2015). Handling missing values in longitudinal panel data with multiple imputation. *Journal of Marriage and Family*, *77*(1), 277–294. https://doi.org/10.1111/jomf.12144

Zhu, X. (2012). Mianxiang weilai de canyu nengli–PISA 'suyang' gainian de fazhan [Participating in tomorrow's world–PISA "literacy" development]. *Waiguo zhongxiaoxue jiaoyu*, *1*, 13–16, 7.

Zhu, X., Yang, Y. & Lu, J. (2015). Shanghai xuesheng de caijing suyang biaoxian ji yingxiang yinsu [Performance of Shanghai students' financial literacy and the influencing factors]. *Bijiao jiaoyu yanjiu*, *305*(6), 36–42.

Zokaityte, A. (2016). Financial literacy and numeracy of consumers and retail investors. *Capital Markets Law Journal*, *11*(3), 405–413. https://doi.org/10.1093/cmlj/kmw014

Appendices

Appendix A

Derivation of Moderated Mediation Effect

A.1 Models with Mediators Only

Consider a SEM model shown in Figure A.1 (excluding any paths in green), where

$$\begin{cases} Y = \mu_0 + b_1 M_1 + b_2 M_2 + c_1 X_1 + c_2 X_2 + c_3 X_3 \\ M_1 = \mu_1 + a_{11} X_1 + a_{21} X_2 + a_{31} X_3 \\ M_2 = \mu_2 + a_{12} X_1 + a_{22} X_2 + a_{32} X_3 \end{cases}$$

or, in matrix form

$$\begin{cases} Y = \mu_0 + \boldsymbol{b}^\intercal \boldsymbol{m} + \boldsymbol{c}^\intercal \boldsymbol{x} \\ \boldsymbol{m} = \boldsymbol{\mu} + \boldsymbol{A}^\intercal \boldsymbol{x} \end{cases} \tag{A.1}$$

where

$$\underset{3\times1}{\boldsymbol{x}} = \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}, \underset{2\times1}{\boldsymbol{m}} = \begin{bmatrix} M_1 \\ M_2 \end{bmatrix}, \underset{2\times1}{\boldsymbol{b}} = \begin{pmatrix} b_1 \\ b_2 \end{pmatrix}, \underset{3\times1}{\boldsymbol{c}} = \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix}, \underset{2\times1}{\boldsymbol{\mu}} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} \text{ and } \underset{3\times2}{\boldsymbol{A}} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{pmatrix}$$

Equation (A.1) can be written as a total equation:

$$Y = \mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu} + \boldsymbol{b}^\intercal \boldsymbol{A}^\intercal \boldsymbol{x} + \boldsymbol{c}^\intercal \boldsymbol{x} = \left(\mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu}\right) + \boldsymbol{x}^\intercal \left(\boldsymbol{A}\boldsymbol{b} + \boldsymbol{c}\right) \tag{A.2}$$

where $\mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu}$ is the intercept, $\boldsymbol{A}\boldsymbol{b}$ is the indirect effect and $\boldsymbol{c}$ is the direct effect.

A.2 Models with Moderated Mediators

Now introduce two moderators D_1 and D_2 (green paths in Figure A.1).

In scalar notation:

$$\begin{aligned} Y_{\text{mod}} = \mu_0 &+ b_1 M_1 + b_2 M_2 + c_1 X_1 + c_2 X_2 + c_3 X_3 \\ &+ f_1 D_1 + f_2 D_2 \\ &+ g_{11} X_1 D_1 + g_{12} X_1 D_2 \\ &+ g_{21} X_2 D_1 + g_{22} X_2 D_2 \\ &+ g_{31} X_3 D_1 + g_{32} X_1 D_2 \\ &+ h_{11} M_1 D_1 + h_{12} M_1 D_2 \\ &+ h_{21} M_2 D_1 + h_{22} M_2 D_2 \end{aligned}$$

and in matrix notation:

