Identifying School Climate Variables Associated with Students' Financial Literacy Outcomes

A Cross-Country Comparison Using PISA 2018 Data

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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

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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.

Richard P. Feynman

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This is a line that recently got added.

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1.3 My topic(s)

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(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)

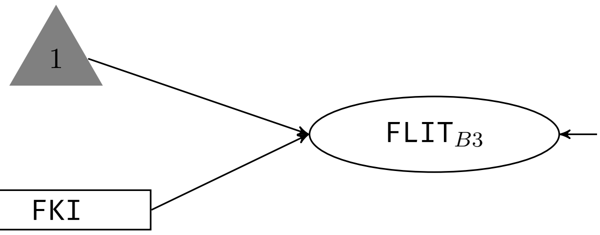
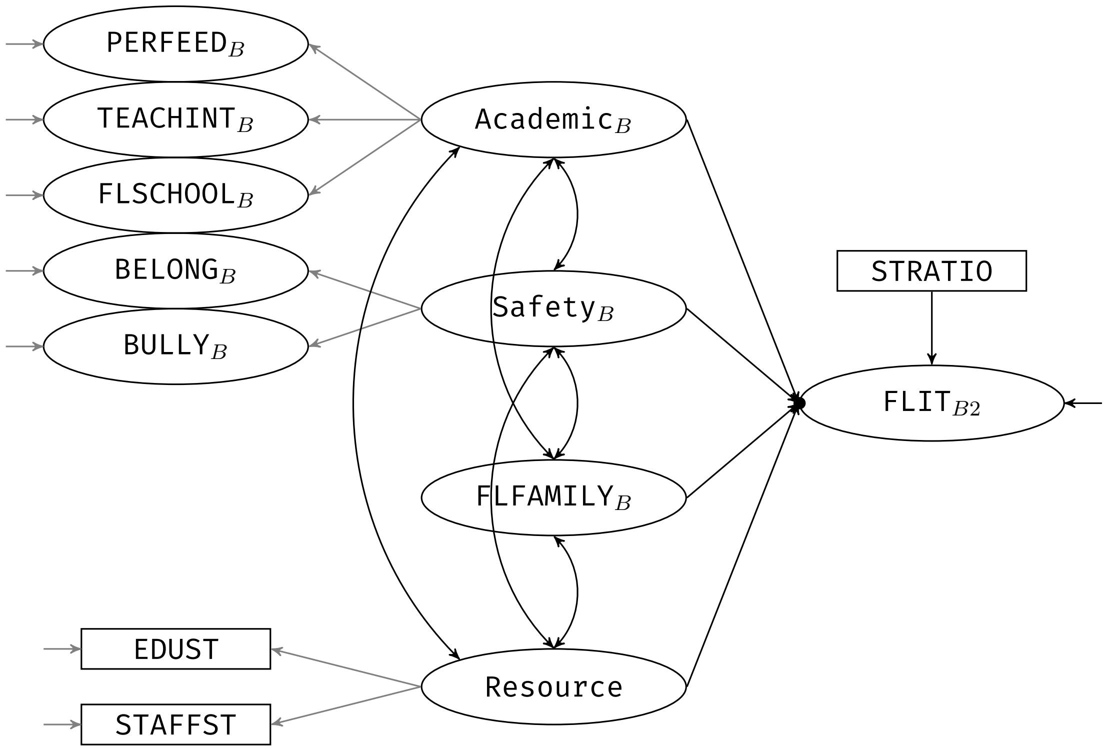


