Understanding and adapting Mogstad ... Kirkebøen et al (2014 [updating to 2015, QJE]); "Field of Study, Earnings, and Self-Selection"

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1 Formulating letter to KLM (WIP)

- Can you help me understand how to interpret the statement "the gains in earnings to persons choosing science instead of teaching [relative to] the gains in earnings to those choosing business instead of teaching"? Does this refer to a comparison of payoffs to first choices for two distinct groups – those who prefer science and those who prefer business, each of which may have distinct returns to each of the three courses. Or does it, perhaps under specified conditions, represent the differential gains (from science versus from business) for some homogenous group?

"For exam by choo science stead of humanities individuals almost t their e ings early their wor career"

[1]

- Proposition 2, part 3: I believe this is the maintained assumption you use in your estimation. How is the underlying assumption and result justified, interpreted, and used in your context?

More specifically...DR: I interpret the Prop. 2, part 3 as follows (perhaps incorrectly). The conditions are:

- A. Irrelevance
- "$d_1^1 = d_1^0 = 0 \Rightarrow d_2^1 = d_2^0$" : Someone who will not enter 1 when assigned to 0 or 1 will enter the same field (either 2 or 0) whether they are assigned to 0 or 1. E.g., an individual does not choose 0 if assigned to 0 and 2 if assigned to 1.

[1]DR: I think this is the most important question. I also want to know what they think about our estimator as the policy-relevant impact, but we should first improve our justification and relate it to their 2014 paper, cited below.

NV: From what they do in the estimation it seems to be two (distinct sub)groups: one prefering science over teaching, the other prefering business over teaching. I think they want to make the claim that even though these are two distinct groups, the gains from these two groups can be still compared to each other. [DR: Compared in what way, and where do they say this? NV: the comparison is that by holding the next-best alternative field fixed-teaching in this example- they can make the statement that the gains from getting into business (relative to teaching) are larger than the gains from science (relative to teaching). This comparison shows up in both the modeling part and in the empirical part]

DR: If we allow heterogeneity in relative payoffs, you need to answer the question 'the gains for whom?' In your above language you just say "the gains from getting into business (relative to teaching) are larger than the gains from science (relative to teaching)" ... but you don't specify *which set of individuals* each of these gains pertain to. E.g., the gains from business relative to teaching could be positive for those choosing business first and teaching second, but the gains to business relative to teaching could be zero for those choosing science first and teaching second.

NV: It helps me to have their research question in mind, which is different from ours. I think what they are after is whether individuals sort themselves into a field based on comparative advantage or absolute advantage (section X). In order to make a statement about sorting on comparative advantage, they need to have a comparison of a pair of fields j and k (actually they need to have a double comparison, those who prefer j over k and k over j. On p. 1107 (QJE) they explain that this is not entirely trivial since it involves multiple cut-offs.)

DR: Agreed. Getting estimates of relative gains from different pairings for groups with different preferences may be relevant to measuring sorting based on comparative/absolute advantage. However, they seem to sell their results as telling us about more than just comparative/absolute advantage. To me, the way they describe their results suggests that certain fields are more lucrative *for everyone* relative to certain other fields, *regardless of the students' preferences.*

- "$d_2^2 = d_2^0 = 0 \Rightarrow d_1^2 = d_1^0$": Someonewho will not enter 2 when assigned to 2 or 0 will enter the same field (either 0 or 1) whether they are assigned to 2 or 0. E.g., no one chooses 1 if assigned to 2 but chooses 0 if assigned to 0