$$Y_{\text{mod}} = \mu_0 + \boldsymbol{b}^\intercal \boldsymbol{m} + \boldsymbol{c}^\intercal \boldsymbol{x} + \boldsymbol{f}^\intercal \boldsymbol{d} + \text{tr}\left(\boldsymbol{G}^\intercal \boldsymbol{x}\boldsymbol{d}^\intercal\right) + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{m}\boldsymbol{d}^\intercal\right) \tag{A.3}$$

where,

$$\underset{2\times 1}{\boldsymbol{f}} = \begin{pmatrix} f_1 \\ f_2 \end{pmatrix}, \ \underset{2\times 1}{\boldsymbol{d}} = \begin{bmatrix} D_1 \\ D_2 \end{bmatrix}, \ \underset{3\times 2}{\boldsymbol{G}} = \begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \\ g_{31} & g_{32} \end{pmatrix}, \ \underset{2\times 2}{\boldsymbol{H}} = \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix},$$

and $\text{tr}(\cdot)$ is the trace operator.

Since $\boldsymbol{m} = \boldsymbol{\mu} + \boldsymbol{A}^\intercal \boldsymbol{x}$, Equation (A.3) can be expanded into:

$$\begin{aligned} Y_{\text{mod}} &= \mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu} + \boldsymbol{b}^\intercal \boldsymbol{A}^\intercal \boldsymbol{x} + \boldsymbol{c}^\intercal \boldsymbol{x} + \boldsymbol{f}^\intercal \boldsymbol{d} + \text{tr}\left(\boldsymbol{G}^\intercal \boldsymbol{x}\boldsymbol{d}^\intercal\right) + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{\mu}\boldsymbol{d}^\intercal\right) + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{A}^\intercal \boldsymbol{x}\boldsymbol{d}^\intercal\right) \\ &= \left[\mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu} + \boldsymbol{f}^\intercal \boldsymbol{d} + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{\mu}\boldsymbol{d}^\intercal\right)\right] + \left[\left(\boldsymbol{b}^\intercal \boldsymbol{A}^\intercal + \boldsymbol{c}^\intercal\right)\boldsymbol{x} + \text{tr}\left(\boldsymbol{d}^\intercal \left(\boldsymbol{G}^\intercal + \boldsymbol{H}^\intercal \boldsymbol{A}^\intercal\right)\boldsymbol{x}\right)\right] \\ &= \left[\mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu} + \boldsymbol{f}^\intercal \boldsymbol{d} + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{\mu}\boldsymbol{d}^\intercal\right)\right] + \left[\left(\boldsymbol{b}^\intercal \boldsymbol{A}^\intercal + \boldsymbol{c}^\intercal\right)\boldsymbol{x} + \boldsymbol{d}^\intercal \left(\boldsymbol{G}^\intercal + \boldsymbol{H}^\intercal \boldsymbol{A}^\intercal\right)\boldsymbol{x}\right] \\ &= \left[\mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu} + \boldsymbol{f}^\intercal \boldsymbol{d} + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{\mu}\boldsymbol{d}^\intercal\right)\right] + \boldsymbol{x}^\intercal \left[\boldsymbol{A}\boldsymbol{b} + \boldsymbol{c} + \boldsymbol{G}\boldsymbol{d} + \boldsymbol{A}\boldsymbol{H}\boldsymbol{d}\right] \\ &= \left[\mu_0 + \boldsymbol{b}^\intercal \boldsymbol{\mu} + \boldsymbol{f}^\intercal \boldsymbol{d} + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{\mu}\boldsymbol{d}^\intercal\right)\right] + \boldsymbol{x}^\intercal \left[\boldsymbol{A}\left(\boldsymbol{b} + \boldsymbol{H}\boldsymbol{d}\right) + \left(\boldsymbol{c} + \boldsymbol{G}\boldsymbol{d}\right)\right] \end{aligned} \tag{A.4}$$

Equation (A.4) differs from Equation (A.2) by one extra term $\boldsymbol{f}\boldsymbol{d}^\intercal + \text{tr}\left(\boldsymbol{H}^\intercal \boldsymbol{\mu}\boldsymbol{d}^\intercal\right)$ in the intercept. The indirect effect $\boldsymbol{A}\boldsymbol{b}$ expanded to $\boldsymbol{A}\left(\boldsymbol{b} + \boldsymbol{H}\boldsymbol{d}\right)$ as a result of introducing the moderators and the direct effect grows from $\boldsymbol{c}$ to $\boldsymbol{c} + \boldsymbol{G}\boldsymbol{d}$.