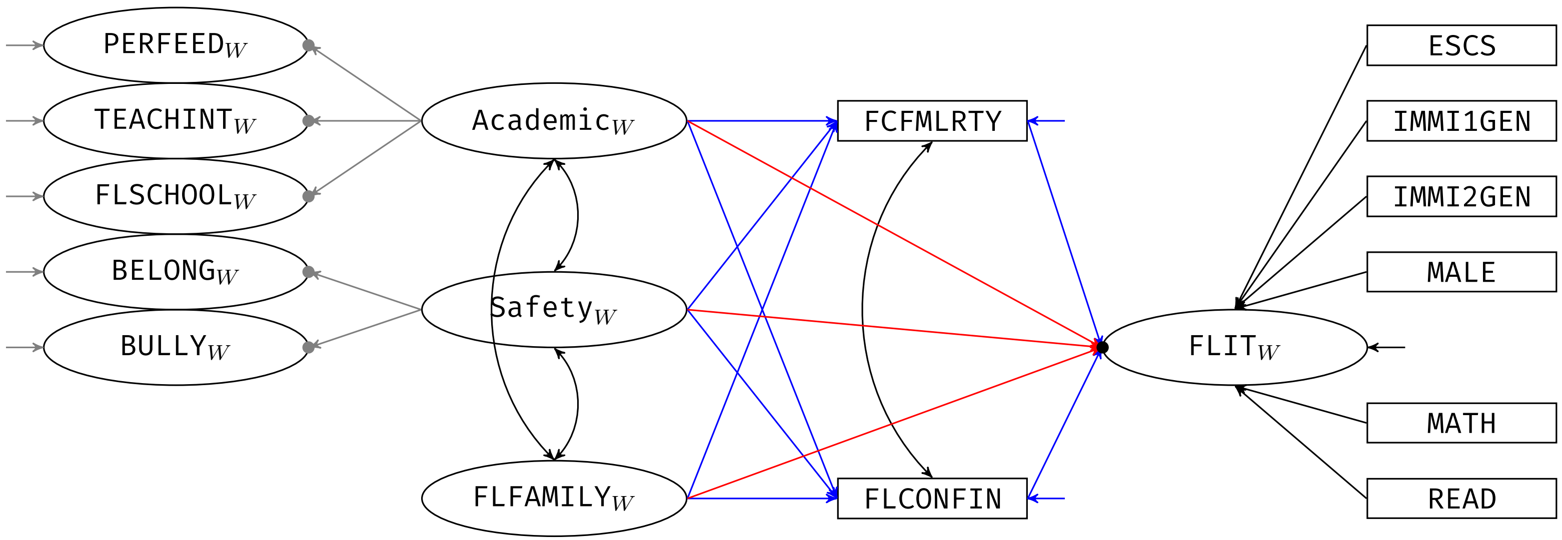
Figure 2.2
Path Diagram: School-level (L2)



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

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

The final sub-index `Need` is compiled as

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

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

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

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

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

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.