- In the words of KLM "In result iii, we assume that if changing z from 0 to 1 (2) does not induce an individual to choose treatment 1 (2), then it does not make her choose treatment 2 (1) either. In our context, for example, this assumption means that if crossing the admission cutoff to field 1 does not make an individual choose field 1, it does not make her choose field 2 either" (KLM, QJE p. 1071).
  - DR: This may offer insight – which case are they referring to? One in which the threshold scores (S_x) needed for admission to field x follow $S_2 > S_1 > S_0$ and we compare an individual whose score is just above or just below S_1? In this case, with a score above S_1, you can go to 1 or 0 without paying a noncompliance cost. The equivalent to my 'counterexample' would be someone who goes to 1 if their score is between $S_1$and S_2, but goes to 2 (paying a noncompliance cost), if their score is below S_1. In this case crossing the threshold (dropping *below* it) for 1 causes you to go to 2 (apparently violating their condition), but crossing the threshold from 0 to 1 does cause you to choose 1 (so their condition holds).
    - another case $S_1 > S_0 > S_2$
    - If we interpret 'crossing the threshold' in a positive direction only then the condition described in words would be violated only if he chose 0 when $s < S_1$, and chose 2 when $S_1 < s < S_2$. I agree that this would not be reasonable under any normal set of preferences. (But is this what their assumptions literally describe?)
  - Alternately, we could have $S_1 > S_2 > S_0$; I assume by 'crossing the threshold' they always mean a, single adjacent threshold. So here we compare the bits in parentheses and the analysis is as in the last bullet. It depends what you mean by 'crossing the threshold'.

I interpret this as "within the group and margin you are looking at, one must assume that someone 'always complies', i.e., attends the programme they are assigned to no matter what, or 'never complies', i.e., goes to their preferred program no matter what (I believe these are called 'always takers"'). However, this is inconsistent with a fairly plausible example I give below; would that example apply to your analysis? If the irrelevance condition is violated, how can we interpret the estimates?

NV If the irrelevance condition is violated, KLM interpret their estimates as heterogeneous pay-offs, with a null-hypothesis of homogeneous pay-offs.

DR: I don't see this; can you explain and cite the part where they say this? I think Prop 2 part 3 already allows for heterogeneous payoffs. It's part 1 that imposes homogenous payoffs. (Also, I don't know what you mean by the null/alternative hypothesis here.)

- B. Next best alternative

- "and we condition on $d_1^0 = d_2^0 = 0$" : I believe this is implied by the conditioning stated below, for both β terms, [2]. However, it does not fully *imply* the conditioning; the conditioning also imposes the compliance $d_1^1 = 1$ for estimating $\Delta_1$and $d_2^2 = 1$ for Δ_2.

- Combining with the irrelevance assumption implies that to consistently estimate each Δ^j for a particular subset we must (sufficient and necessary? condition) assert that for these individuals the mapping is:[3]

[2] $d_2^0 = 0$ in combination with $d_1^1 - d_1^0 = 1$ implies one does not go to 1 or 2 if assigned to 0, so must go to 0. Similarly for other estimate.

[3] Conclusion (tentative): The IV technique can consistently estimate Δ^1 and Δ^2 (returns to 1 versus 0 and for 2 versus zero respectively) for distinct populations with 'some' noncompliance ... (see table) However, to be able to estimate these returns for the same group, to be able to say 'for this group the returns to Science vs Humanities exceeds the return to Business vs Humanities'*, one needs full compliance for this subset for the conditions of their theorem to work. (And with full compliance, one wouldn't need IV, correct?)
DR If we don't have the "right kind of compliance" this I don't think this allows us to say "OK, but the estimates are valid for compliers" ... I think they need these conditions for the estimates to be consistent even for compliers.
(Of course there may be weaker sufficient condition they haven't specified).
*Logically, isn't this the same as saying 'the returns to Science exceeds the return to Business for this group'?

To estimate Δ_1		*To estimate* Δ_2			*To estimate both on same subset*	
Assigned	**Attend**	**Assigned**	**Attend**		**Assigned**	**Attend**
0	0	0	0		0	0
1	1	1	0 or 1		1	1
2	0 or 2	2	2		2	2

- This condition
  - (Of course the hypothetical choices are not observed empirically)
- NV: they definitely use this in the empirical part, but I believe they want to narrow the implications of the irrelevance assumption, because the irrelevance assumption itself does not identify the pay-offs.
- In the words of KLM "On its own, this irrelevance condition does not help in resolving the identification problem posed by heterogeneous effects under Assumptions 1–4. But together with information about individuals' next-best alternatives, it is sufficient to identify LATEs for every field." (KLM, QJE, p. 1071).
- DR: What do you mean 'narrow the implications of the irrelevance assumption'?
- DR: What is meant by 'LATEs for every field'? The "Local" part of this has to do with the compliers. But is the averaging only for a specific pairing of choices (a particular choice ordering)?