Expand the indirect and direct effects back to their scalar forms:

$$
\begin{aligned}
&\text{indirect effects} \\
=&\boldsymbol{A}\left(\boldsymbol{b}+\boldsymbol{H}\boldsymbol{d}\right) \\
=&\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{pmatrix}\left[\begin{pmatrix} b_1 \\ b_2 \end{pmatrix}+\begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix}\begin{bmatrix} D_1 \\ D_2 \end{bmatrix}\right] \\
=&\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{pmatrix}\begin{pmatrix} b_1+h_{11}D_1+h_{12}D_2 \\ b_2+h_{21}D_1+h_{22}D_2 \end{pmatrix} \\
=&\begin{pmatrix} a_{11}b_1+a_{11}h_{11}D_1+a_{11}h_{12}D_2+a_{12}b_2+a_{12}h_{21}D_1+a_{12}h_{22}D_2 \\ a_{21}b_1+a_{21}h_{11}D_1+a_{21}h_{12}D_2+a_{22}b_2+a_{22}h_{21}D_1+a_{22}h_{22}D_2 \\ a_{31}b_1+a_{31}h_{11}D_1+a_{31}h_{12}D_2+a_{32}b_2+a_{32}h_{21}D_1+a_{32}h_{22}D_2 \end{pmatrix}; \\
&\text{direct effects} \\
=&\boldsymbol{c}+\boldsymbol{G}\boldsymbol{d} \\
=&\begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix}+\begin{pmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \\ g_{31} & g_{32} \end{pmatrix}\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} \\
=&\begin{pmatrix} c_1+g_{11}D_1+g_{12}D_2 \\ c_2+g_{21}D_1+g_{22}D_2 \\ c_3+g_{31}D_1+g_{32}D_2 \end{pmatrix}.
\end{aligned}
$$

