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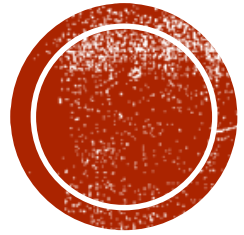## in the New Millennium

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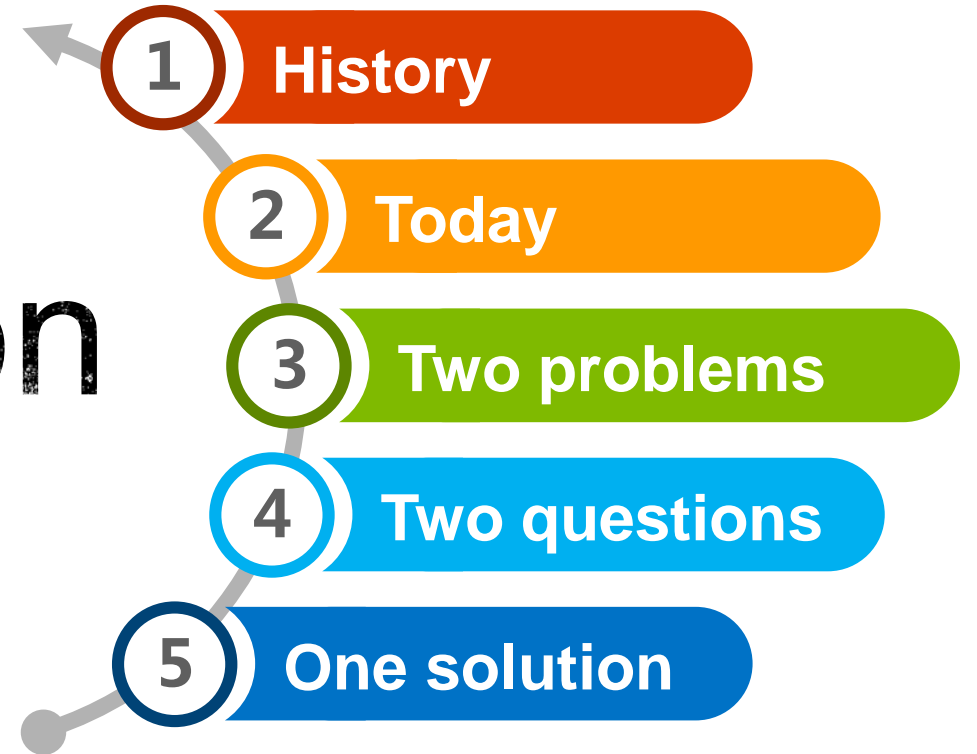
for MMM Conference 2018, Storrs, CT

Contents

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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)

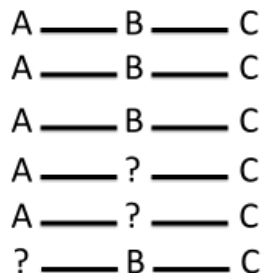Pair-Wise vs. Network Meta-Analysis

Pair-wise meta-analysis

A —— B —— C
A —— B —— C
A —— B —— C
A —— ? —— C
A —— ? —— C
? —— B —— C

Network meta-analysis

$$\theta_{BC}^I = \theta_{AC}^D - \theta_{AB}^D$$

Chaimani et al., 2013; Mavrids et al., 2015; White, 2015

Network structures

A. Single closed loop

B. Star network

C. Connected network

D. Complex network

Cipriani et al., 2013

Source: Hennessy, E. (2018)

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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)
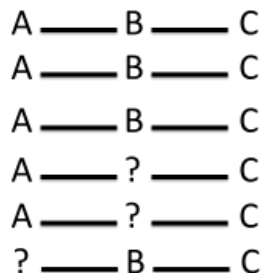

Pair-Wise vs. Network Meta-Analysis

Network structures

$$\theta^I_{BC} = \theta^D_{AC} - \theta^D_{AB}$$

Chaimani et al., 2013; Mavrids et al., 2015; White, 2015

Cipriani et al., 2013

Source: Hennessy, E. (2018)