(NV) The result is:

$$\beta_1 = E[\Delta^1 | d_1^1 - d_1^0 = 1,\ d_1^0 = d_2^0 = 0]$$

$$\beta_2 = E[\Delta^2 | d_2^2 - d_2^0 = 1,\ d_1^0 = d_2^0 = 0]$$

NV: in words, β_1 is the expected pay-off of completing field 1 relative to field 0, given that if the instrument shifts you to field 1, you complete field 1, but if the instrument shifts you to field 0, you do not go to field 1, nor to field 2, hence you must go to field 0.

DR: You have pasted in the $d_2^0 = 0$ from the *assumption* ("If") part of condition 3. What confuses me here is I am never sure what is an assumption about behavior and what is referring to the empirical subset that they are choosing for their estimation procedure.

What you state in the line above could hold for someone with any set of preferences, as long as they always comply with an assignment to courses 1 or 0.

The $d_2^2 = d_2^0 = 0 \Rightarrow d_1^2 = d_1^0$ part of the irrelevance condition then implies that if they *also fail to comply with an assignment to 2*, you do not go to field 1 if assigned to 2, thus you must go to field 0 if assigned to 2. In other words, adding the irrelevance condition to the above means that either $d_2^2 = 1$ or $d_0^2 = 1$ (but not $d_1^2 = 1$).

So, someone who complies with *every* assignment meets the above assumptions and conditioning, as well as someone who complies with 1 and 0 but goes to 0 when assigned to 2. This is as in the table above.

DR thought: is it possible that there is a group of people for whom the condition applies so that the betas are comparable?

NV. I don't think so, both groups have the same next best alternative (field 0) but differ in the field just above the next-best alternative, in the construction of groups and the institional set-up with a ranking and a single cut-off it must be different groups.

DR: Based on the actual algebra, why do you think that field 0 must be the NBA here? Can't they have any *ranking* as long as they comply with the assignments in the way described above? This is important – we are missing something about the correspondence between this theory and their empirical work.

DR You [KLM] interpret or exemplify the assumption as: "[here] if crossing the admission cutoff to field 1 does not make an individual choose field 1, it does not make her choose field 2 either."

I am having trouble understanding the logic for this in your context. Suppose an individual's potential (earnings) outcomes for three courses are ranked $Y_2 > Y_0 > Y_1$.

I assume 'assignment to a course' means it is less costly to enter or complete this course ('comply') than to complete any other course.

Here, if she is assigned to 0 she might choose 0 (rather than 2), i.e., $d_0^0 = 1$ ($\Rightarrow d_1^0 = d_2^0 = 0$), to avoid the cost of noncompliance, as the gain to noncompliance ($Y_2 - Y_0$) may be small.

DR: Here 'crossing admission cutoff to 1' make harder for to enter fi ... relati the case u d=0, or these ord in some

On the other hand, if she is assigned to 1 it might be worth paying the noncompliance cost to obtain the larger gain $Y_2 - Y_1$, and thus choose 2, i.e., $d_2^1 = 1$ ($\Rightarrow d_1^1 = d_0^1 = 0$).

This would violate the first bulleted condition above as $d_1^1 = d_1^0 = 0$ but $d_2^1 = 1 \neq d_2^0 = 0$. What is the logic for ruling this out in the Norway context, or is there an error in my above depiction?

NV: first of all, I think it depends on which two pay-offs you are comparing. They do not estimate the pay-off $Y_2 - Y_1$, because in your ranking the next best alternative for Y_2 is Y_0, not Y_1.
DR: OK, but whether or not they are *estimating* this payoff should not the compliance condition itself, no?

NV: The two relevant comparisons [DR: by 'relevant' you mean the estimates they could produce for someone with the above rankings, I guess?] are field 2 with next-best alternative field 0 (Y_2, Y_0), respectively, and field 0 with next best alternative 1 (Y_0, Y_1). The first one is [DR: I don't agree that choosing people with these *rankings* is necessary or sufficient for the conditions after the vertical bar to hold. The elements after the vertical bar are (I guess) 2 of the 3 maintained assumptions, and I question the validity of these assumptions]:

$$\beta_2 = E[\Delta^2 | d_2^2 - d_2^0 = 1,\ d_1^0 = d_2^0 = 0]$$

NV: The second comparison is the pay-off from completing field 0 relative to field 1, which would be the equivalent to:.

