A Bayesian Network Meta-analysis of the Relationship between Corruption and Educational Outcomes in the New Millennium

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1. Introduction

1. History
2. Today
3. Two problems
4. Two questions
5. One solution
Introduction

- **2000-2015**
  The “Education for All” (a global movement led by UNESCO) focusing on schooling.

- **2011-2020**
  The “Learning for All” (a 10-year strategy of the World Bank Group focusing on learning.

Consequently, we have

- **2000-2015 The Millennium Development Goals (MDGs)**
  - GOAL 2: “Achieve universal primary education” (United Nations, n.d.a)

- **2015-2030 The Sustainable Development Goals (SDGs)**
  - GOAL 4: “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (United Nations, n.d.b)
Introduction

- **Challenge**: Corruption is serious in the education system, wasting the international aid on education and hindering the global educational progress
  - In India, according to TIB’s Corruption Database Report 2005, education was ranked the most corrupt sector (TIB, 2006)
  - In South Africa, the PETS program applied in 2007 found that about one-half of the fund not reaching the most disadvantaged (Boateng, 2014)
  - In the United States, the number of government officials convicted in a state for crimes related to corruption was found negatively associated with enrollment in elementary and secondary school (Apergis et al., 2010)

- Despite its importance and urgency, corruption in education remains an understudied area, and there are **two essential problems** on corruption in education
  1. **Measures of corruption related to education**: Not fully developed
  2. **Relationship between corruption and education**: Not clear
Introduction

- Correspondingly, there are **two research questions** to be resolved—
  1. How are the measures of corruption related to education associated with each other as reflected in the current literature?
  2. How strong is the relationship between corruption and educational outcomes?

- Because the literature I have looked at is the publications after 2000, spanning from 2000 to 2018, my study essentially focuses on the corruption in education in the new millennium.
Introduction

Solution: Bayesian network meta-analysis

- Terminology
  - Network meta-analysis (NMA)
    - It is an extension of the traditional pairwise meta-analysis, synthesizing both the direct and indirect evidence in one single model (Tonin, Rotta, Mendes & Pontarolo, 2017)

Pair-Wise vs. Network Meta-Analysis

Pair-wise meta-analysis

A --- B --- C
A --- B --- C
A --- B --- C
A --- ? --- C
A --- ? --- C
? --- B --- C

Network meta-analysis

A --- B
A --- B
A --- B
A --- B
A --- B
A --- B
A --- B

\[ \theta_{2} = \theta_{1} - \theta_{0} \]

Network structures

Introduction

Solution: Bayesian network meta-analysis

- Terminology
  - Meta-analysis:
    - It is “a quantitative method of synthesizing empirical research results in the form of effect sizes” (Card, 2012, p. 7)

Pair-Wise vs. Network Meta-Analysis

Pair-wise meta-analysis

A --- B --- C
A --- B --- C
A --- B --- C
A --- ? --- C
A --- ? --- C
? --- B --- C

Network meta-analysis

A --- B
A --- C

\[ \theta_{BC} = \theta_{AC} - \theta_{AB} \]

Network structures

### Introduction

**Solution:** Bayesian network meta-analysis

- **Terminology**
  - **Effect size:**
    - It is “a statistical concept that measures the strength of the relationship between two variables on a numeric scale” (Statistics Solutions, 2013). The effect sizes commonly provided in empirical reports include the Pearson correlation $r$, Cohen’s $d$, and the regression coefficients.

### Pair-Wise vs. Network Meta-Analysis

<table>
<thead>
<tr>
<th>Pair-wise meta-analysis</th>
<th>Network meta-analysis</th>
</tr>
</thead>
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<tr>
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<td>A — B — C</td>
<td>A — B — C</td>
</tr>
</tbody>
</table>

**Network structures**

- $\theta_{BC}^{\theta} = \theta_{AC}^{\theta} - \theta_{AB}^{\theta}$

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*Source: Hennessy, E. (2018)*
Introduction

Solution: Bayesian network meta-analysis

Network meta-analysis (NMA)

A. How it address the two problems

- Measures → comparators in an NMA
- Association → effect size in an NMA (but it is about the association between any two variables, not the difference between control and treatment groups)

Pair-Wise vs. Network Meta-Analysis

Pair-wise meta-analysis

\[
\begin{align*}
\text{A} & \quad \text{B} & \quad \text{C} \\
\text{A} & \quad \text{B} & \quad \text{C} \\
\text{A} & \quad \text{B} & \quad \text{C} \\
\text{A} & \quad ? & \quad \text{C} \\
? & \quad \text{B} & \quad \text{C}
\end{align*}
\]