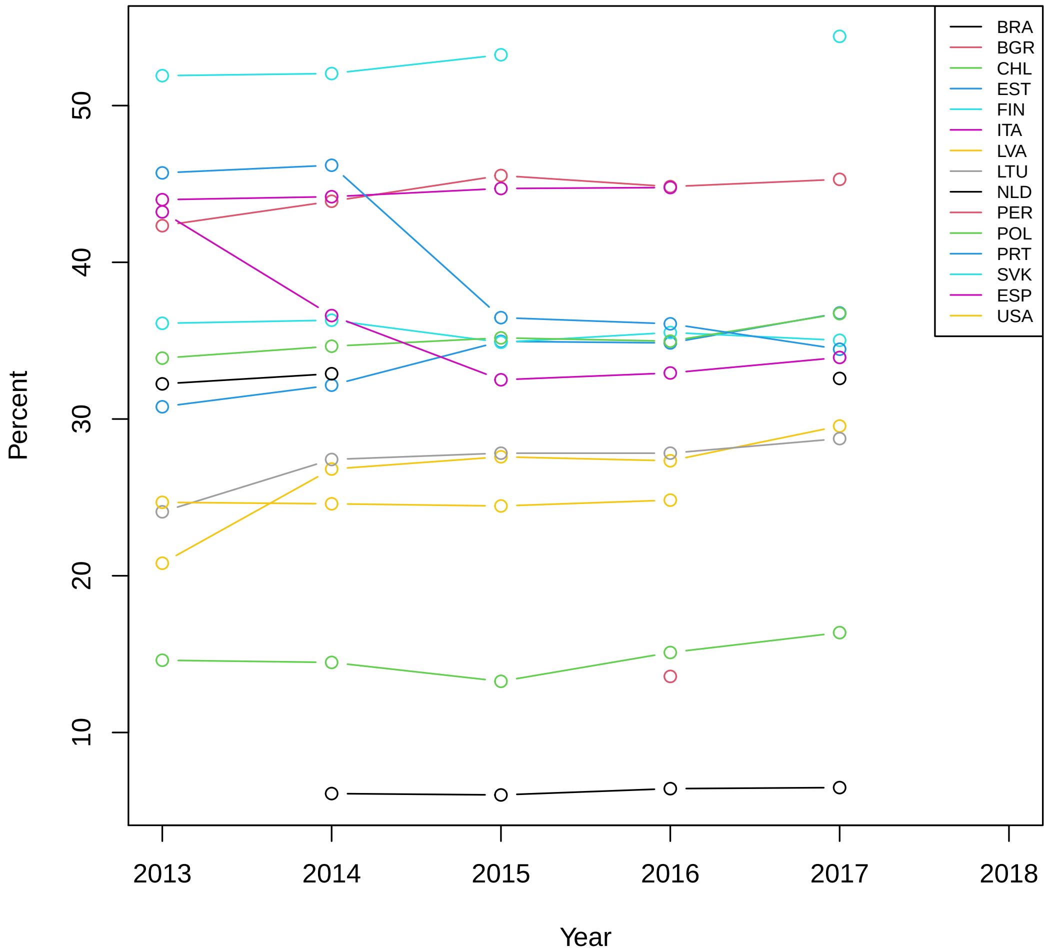
Sub-index **ET**

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)

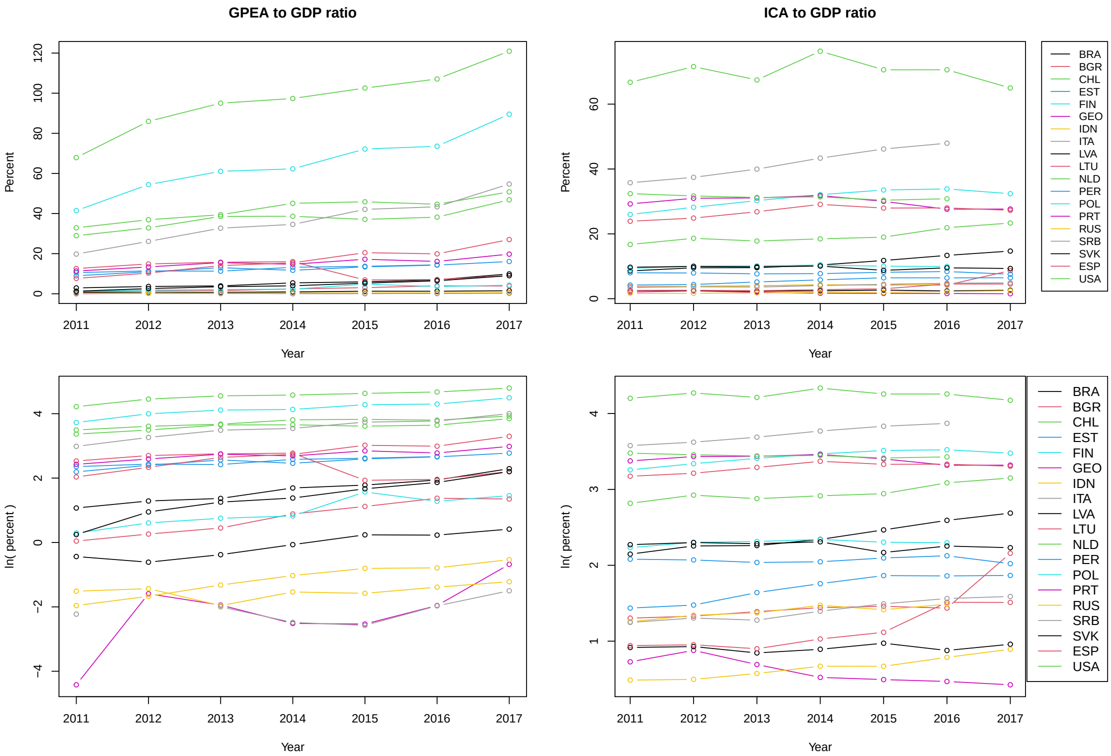
and suggests that this ratio is likely to be stable over time, especially between adjacent years. A “naive forecast”, where the nearest available year’s data are to be duplicated for 2018, is applied for SKILLED.