$$\beta_0 = E[y^0 - y^1 | d_0^0 - d_0^1 = 1,\ d_0^1 = d_2^1 = 0]$$

NV: second, KLM select their sample in such a way that for the comparison of field 2 relative to field 0 they construct the sample to force the comparison. In other words, in your example for the comparison of (Y_2, Y_0) they take all people with this particular preference ordering AND having either their application score in between (Y_2, Y_0) or right aboveY_2(top panel in Table 1). So if I am assigned to field 0, this implies that my application score is lower than the cut-off and field 2 is unreachable to me. (This is unless I do not comply and try again next year for field 2 (always-taker), and there KLM state that their analysis is silent on never-takers and always-takers (QJE, p. 1083).) Continuing your example, if I am assigned to field 1, of course the gain to noncompliance might be larger and I would like to get into field 2. However, by construction, this is either not possible–your application score is in between field 0 and 1 and I really will not get into 2; or you try again next year for field 2 (always-taker).

DR: But why shouldn't it be possible that I would not try again for field 2 if I got into field 0 but I *would* try again if I failed to get into either field 0 or field 2 but I got in to field 1? And if "not getting into fields 2 nor into 0" is impossible for the people in the relevant sample, why do they need to have the irrelevance assumption (limiting d_x^1) for this person? Or what am I misunderstanding?

NV: there is a subtle way of non-compliance, again taking your ordering and comparing fields 2 and 0 (Y_2, Y_0). Remember that for the comparison in β_2(see formula) they compare people with the preference ordering (Y_2, Y_0) and for some the instrument assigns them to field 2. For the others the instrument does not assign them to field 2, but where will they go to? KLM assume irrelevance and independence, so that the losers will go into field 0. Non-compliance here would be going into field 1 (taking your preference ordering).
DR: Not sure what you are getting at here. If these people didn't get in to field 2 but instead got into 0, there is no reason they would select their third choice (field 1), so that would be perverse non-compliance.

DR: I think the relevant concern is that there are some who 'comply' in the way described and others who don't (and their potential returns differ?) ... the first stage will predict something not reflected in the 2nd stage (complete the thought...)

- Ask about compliance: what does noncompliance mean in the context of their theoretical discussion
- Footnote 19, in context:

> In particular, Proposition 2 showed that we can identify the LATE from choosing one field of study as compared to another if our instruments satisfy an irrelevance condition, and if we can condition on individuals' next-best fields.

(19): If the irrelevance condition does not hold or if individuals do not understand the allocation mechanism, then our estimation approach should be interpreted as relaxing the constant effects assumption in part (i) of Proposition 2 to allow for heterogeneity in payoffs according to next-best fields.

- ... I thought that your estimation was based on part iii (not part i) of Proposition 2. Part iii is in fact referred to as the 'irrelevance condition', and it does not require the constant effects association of part i (unless I misread it).
- NV: part (iii) nests part (i) (and part ii) as special cases. In part VIII.A they test for constant pay-off effects and restrictive preferences, and report rejecting both.
  - DR: are you sure? I wasn't convinced these were nested. Why should (i = constant effects) imply any particular compliance behavior?
- Given that you are conditioning on next-best fields anyway, aren't you already allowing for the 'heterogeneity in payoffs according to next-best fields', rather than relying on part i?
  - NV: exactly
- DR: If part iii already allows for payoff heterogeneity, what is the consequence of a violation of the 'irrelevance' condition?
  - NV if assumption (iii) fails the following happens. By construction KLM looks at single (local) comparisons of two fields. [DR: So you are saying they will either be assigned to 1 or 0 here, correct?] Again, looking at $\beta_1$compares the pay-off of field 1 versus field 0. Now if assumption (iii) fails, this means that people NOT assigned to field 1 will go into field 0 AND into field 2 (or any other lower-ranked field in the menu with all fields). When assumption (iii) holds, losers would only go into field 0. [DR: The 'going to field 0 if assigned to it' is implied by only a part of the assumption, the "and we condition on $d_1^0 = d_2^0 = 0$" part; I'm not sure whether this is the assumption or the 'conditioning'; it's confusing.] When assumption (iii) fails, losers will also go into field 2. This will show up in the data as $d_1 = 0$ and $y > 0$, so in a way KLM would have a different version of the problem they started out with: equation 6 (QJE, p. 1067). The comparison of two fields is a weighted average across person with different next-best alternatives.
    - DR: I believe you are correct that it would be a weighted average across people with different NBAs. However, the footnote does not say this. It says "to allow for heterogeneity in payoffs according to next-best fields" and not [what I think this should say] "to allow that our payoffs reflect payoffs a particular field relative to a weighted combination of next-best fields, for those with a particular single next-best field."
    - DR: Second thought - each estimate that they give focuses on those whose qualification and preferences place them at the margin of two particular fields (say A and B), comparing those who get into the preferred field to those who get in to the less-preferred field. However, they are pooling between "ABC people" for whom A and B were (e.g,) the first and second preference (so A>B>C) and "CAB people" for whom these were the second and third preference (so C>A>B but their mark is far too low for C). If all ABC and CAB people go to A if assigned to A but go to B if assigned to B (as implied by the conditioning, correct?) we have 'full compliance' at this margin, so the estimate should give us the weighted average payoff for CAB and ABC people.
      - ... So if the above is correct and implied by the conditioning, why do we need the additional irrelevance assumptions? Do the irrelevance assumptions tell us something about the comparability of the CAB and the ABC people?