Network meta-analysis

\[
\begin{align*}
\text{A} & \quad \text{B} & \quad \text{C} \\
\text{A} & \quad \text{B} & \quad \text{C} \\
\text{A} & \quad ? & \quad \text{C} \\
? & \quad \text{B} & \quad \text{C}
\end{align*}
\]

\[
\theta_{BC}^\prime = \theta_{AC}^\prime - \theta_{AB}^\prime
\]

Network structures

Introduction

Solution: Bayesian network meta-analysis

- Network meta-analysis (NMA)

B. What assumptions to be met:

1) Similarity
   - the selected studies should be similar

2) Homogeneity
   - a common heterogeneity variance exists across all pairwise comparisons

3) Transitivity
   - the direct and indirect estimates are consistent or comparable
   (e.g., the direct and indirect estimates in a closed loop network are consistent – also called consistency, or comparability)

Source: Tonin et al. (2017)
Introduction

Solution: Bayesian network meta-analysis

- Network meta-analysis (NMA)

  c. A Bayesian NMA

  ▪ Studies not using random selection or random assignment can be included (Goring et al., 2016)
  ▪ Estimates are closer to reality, with the inference based on the actual occurring data (Bolstad, 2007, p. 7)
  ▪ Small study effects are addressed (e.g., the number of relevant studies is low, the number of direct comparisons is low, there is no common comparator between moderator levels) (Lunn et al., 2000)
2. Conceptual framework
Taxonomy and Specification of Corruption and Its Outcomes in Education

Conceptual Framework
Which delineates the indicators of corruption and educational outcomes, guiding the literature search

Source: Adapted from Patrinos and Kagia (2008) with additional information on educational outcomes.
3. Methodology

1. Sampling plan
2. Inclusion criteria
3. Literature search
4. Coding
5. Analysis
Methodology

- My sampling frame:
  - Population: studies published in 2000-2018 that report information relevant to the effect size of the relationship between corruption and educational outcomes in any part of the world
  - Sample: a convenience sample of 14 online research databases relevant to education – they are the ones that cover education research and also available on Uconn’s EBSCO, where multiple databases can be used for the search simultaneously.
Methodology

- **Definitions of constructs of interests**
  - **Corruption**: “the abuse of public office for private gain” (World Bank, 1997, p. 8)
  - **Educational outcomes**: any of the outcomes specified in the conceptual framework, i.e., enrollment rate, dropout rate, completion rate, test score, exam pass/fail rate, students’ willingness to learn, instruction time, teachers’ willingness to teach, teachers’ turnover rate

- **Sample characteristics**
  - **Geographic coverage**: any part of the world
  - **Study design**: any types of studies that report effect sizes
  - **Effect size information**: contain sufficient information for reporting effect sizes

- **Time frame**: January 1, 2000 – May 13, 2018

- **Publication type**: in English, empirical studies, full-text available in the database, peer-reviewed journal articles
Methodology

- **60 Key words** (extracted from the conceptual framework):
  - Must contain “corruption” and “education”
  - Other key words to be included:
    - System, outcome, manifestation, indicator, vulnerability, weakness
    - Ministerial, central, schools, teachers, contractors, students, parents, communities
    - Policy, regulation, management, procurement, budget, selection, appointment, assignment, promotion, bidding, exam, assessment, certificate, diploma
    - Finance, expenditure, interests, equipment, construction, supply, provision, allowance, fellowship, subsidy, fee, payment, leakage
    - Attendance, absenteeism, absence, favoritism, nepotism, collusion, cheating, selling, ghost teachers, instruction time, private tutoring, moonlighting
    - Enrollment, dropout, completion, turnover, score, willingness

- **14 Databases** (available on Uconn’s EBSCO):
  - Academic Search Premier, Alternative Press Index, Anthropology Plus, EconLit through EbscoHOST, EBSCO (covering ERIC, PsycINFO, PsycARTICLES, Teacher Reference Center, and Professional Development Collection), Political Science Complete, Public Affairs Index, Social Work Abstracts, SociINDEX, and Women’s Studies International.
Methodology

1. Definitions
2. Inclusion criteria
3. Literature search
4. Coding
5. Analysis
Methodology

1. Definitions
2. Inclusion criteria
3. Literature search
4. Coding
5. Analysis
## Methodology

### Literature Search

<table>
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<th>Remarks</th>
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<td>S8 OR S9 OR S11 OR S12</td>
<td>education AND enrollment OR dropout OR completion OR turnover OR score OR willingness</td>
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<td>S19</td>
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<td>S15</td>
<td>(S1 AND S8) AND corruptic</td>
<td>education AND ministerial OR central OR schools OR teachers OR contractors OR students OR parents OR communities</td>
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<td>S14</td>
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<td>S11</td>
<td>(S1 AND S4) AND corruptic</td>
<td>education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness</td>
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</table>