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

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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:

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

where,

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

and $\operatorname{tr}(\cdot)$ 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} + \operatorname{tr}\left(\boldsymbol{G}^{\intercal}\boldsymbol{x}\boldsymbol{d}^{\intercal}\right) + \operatorname{tr}\left(\boldsymbol{H}^{\intercal}\boldsymbol{\mu}\boldsymbol{d}^{\intercal}\right) + \operatorname{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} + \operatorname{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} + \operatorname{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} + \operatorname{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} + \operatorname{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} + \operatorname{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 $\boldsymbol{f}\boldsymbol{d}^{\intercal} + \operatorname{tr}\left(\boldsymbol{H}^{\intercal}\boldsymbol{\mu}\boldsymbol{d}^{\intercal}\right)$ 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

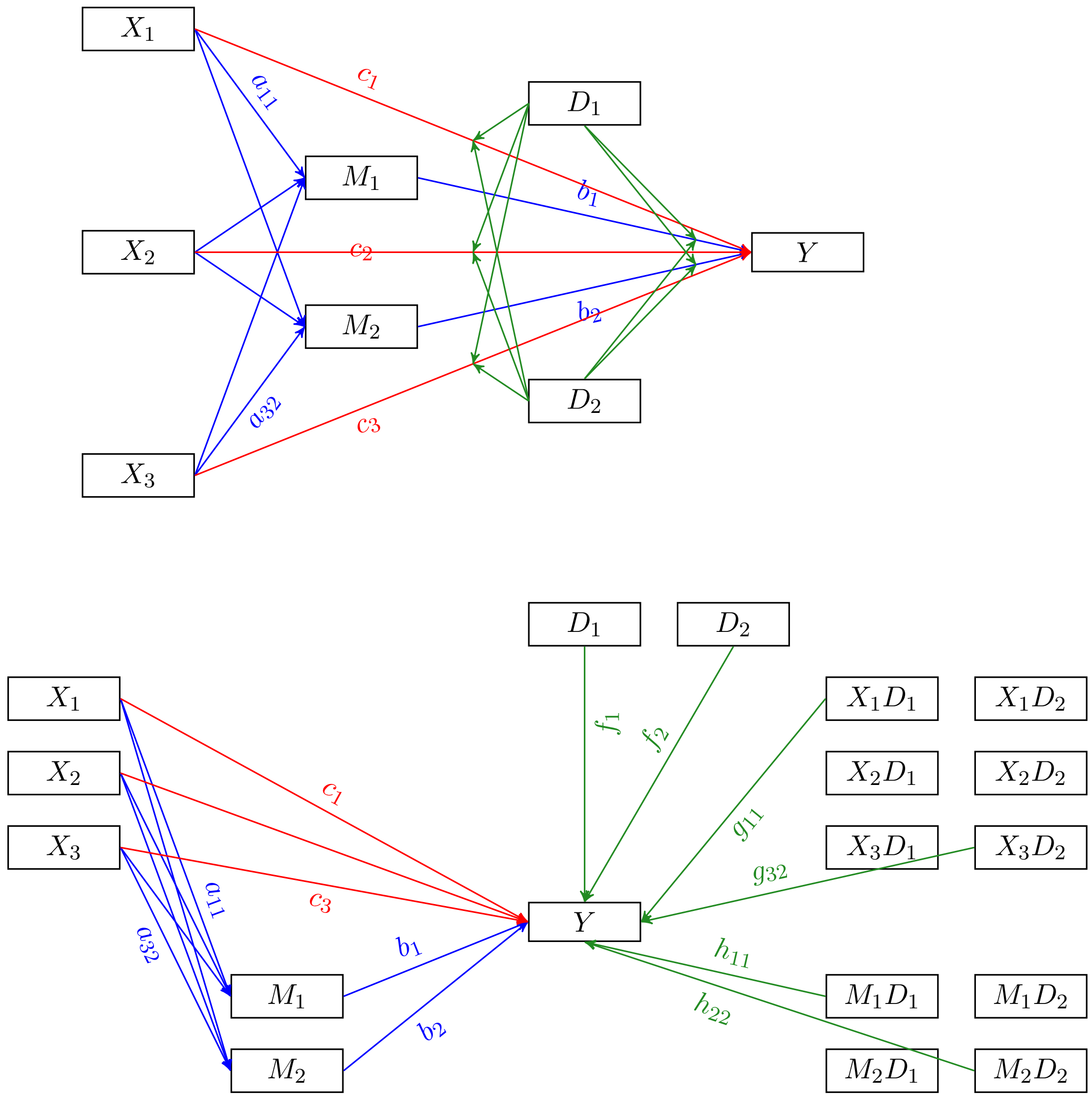
The `DEFINE:` and `MODEL:` sections of the Mplus code is given as following:

```
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.