NV: it might help to write out the empirical estimation of the model counterpart, so three fields, field 0 is the next best alternative (first subscript is completed field, second is next best alternative). I doublechecked the π_{10} and π_{20} in the second and third line, and I think this is the way it should be.

$$y = \beta_{10}d_1 + \beta_{20}d_2 + \gamma_0 x + \mu_0 + \theta_1(+\theta_2) + \epsilon_0$$

$$d_1 = \pi_{10}z_1 + \pi_{20}z_2 + \psi_{10}x + \tau_0 + \sigma_1(+\sigma_2) + u_{10}$$

$$d_2 = \pi_{10}z_1 + \pi_{20}z_2 + \psi_{20}x + \tau_0 + \sigma_1(+\sigma_2) + u_{20}$$

The first line is *estimated for two groups*, those who prefer field 1 over 0 and those who prefer field 2 over 0. $z_1 = 1$ means that the preferred field is 1 and the score exceeds the cutoff for 1, and is zero otherwise.

NV: I made up the following example, with compliance and non-compliance. Take three candidates with the same rankings, cut-offs are the same, but the individual application scores are different. For A and B the comparison works according to KLM. Applicant C completes field 2 instead of field 0. If my understanding is correct, he will be counted with B in contrasting the pay-off comparison of fields 1 and 0. I don't think C will be added to the comparison of field 2 versus field 0, because field 2 is the next best alternative after field 0, and not the other way around ($d_2$is the comparison of field 2 with next best alternative field 0).

DR: I think something is missing in your example. You gave everyone identical preferences and payoffs in the table. Is that what you meant?

Bernard and Chris have identical preferences and identical scores in your example

NV: Assumption (iii) rules out this type of non-compliance. If assumption (iii) fails–as in the example– completing field 1 versus field 0 will be a comparison involving an average of other fields.

DR: I don't understand why Chris goes to field 2 in your example, if it gives him the lowest payoffs and he is assigned to field 0. One thing that strikes me, however, is that this sort of noncompliance may be costless to Chris, whereas to noncomply to try to go to field 1 he would need to wait another year, presumably.

Can you identify specifically which assumption (using the KLM notation) that Chris is violating?

ranking	field	cutoff	pay-off		ranking	field	cutoff	pay-off		ranking	field	cutoff	pay-off
1st	1	48	150		1st	1	48	150		1st	1	48	150
2nd	0	45	100		2nd	0	45	100		2nd	0	45	100
3rd	2	40	75		3rd	2	40	75		3rd	2	40	75
Anton	$z_1 = 1$				**Bernard**	$z_1 = 0$				**Chris**	$z_1 = 0$		
score=49	$d_1 = 1$				**score=47**	$d_1 = 0$				**score=47**	$d_1 = 0$		
	$d_2 = 0$					$d_2 = 0$					$d_2 = 1$		
	compliance					compliance					non-compliance		

Questions to maybe skip, (at least for now), but I'd still like to understand: [4]

1.1 28 Feb 2017 comments

1. If the irrelevance condition (assumption in part three in Prop 2) is meant to refer to "where field 1 is preferred over field 0" it should follow from an optimizing agent with a fixed 'noncompliance cost', but I do not see this state somewhere explicitly. (See discussion 'more on proposition 2 part 3' below). Let me call this the *'ordered irrelevance condition'*.