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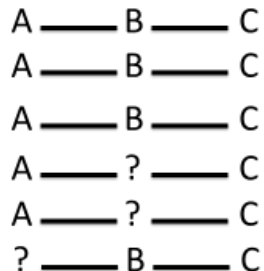
Solution: Bayesian network meta-analysis
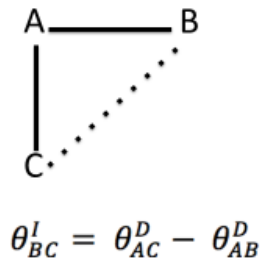
- **Terminology**
  - **Effect size:**
    - It is "a statistical concept that measures the strength of the relationship between two variables on a numeric scale" (Statistics Solutions, 2013) The effect sizes commonly provided in empirical reports include the Pearson correlation r, Cohen's d, and the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

Pair-Wise vs. Network Meta-Analysis

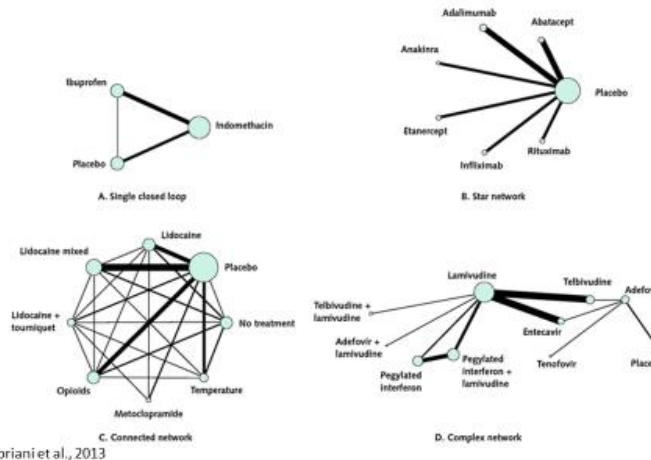$$\theta_{BC}^{I} = \theta_{AC}^{D} - \theta_{AB}^{D}$$

Chaimani et al., 2013; Mavrids et al., 2015; White, 2015

Cipriani et al., 2013

Network structures

Source: Hennessy, E. (2018)

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Introduction

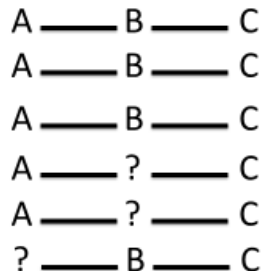**Solution:** Bayesian network meta-analysis

- **Network meta-analysis (NMA)**
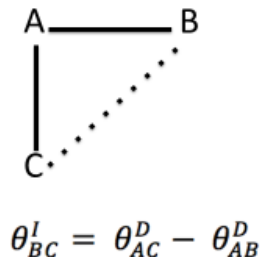
  A. **How it address the two problems**
     - Measures → comparators in an NMA
     - Association → effect size in an NMA (but it is about the association between any two variables, not the difference between control and treatment groups)
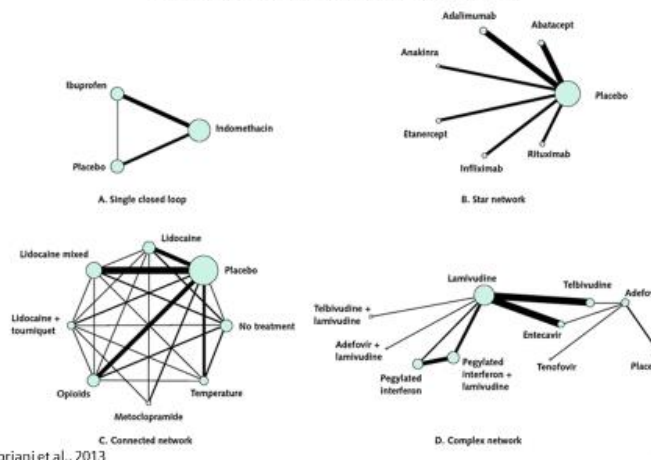

