Some notes on conducting a meta-analysis

1) Read several meta-analyses from meta-analysis.cz to get an idea of the task required of you. Focus on the ones published within the last three years; the best paper so far is here. Don't get intimidated: these are typically large projects that took many months to complete and were written or co-written by people who do this for a living. The great thing about meta-analysis is that you are in control, you construct your own dataset. It's not that you would just download some data created by someone else. But before you can start collecting the data, you need to really understand the underlying literature.

2) Read the most prominent studies on the effect you are interested in (or a narrative survey if you can find one). These will typically be studies published in top 5 journals (AER, QJE, ECTRA, JPE, RESTUD), in the Journal of Economic Literature, or simply those that are heavily cited. Do a basic Google search, just describe the effect you are interested in and inspect the studies (or even blog posts) on the top of the list. Wikipedia can be useful at this stage as well to give you a birds-eye view of the literature.

3) Based on these prominent studies and their references (and citations), try to assemble a list of about 10 studies that you absolutely must include in your meta-analysis.

4) Now design your main search query in Google Scholar. Always use Google Scholar, it's strictly superior to all other databases because it has powerful full text search and includes ALL papers. Also, if you have just one query for one database, people will be able to replicate your search. For the query use different combinations of the keywords employed in the papers. You will know that your query is OK when you have most of the 10 studies identified earlier among the top hits. For inspiration, see http://meta-analysis.cz/eis/Scholar_search.htm.

5) At this point you will have a rough idea about how many primary studies you could expect to find. For one person, it is usually infeasible to collect data from more than 100 studies. Depending on how much time you have, it might be 50. So it's no shame to restrict your attention only to studies published in refereed journals. For justification, see this paper.

6) If you find a working paper you want to include, there is a solid chance it has already been published. Always check for a published version (ideally by inspecting the website of the corresponding author; sometimes the paper will be accepted in a journal, but not yet available on the journal's website). If you have several versions of the same paper, use only the published one.

7) As a minimum for meta-analysis, you need at least 10 studies (at the very least; 20 is the minimum if you want to publish your paper afterwards) and 50 estimates from these studies (100 if you want to publish). Always use all estimates reported in the papers.

8) Your Google Scholar search will return hundreds of studies. As a general rule, you should go through the first 500 of them (that is, read the abstracts) and download all that could potentially contain some empirical estimates.

9) Note the existence of https://sci-hub.se/ and https://whereisscihub.now.sh/. But I encourage you to always use official sources if possible.

10) Then go through the downloaded studies in detail and omit those that do not report estimates of the effect you are interested in. Also omit those that do not report standard errors (unless you really don't have many studies to choose from).

11) Now repeat your baseline Google Scholar search, but only for papers under 3 years of age. Haven't you missed some new studies you can use?

12) Do snowballing: that is, inspect the references of the studies you have collected. Not all of them, but the ones published within the last 3 years. Most likely you will find several studies that were not captured by your Scholar search. Also examine all studies included in previous meta-analyses on the same topic.

13) Make notes throughout the study search in order to be able to construct a PRISMA diagram and include it in an Appendix.

14) Now the real data collection starts. Collect estimates of the effect you are interested in (typically an elasticity), the corresponding standard error (use the delta method for the standard error when the elasticity is not reported directly but you have to compute it, for example, by taking the inverse number of what is reported), and variables that reflect the most important ways in which studies (and individual estimations) differ. See an example for inspiration.

15) You need estimates that are directly comparable, so that you can use them in meta-regression. But quite often different studies will use different functional forms and different units. Always try to use comparable economic effects (elasticities). If this is not possible, you can recompute the effects to partial correlation coefficients (see this). Refer to Doucouliagos's guidelines for practical significance of partial correlations. If you rely on partial correlations, always include a robustness check with the largest possible subset of the studies for which you can use the economic effect (typically elasticity).

16) Focus especially on differences that might have a clear and theoretically grounded effect on the estimated elasticity. For example, if there are studies in the literature that show a theory why data aggregation results in an upwards bias of the estimates, you should create a dummy variable that equals one if aggregated data are used.

17) This means that after you finalize the list of studies you will include in your meta-analysis you should take a break, read many of them, make careful notes, and decide which variables you will collect. This is a crucial part of conducting a meta-analysis.

18) For some variables the theory will not help you, but you should still include them as controls. For example: the average year of data, number of years in the data, number of cross-sectional units,

the number of citations of the study, publication in a peer-review journal, the RePEc impact factor of the journal, etc.

19) In general, you need at least 15 variables for a full-fledged meta-analysis. Be careful about collinearity, inspect variance inflation factors – they should be all below 10. For ease of exposition, divide the variables into groups (data characteristics, estimation characteristics, publication characteristics, etc. – see papers on meta-analysis.cz for inspiration).