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[4]

- Terminology stuff ... they conflate 'field chosen' and 'field completed' at times
- Discussion of returns to 'compliers' taking into account differential completion rates, particularly between fields
- Payoffs to 2 versus 0 exceed the payoffs to 1 versus 0 across all of those choosing 2 and 1 as first choices respectively, i.e., $E[\Delta^2|d=2] > E[\Delta^1|d=1]$ [while]...the opposite holds for those at the "relevant choice margins", those choosing 2 and 1 as first choices and 0 as a second choice: $E[\Delta^2|d=2, d_{/2}=0] < E[\Delta^1|d=1, d_{/1}=0]$
  - *Ffor which question are these the 'relevant margins', i.e., what is the relevance of the above comparison?*
- "OLS estimates of the payoffs to field of study can vary either because of selection bias, differences in potential earnings across fields, or differences in weights across the next-best alternatives." ... *doesn't this leave out the possibility that payoffs to a field could also vary because of different potential outcomes between those who choose different fields as first choices?*
- Prop 1 intuition: Why should (e.g.) the IV-estimated β_1 be affected by Δ^2 (the payoff to 2 relative to 0)? I would have thought the estimated β_1 would pick up a weighted average of payoffs to getting 1 instead of 0 for those with NBA=0 and those with NBA=2. What does this have to do with the payoffs to 2 versus 0? For this measure, are we not simply comparing those, for whatever preference, whose marks put them just above or just beow the margin between fields 1 and field 0 ... so they never should enter field 2, I would think.

2. I believe that for each of these parts they mean the β_1 and β_2 to refer to the IV estimation result where we look at students (with scores near the threshold of two fields), *where these fields are adjacent in the student's rankings.* (E.g., if field A requires 90 marks, and the next highest field is B requiring 80 marks, we look only if students who rank B directly below A in some part of their rankings.)

... However, for part 1 (homogenous effects) this empirical restriction should not matter, while it is critical for part 3. For part 3, I believe that with the ordered irrelevance condition assumption, looking at this subset means the IV-"LATE" estimator tells me about those for whom the condition after the bar holds. If I have someone for whom A>B>C or C>A>B, I know that they either comply with an assignment to A and to B, or they 'always go to C'. If this is the case, the LATE estimator of the returns to A over B tells me about the average of those relative returns for compliers who have A>B somewhere in their ranking (without any others in between).

3. I do see how they can test for constant effects if they assume condition 3 and produce the estimate mentioned above. If 'constant effects' holds, then we can simply add things up and see if the sums agree. E.g., add 'payoffs to A-B for those with this ranking in one year' to 'payoffs to B-C for those with these rankings in some year', and see if they add up to 'payoffs to A-C for those with this ranking in some year.'

4. I still find it unclear what they're claiming to infer about "“the gains in earnings to persons choosing science instead of teaching [relative to] the gains in earnings to those choosing business instead of teaching". I suspect that statements like “for example, by choosing science instead of the humanities, individuals almost triple their earnings early in their working career” is overstated and a bit misleading. If payoffs are heterogeneous and can vary for people with different first and second preferences, and we only observe payoffs for those who *state this particular preference ranking*, how can we ever say something about 'average payoffs to A-B for everyone', or even for any group including people who did not state this preference ordering?

They can do things like in figure IX and examine the "average pay off relative to next best field -- for those with these next-best fields -- and compare this across (preferred) fields". However, this would seem to be vulnerable to their own basic critique -- we are adding heterogeneous payoffs relative to heterogeneous fields, so some may not be informed of any particular labor market returns.