Pair-Wise vs. Network Meta-Analysis

$$\theta_{BC}^I = \theta_{AC}^D - \theta_{AB}^D$$

Network structures

A. Single closed loop

B. Star network

C. Connected network

D. Complex network

Chaimani et al., 2013; Mavrids et al., 2015; White, 2015

Cipriani et al., 2013

Source: Hennessy, E. (2018)

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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)

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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)
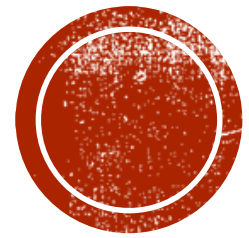
2. Conceptual framework

Taxonomy and Specification of Corruption and Its Outcomes in Education

Value chain a. Upstream	Vulnerabilities/ weaknesses to corruption	Manifestations/indicators of corruption	Affected educational outcomes
Policymakers (ministerial, central)			
• Policy making, regulation	• Policy capture, political interference	• Bias in laws and regulations toward narrow vested interests	• Enrollment rate
• Annual budget allocation	• Budget formulation— "pork barrel"	• Misallocation of expenditures (wage-nonwage ratio in expenditure is out of line), ad hoc budget insertions	• Dropout rate
• Human resources management (e.g. appointments, assignments and promotions)	• Civil service regulations, data, and information management	• Favoritism, nepotism, selling of posts (misalignment between job requirements and actual skills)	• Test score
			• Exam pass/fail rate
Providers (schools, teachers, contractors)			
• Budget implementation	• Procurement of works, equipment goods, and supplies; financial management	• High incidence of noncompetitive bidding, collusion, bid rigging, poor construction, frequent delayed payments, and leakage of funds from center to district	• Students' willingness to learn
			• Students' school completion rate

Value chain b. Downstream

Value chain b. Downstream			
Beneficiaries (students, parents, communities)			
• Teacher assignments	• Teacher attendance	• Teacher absenteeism, ghost teachers, private tutoring, moonlighting	• Actual instruction time
• Exams, certificates, diplomas	• Fees and assessments	• "Unofficial fees," low student attendance, rampant cheating	• Teachers' willingness to teach
• School finances, allowances (fellowships, subsidies)	• Provision of information	• Selling of information, lack of selection criteria	• Teachers' turnover rate

Conceptual Framework

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

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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
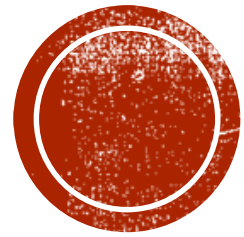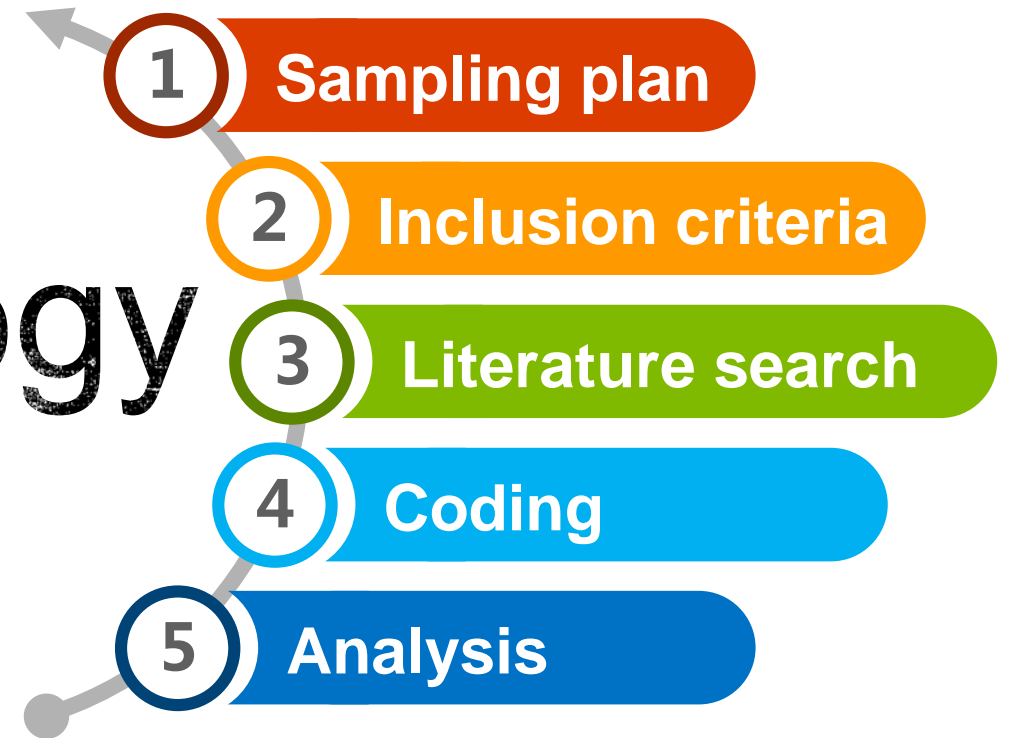
Methodology

