Identifying School Climate Variables Associated with Students' Financial Literacy Outcomes

A Cross-Country Comparison Using PISA 2018 Data

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敬致父母

To my parents

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

Richard P. Feynman

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Acknowledgement

Thank-you goes to

Popular Abstract

This is a press release style abstract.

Abstract

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

Chapter 1: Conceptual Framework

1.1 In-depth definitions of "financial literacy"

1.1.1 Every term my readers need in order to understand my research question

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

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

1.2 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. (2018) 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 (2012)—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 1.1

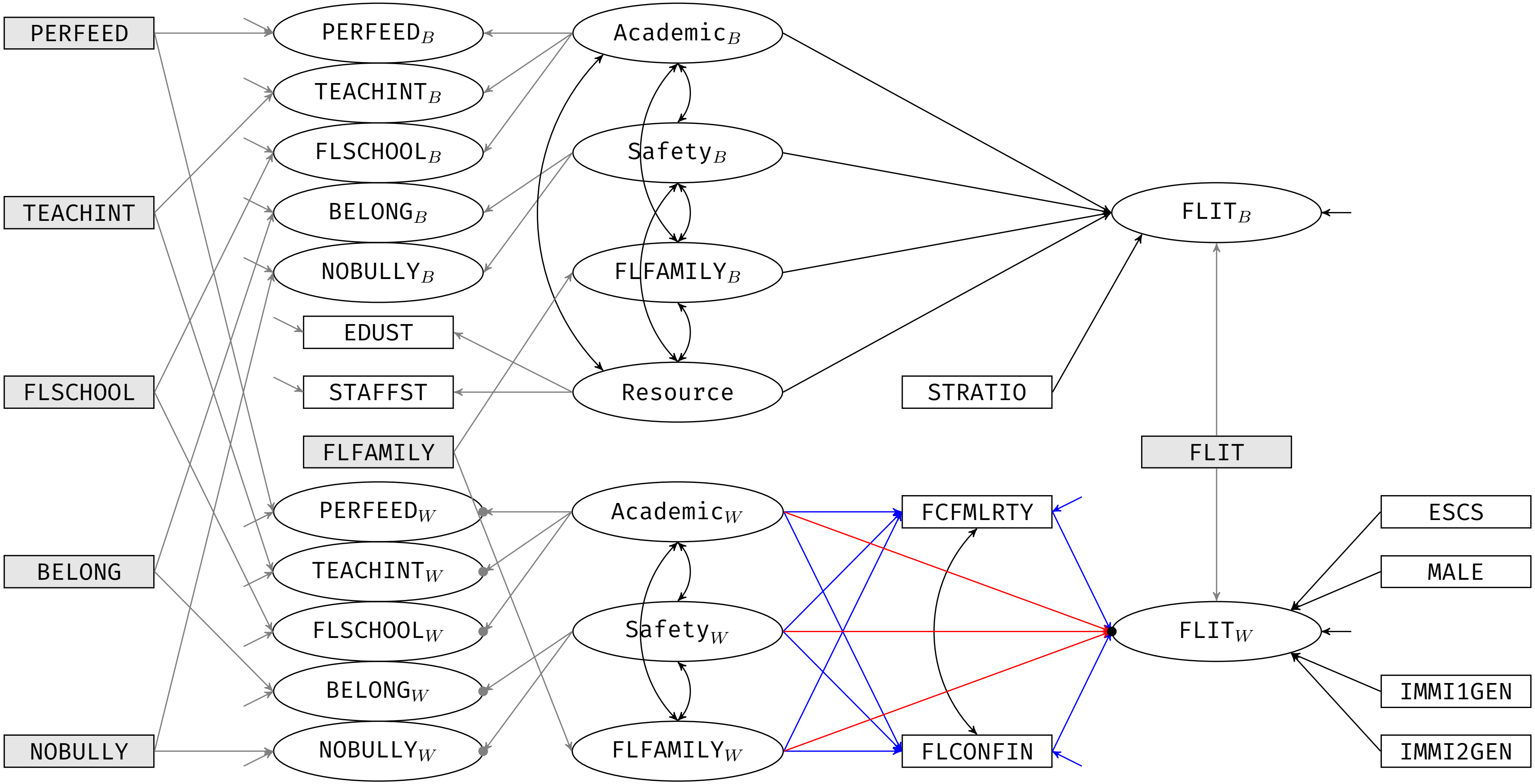
Percentages of Missing Values

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 1.1

Path Diagram



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

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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

$$\underset{3\times 1}{\boldsymbol{x}} = \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}, \underset{2\times 1}{\boldsymbol{m}} = \begin{bmatrix} M_1 \\ M_2 \end{bmatrix}, \underset{2\times 1}{\boldsymbol{b}} = \begin{pmatrix} b_1 \\ b_2 \end{pmatrix}, \underset{3\times 1}{\boldsymbol{c}} = \begin{pmatrix} c_1 \\ c_2 \\ c_3 \end{pmatrix}, \underset{2\times 1}{\boldsymbol{\mu}} = \begin{pmatrix} \mu_1 \\ \mu_2 \end{pmatrix} \text{ and } \underset{3\times 2}{\boldsymbol{A}} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \\ a_{31} & a_{32} \end{pmatrix}$$