### Inclusion Criteria

- [ ] S7: education AND enrollment OR dropout OR completion OR turnover OR score OR willingness
- [ ] S10: education AND attendance OR absenteeism OR absence OR favoritism OR nepotism OR collusion OR cheating OR selling OR ghost teachers OR instruction time OR private tutoring OR moonlighting
- [ ] S11: education AND policy OR regulation OR management OR procurement OR budget OR selection OR appointment OR assignment OR promotion OR bidding OR exam OR assessment OR certificate OR diploma
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- [ ] S13: education AND ministerial OR central OR schools OR teachers OR contractors OR students OR parents OR communities
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- [ ] S15: education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness
- [ ] S16: education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness
- [ ] S17: education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness
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- [ ] S19: education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness
- [ ] S20: education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness
Methodology

- **Study characteristics to be considered for coding**
  - Sampling procedures
  - Demographic features
  - Sources of information
  - Measurement process
  - Specific measures used
  - Type of design
  - Specific design features
  - Publication status, year of study, funding, researcher characteristics
  - Study quality (internal validity, external validity, construct validity)

Source: Card, 2012

- Note: The **bias score** here is the average of the ratings when coding the internal validity, external validity and construct validity (1-5 from low to high; the studies that use the secondary data are usually rated with “4-4-3” for the three characteristics; if the significance of the effect size is not reported, the bias score will be lowered to reflect this limitation.)
# Methodology

- Study characteristics to be considered for coding
  - Sampling procedures
  - Demographic features

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Methodology

- Report/compute the effect size of each study
  1. Mainly extracted the Pearson coefficient r, and regression coefficients from the studies
     - When both the Pearson coefficient and the regression coefficient are reported, keep only the Pearson coefficient;
     - When there is one coefficient, and it is significant, perfect;
     - When there are multiple coefficients, select only the significant one;
     - When there is one coefficient, and it is not significant, report it but reduce the bias score;
     - When there are multiple significant coefficients of the same type (e.g., regression coefficients of different regression models), select the one that is statistically significant & the strongest R-square in the model - if there is no statistically significant one, report it and reduce the bias score.
  2. Compute the t-statistic of the original regression coefficients (the t-statistic is just the estimated coefficient divided by its own standard error), and converted the t-statistic into the r
  3. Convert the standardized regression coefficient to Cohen’s d and then to r, using the online calculator from [www.campbellcollaboration.org](http://www.campbellcollaboration.org)
  4. Put the r of each study together into a data set
Methodology

- **Select the Bayesian prior distribution** (relying on the one used by Belland et al., 2017, p. 1048):
  - This study employs the uniform prior distribution on $\tau$ (0, 5) a noninformative prior distribution model often used when there is insufficient information about a relationship
    - There are few prior meta-analyses on this topic, if any, so the existing results are not developed enough to establish an informative prior distribution of this study.
    - Also, I hope to use this coding to drive the structuring of the posterior distribution.

- **Use the random effects** approach, instead of the fixed effects
  - The fixed effects approach assumes that all studies have one true effect size and any difference from the true effect size for each study is attributable to sampling error only, i.e., within-study variation;
  - The random effects approach assumes that this difference is also attributable to the variation of true effect size across studies, i.e., between-study variation (Tonin et al., 2017, p. 6).

- **Software needed:**
  - Excel for coding
    (FileMaker Pro helps automate the coding process, but it is expensive)
  - R (Version 3.4.2) for data analysis, using the “gemtc” package
4. Results

- Search results
- Network plot
- Contribution plot
- Inconsistency plot
- Funnel plot
- Ranking
895 records identified via 14 databases on EBSCO

369 records removed because they were duplicates or without quantitative analysis

526 potentially relevant records screened

458 studies removed because they did not have the data in education settings

68 studies retained for further analysis

49 studies removed because they did not present relationship between corruption and education

19 studies included in the Bayesian NMA
Results

List of measures
- A1: Control of corruption
- A2: Corruption perceptions
- A3: Corruption level
- A4: Incidence of the bribes
- B1: Literacy
- B2: Years of schooling
- B3: Enrollment
- B4: Completion
- B5: Average scores
Results

Findings

- No closed loops
- A4 is excluded from the consistency analysis because it contains missing data.
- Consistency (random effects)
Results

- Coming soon.
Results

- Coming soon.
Results

- Coming soon.
Results

- Coming soon.
5. Discussion

1. Limitation
2. Recommendation
Discussion

- Lack of measure of intra-coder reliability
- No search of the unpublished studies
- No evaluation of the publication bias
Discussion

- If more studies are needed
  - Consider involving earlier studies
  - Search studies mentioned in the reference list of the selected studies
  - Search literature in other databases, such as Jstor
- Contact the authors of those studies without the effect size to request this information
- Consider a moderator analysis
- Consider artifact correction of the effect sizes (might be hard due to limited statistics in the original studies)
References


THANK YOU!

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University of Connecticut-Storrs