- **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.
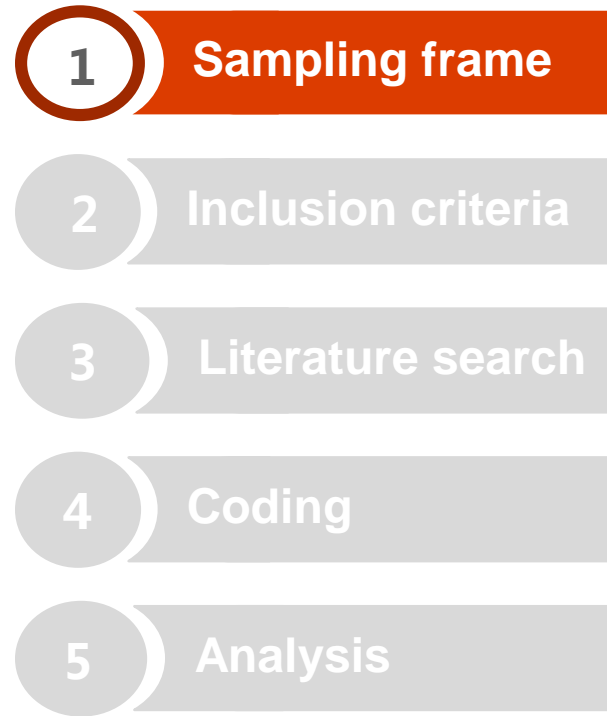
Methodology

- **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, SocINDEX, and Women's Studies International.

Methodology

Methodology

	Search ID#	Search Terms
☐		Select / deselect all **Search with AND** **Search with OR** **Delete Searches**
☐	S20	S8 OR S9 OR S11 OR S12 OR S13 OR S19
☐	S19	(S1 AND S7) AND corruption AND education
☐	S18	S10 OR S14 OR S15 OR S16 OR S17
☐	S17	(S1 AND S6 AND S7) AND corruption AND education
☐	S16	(S1 AND S5 AND S7) AND corruption AND education
☐	S15	(S1 AND S4 AND S7) AND corruption AND education
☐	S14	(S1 AND S3 AND S7) AND corruption AND education
☐	S13	(S1 AND S6) AND corruption AND education
☐	S12	(S1 AND S5) AND corruption AND education
☐	S11	(S1 AND S4) AND corruption AND education
☐	S10	(S1 AND S2 AND S7) AND corruption AND education
☐	S9	(S1 AND S3) AND corruption AND education
☐	S8	(S1 AND S2) AND corruption AND education