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

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

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

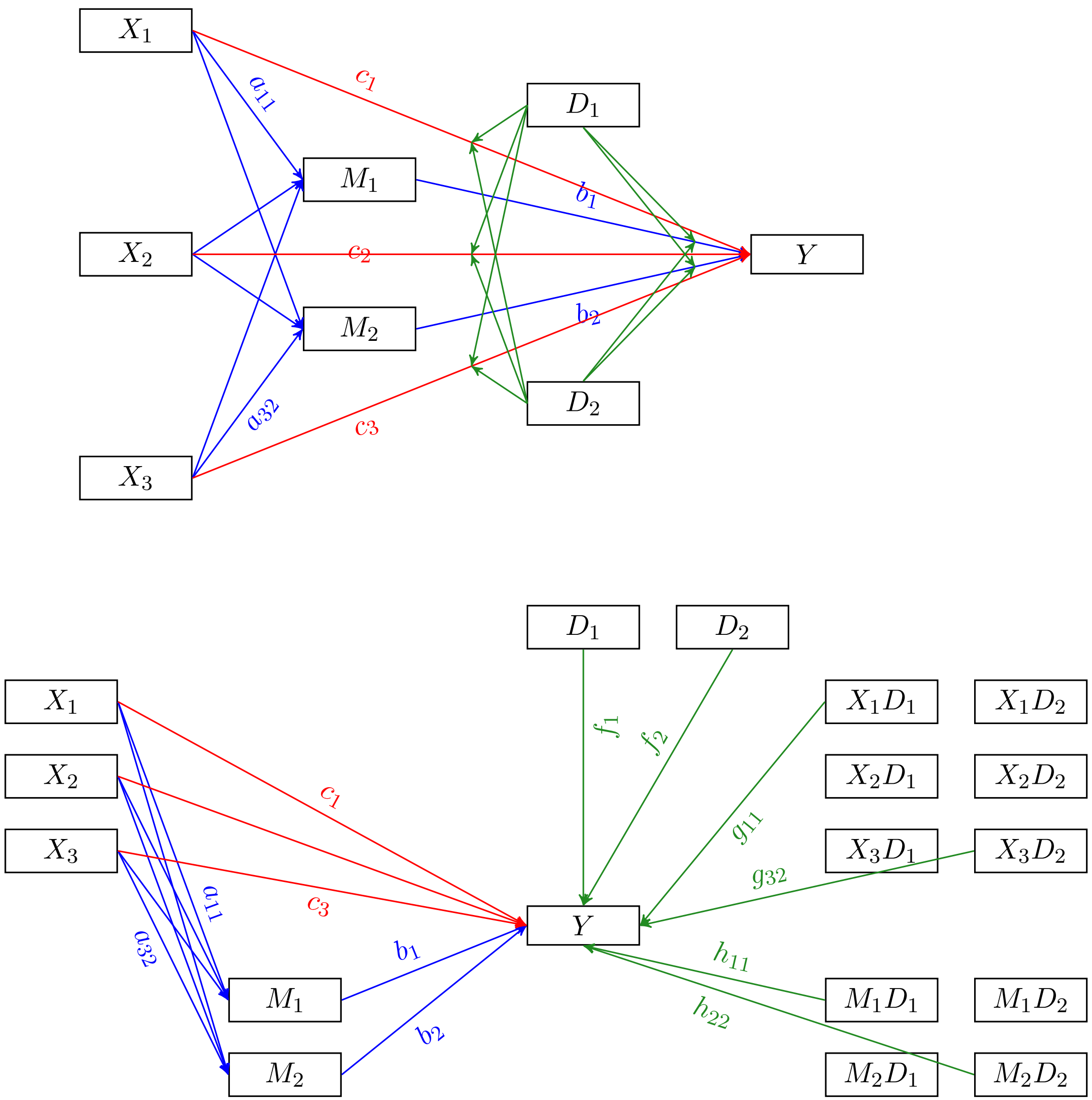
The `DEFINE:` and `MODEL:` sections of the Mplus code is given as following:

```
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.