20) Sometimes it's useful to include country-level variables. This way, you can go beyond meta-analysis and examine hypotheses that primary studies were unable to test due to data limitations. See this paper for inspiration.

21) Do not attempt to collect all data within a few days. Instead, plan ahead and do it slowly: just about 5 papers a day. When you do it this way, it will be much less stressful, and you will enjoy your research more.

22) Regarding the techniques used in the meta-analysis, follow http://meta-analysis.cz/sigma, which features up-to-date methodology, including robustness checks.

23) Now more details on methodology and the composition of your paper. When you are finished collecting your data, you should clean them. What I mean is that you should inspect the histogram, funnel plot, and summary statistics for each variable and pay particular attention to outliers. Aren't typos involved? Couldn't the authors make a mistake when reporting their estimates (misplaced decimal points, etc.)? Spend several days going through the data set and randomly control portions of the data.

24) Now you need to assemble the final set of variables you will use in your meta-analysis. You have collected many of them, but not all will be usable. As a general rule, you shouldn't use dummy variables that have means below 0.03 or above 0.97 (it means that there is hardly any variation in these variables). You should drop them or merge them with other variables. Do collinearity tests (see above).

25) Even after you clean your data set, you will still see some outliers (perhaps mistakes by the authors of the primary studies). You will have to winsorize the elasticities and their standard errors. The level of winsorization is up to you; typically one will need 2,5 % from each side. But it can be 1 % or 5 % (not more). You know you have the correct level if your results don't change much when you increase the winsorization level.

26) Most meta-analyses have two parts: 1) examination of publication bias, 2) examination of heterogeneity. In part 1, you should use the following specifications: FAT-PET with OLS, fixed effects, between effects, weighted by inverse variance, weighted by the inverse of the number of estimates reported per study, IV (the inverse of the square root of the number of observations taken as an instrument for the standard error). Note that when you say "I weight by X in regression", it means that you multiply all variables by a square root of X. See explanation.

27) Use also non-linear techniques, in which publication bias is not a linear function of the standard error: Ioannidis et al., Andrews & Kasy, (see also their web app), Furukawa, Bom & Rachinger (this is an improved version of PEESE), p-uniform*. When possible, cluster standard errors at the study level (sometimes it makes sense to use double clustering at the study and country level, see this paper). As a robustness check, in the table also show confidence intervals obtained via wild bootstrap. You can find codes for these techniques at http://meta-analysis.cz/sigma/. Code for Bom's technique is here.

28) In part 2, you should do Bayesian (baseline) and frequentist model averaging. In the appendix (or a separate section), report robustness checks with different priors or weights for BMA. The baseline BMA should be unweighted or weighted by the inverse of the number of estimates reported per study (see this paper for explanation). But the more robustness checks the better.

29) Before you start writing the paper, you should have your figures and tables ready. They should form a consistent story that you want to convey to the reader. An example of a story: publication bias matters more than differences in methodology. First you start writing about your results. The last thing you write is the Conclusion, Introduction and abstract (you will probably have the literature review section already prepared).

30) Before writing any important academic text, you should read about how to write. I recommend 3 short books: The Elements of Style, Economical Writing, How to Write a Lot. Please read them all. Also, inspect John Cochrane's Writing Tips for PhD students.

31) In the introduction you should forcefully argue why your study is needed, what the contribution is. You can even use your data and graphs to illustrate the motivation of your study in the introduction section if it's needed (a histogram that shows how estimates vary, they that do not converge in time to a consensus value, etc.). If possible, always quote in the intro the following papers: Methods Matter, Power of Bias, Andrews and Kasy, Star Wars, Credibility, Editorial Statements, p-hacking.

32) It's useful to show a boxplot of studies somewhere in your paper (that results vary both within and across studies). Sort the studies by year of data from oldest to newest. You can do the same thing for countries if your data are rich in the cross-country dimension.

33) Somewhere in the paper you should show a table with summary statistics and detailed explanations for all the variables. Please also choose variable labels in a way that is easy to understand (don't name your variable INSTC but Instutition control, etc.).

34) Be careful that some characteristics of study design may be important enough to warrant separate analysis – typically short-run vs. long-run estimates. If you feel that some groups of estimates don't really go well together, it seems like comparing apples and oranges, do separate analyses for these groups in stage 1 (publication bias, separate funnel pots, etc). But generally you should design your meta-analysis in a way that you can at least pool all the estimates for stage 2 (examination of heterogeneity).

35) Derive a best practice estimate. What mean size of the effect in question does the literature imply when you correct it for publication bias and various misspecifications? This can be seen as the bottom line of your meta-analysis. See this paper for inspiration.