1   Definitions

2   Inclusion criteria

3   **Literature search**

4   Coding

5   Analysis

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Methodology

Select / deselect all **Search with AND** **Search with OR** **Delete Searches**

Search ID#	Search Terms
S20	S8 OR S9 OR S11 OR S12 (
S19	(S1 AND S7) AND corruptic
S18	S10 OR S14 OR S15 OR S1
S17	(S1 AND S6 AND S7) AND
S16	(S1 AND S5 AND S7) AND
S15	(S1 AND S4 AND S7) AND
S14	(S1 AND S3 AND S7) AND
S13	(S1 AND S6) AND corruptic
S12	(S1 AND S5) AND corruptic
S11	(S1 AND S4) AND corruptic
S10	(S1 AND S2 AND S7) AND
S9	(S1 AND S3) AND corruptic
S8	(S1 AND S2) AND corruptic

	S7	education AND enrollment OR dropout OR completion OR turnover OR score OR willingness
	S6	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
	S5	education AND finance OR expenditure OR interests OR equipment OR construction OR supply OR provision OR allowance OR fellowship OR subsidy OR fee OR payment OR leakage
✔	S4	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
✔	S3	education AND regulation OR policy OR management OR procurement OR budget OR selection OR appointment OR assignment OR promotion OR bidding OR exam OR assessment OR certificate OR diploma
✔	S2	education AND ministerial OR central OR schools OR teachers OR contractors OR students OR parents OR communities
✔	S1	education AND corruption OR system OR outcome OR manifestation OR indicator OR vulnerability OR weakness

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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

No.	ID	Selecte	Doume	Year of	Countr	Treatm	Control	Depend	f1	f1-corru-measure	f2-general
1	6	Y	55	2000-2010	Global				Control of corruption	Control of corruption measure complied year	Literacy
2	7	Y	55		Global				Corruption perceptions	Corruption Perceptions Index compiled by Tra	Literacy
3	8	Y	55		Global				Control of corruption	Freedom from Corruption Index compiled by	Literacy
4	9	Y	4	2008	Ghana				Corruption level	Corruption (from 2008 Afro-barometer survey	Education level
5	10	Y	4		Ghana				Corruption level	Corruption (from 2008 Afro-barometer survey	Education level
6	11	Y	4		Ghana				Corruption level	Corruption (from 2008 Afro-barometer survey	Education level
12	19	Y	45		Global				Corruption perceptions	Corruption Perceptions Index compiled by Tra	Average scores
	20	Y	45		Global				Corruption perceptions	Corruption Perceptions Index compiled by Tra	Years of schooling
13	21	Y	10		South Korea		Grants fro		Favoritism	Hiring a former bureaucrat in university - revo	Grants for education
14	24	Y	48		Global		the exten		Incidence of the bribes	the extent to which bribes and bribe asking w	Years of schooling
15	31	Y	19				Enrollmer		Control of corruption	Newspapers per school (a proxy of the expos	Enrollment
16	39	Y	31	2013	European Union's NUTS regions				Control of corruption	The respondents' rating of quality of governm	Education level
17	42	Y	30	2001					Corruption perceptions	Corruption Perception Index (COR1)	Enrollment
18	43	Y	30						Corruption level	ICRG corruption index (COR2)	Enrollment
19	44	Y	30						Corruption level	Kaufmann et al.'s corruption index (COR3)	Enrollment
20	46	Y	1		Vietnam		Secondary		Corruption perceptions	corruption (CPI, rescaled)	Enrollment
21	47	Y	26		US				Corruption level	FIRST DIFFERENCE in the number of governme	Enrollment
22	48	Y	52		Global				Corruption level	HIGH level of perceived corruption	Literacy
23	49	Y	52		Global				Corruption level	HIGH level of perceived corruption	Enrollment