A.3 Mplus Execution

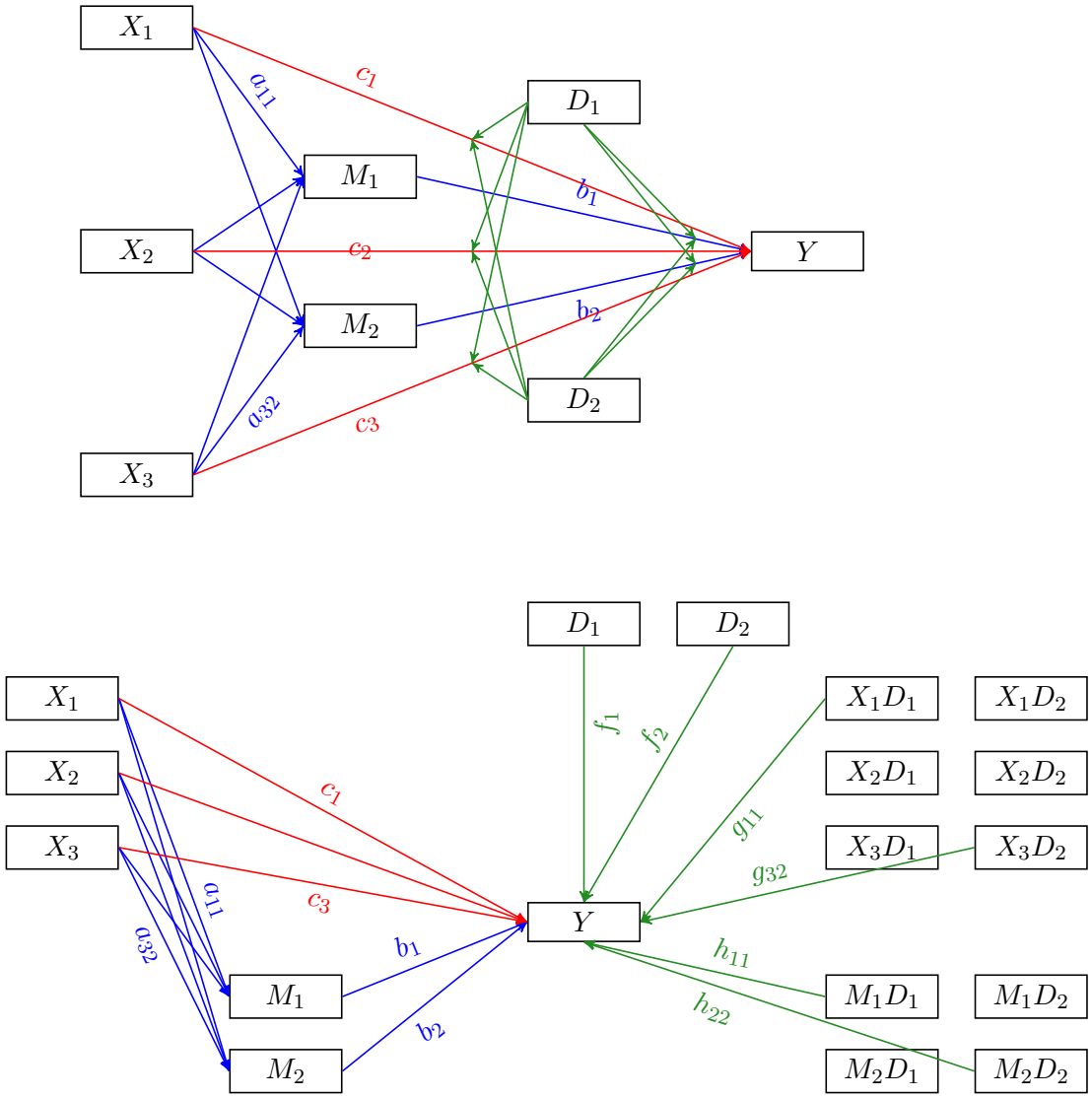
The `DEFINE:` and `MODEL:` sections of the Mplus code is given as following:

```
DEFINE:

    ! G matrix
    X1D1 = X1 * D1;
    X2D1 = X2 * D1;
    X3D1 = X3 * D1;
    X1D2 = X1 * D2;
    X2D2 = X2 * D2;
    X3D2 = X3 * D2;
    ! H matrix
    M1D1 = M1 * D1;
```

```
    M2D1 = M2 * D1;
    M1D2 = M1 * D2;
    M2D2 = M2 * D2;

MODEL:

    [Y] (mu0);
    Y on M1 (b1);
    Y on M2 (b2);
    ! ---
    Y on M1D1 (h11);
    Y on M2D1 (h21);
    Y on M1D1 (h12);
    Y on M2D1 (h22);
    ! ---
    Y on X1 (c1);
    Y on X2 (c2);
    Y on X3 (c3);
    ! ---
    Y on D1 (f1);
    Y on D2 (f2);
    ! ---
    Y on X1D1 (g11);
    Y on X2D1 (g21);
    Y on X3D1 (g31);
    Y on X1D2 (g12);
    Y on X2D2 (g22);
    Y on X3D2 (g32);

    [M1] (mu1);
    M1 on X1 (a11);
    M1 on X2 (a21);
    M1 on X3 (a31);

    [M2] (mu2);
    M2 on X1 (a12);
    M2 on X2 (a22);
    M2 on X3 (a32);

```

Figure A.1

Moderated Mediation Model



Note. A moderated mediation is shown in both model diagram (upper panel) and statistical diagram (lower panel). Direct paths, indirect paths and moderations are differentiated by colour.