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
  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 <u>the uniform prior distribution on т (0, 5)</u> <u>a noninformative prior distribution model</u> 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)
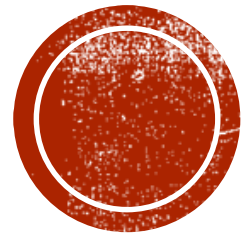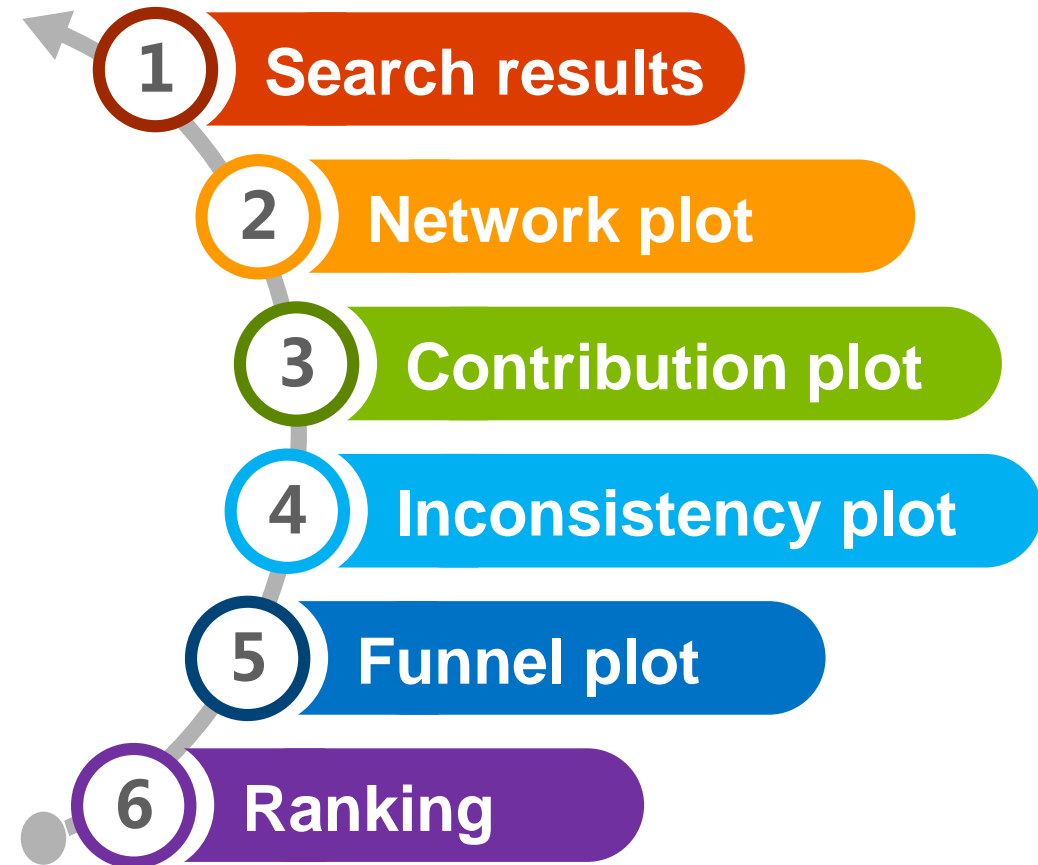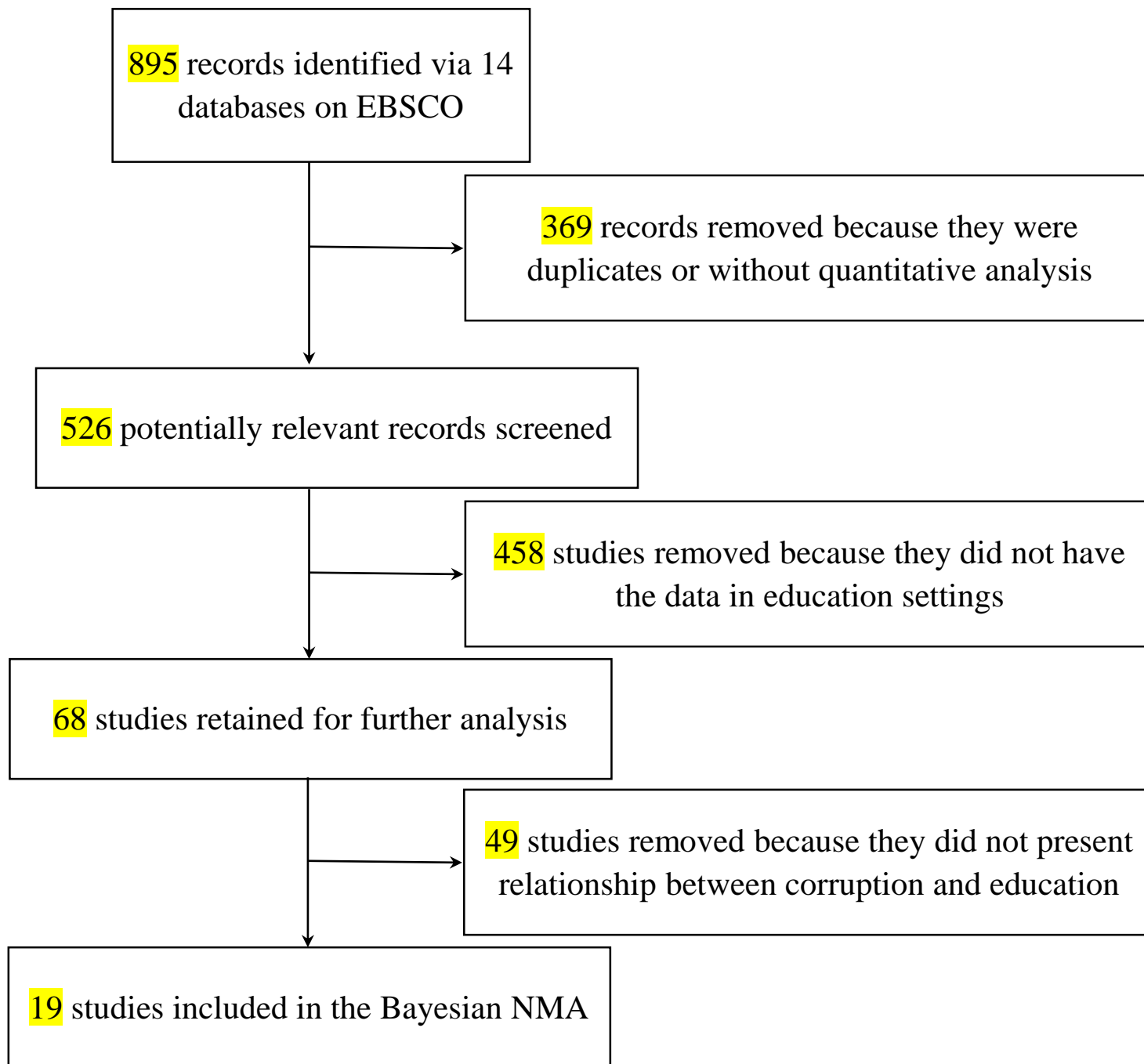 - R (Version 3.4.2) for data analysis, using the "gemtc" package

4. Results

1 Search results
2 Network plot
3 Contribution plot
4 Inconsistency plot
5 Funnel plot
6 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
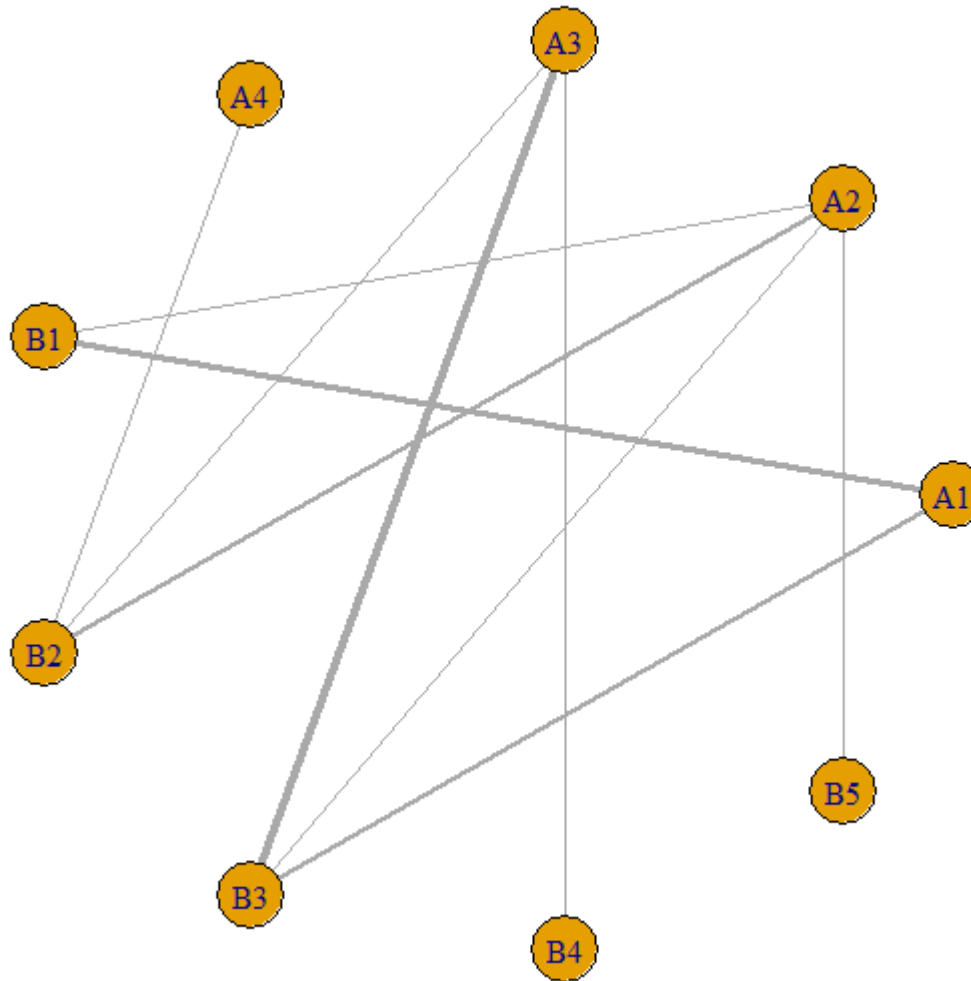
19 studies included in the Bayesian NMA

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
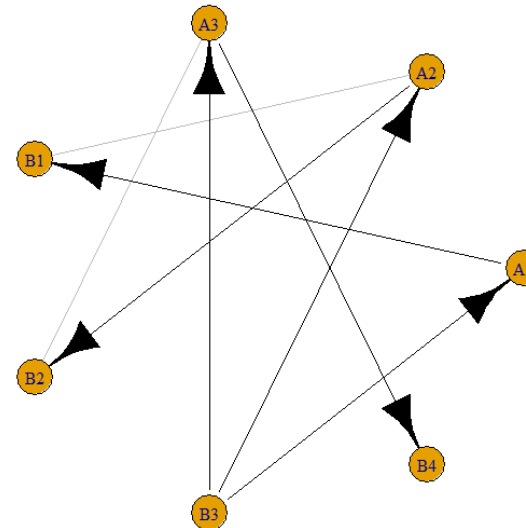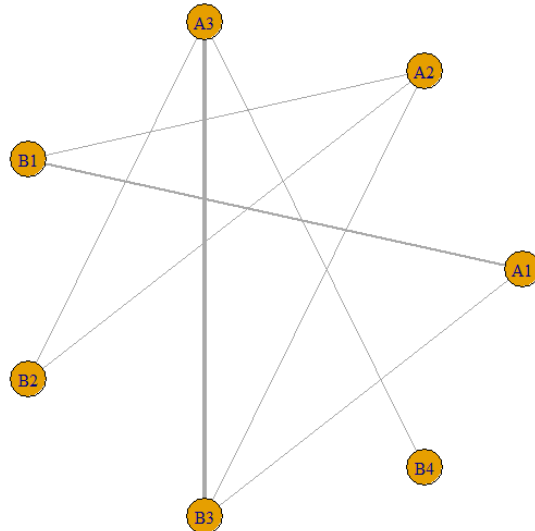- B3: Enrollment
- B4: Completion
- B5: Average scores

Results

Findings

- No closed loops

- A4 is excluded from the consistency analysis because it contains missing data.

- Consistency (random effects)

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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)

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THANK YOU!

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