5. I still think there is something mis-stated in Footnote 19. However, if proposition 2 part 3 now makes more sense, this may be less important -- unless our own work violates the equivalent of the assumptions of part 3. I suspect what they meant was something like

> If the irrelevance condition does not hold [e.g., because of differential non-compliance costs depending on one's allocation] or if individuals do not understand the allocation mechanism [?so they don't rank their true preferences], then our estimation approach should be interpreted as *[cut: relaxing the constant effects assumption in part (i) of Proposition 2 to allow for heterogeneity in payoffs according to next-best fields]* an estimate of returns to admission to the more preferred field for those specifying a particular set of preferences (1>0) reflecting a weighted estimate of returns to fields.

1.1.1 More on proposition 2 part 3

1. Their proposition 2 (part three) makes sense to me if I assume they mean that field 1 is preferred over field 2 in this proposition. Then when you think about: ... holding constant the threshold required for entry into each field, ... and note that we are looking exclusively at:

- the comparison of individuals just below or just above a particular threshold (e.g., let field A have the threshold of 90, and field B has the next highest threshold of 80; we look at individuals with a score of 89 or 90)
- where that individual has ranked the institutions in this order (in their preference ranking A>B, with no institutions in between).

Adapting their irrelevance assumption: "Someone who will not enter A when assigned to A orB will enter the same field (either C or B) whether they are assigned to A or B. E.g., an individual does not choose B if assigned to B and C if assigned to A."

For the set of students we're looking at, this guy could have $C > A > B$ or $A > B > C$ (but not B>A and not A>C>B).

- If $A > B > C$ he will enter A if assigned to A.

- If C>A>B then if he is willing to pay the noncompliance cost and go to C when assigned to A, he would certainly pay this cost and also go to C when assigned to the less-preferred B.

However, if we are not meant to assume that field 1 is preferred over field 2 in their statement, then I can switch B and A in their statement ... so it becomes

"Someone who will not enter B when assigned to B or A will enter the same field (either C or A) whether they are assigned to A or B. E.g., an individual does not choose A if assigned to A and C if assigned to B."

- Here if $C > A > B$ it is reasonable to expect that he may enter A if assigned to A but C if assigned to B; this is the example I gave earlier.

... So are we to assume that they mean the irrelevance condition to refer to 'where field 1 is preferred over field 0?'

2 Introduction (and abstract)

1. "Different fields of study have substantially different labor market payoffs, even after accounting for institution and peer quality. "
2. "The effect on earnings from attending a more selective institution tends to be relatively small compared to payoffs to field of study."
3. "The estimated payoffs to field of study are consistent with individuals choosing fields in which they have a comparative advantage."

> ...allows us identify the payoff to completing one type of education relative to a particular next-best alternative ...
>
> [Also, later:] While a complete characterization of the pattern of selection would require a number of strong assumptions, we can use the estimated payoffs to learn about the comparative advantages of the compliers to our instruments.

DR: I am unclear whether they are able to identify the 'payoff' mentioned *for a general group or whether it is only for those who choose this pairing of first and second choices. In the latter case, comparisons of relative returns should not be used to claim that certain fields yield higher payoffs than other fields for the average person.*

DR, 17-11-16: *I am fairly sure it is the latter. However, they argue the choices are incentive-compatible, so we are getting at the payoffs for people for whom these are the actual next-best alternatives. But: this doesn't mean their NBA is the second-highest paying field for them, if we allow for compensating differentials/amenities.*

> "the admission system we study creates exogenous variation in both field and institution choice"

DR: I think they mean in the allocations not the choices*; choices are endogenous which makes the interpretation problematic.*

MP: this is standard terminology in IV models, to say that the IV gives you exogenous variation to understand the effect of the endogenous variable. (In some sense that's the whole point of the IV model, to allow you to make a causal statement about an endogenous variable.)

DR: Of course that's what IV is about, but here the distinction between allocations and choices matter, for the reasons mentioned above. The returns to 'going to A versus B' are likely to vary on average for between those who chose A as a first choice, and those who made another choice. But ultimately, this may just be an error in their wording, their analysis is what it is.

> [Noting] completion rates are sometimes low and vary systematically across fields...
>
> ...We are able to estimate the impact of graduating with a degree in a field in addition to the intention-to-treat effect of crossing the admission cutoff to a field

DR: How do they deal with selection issues in doing this? *If some fields are harder to complete one would imagine the estimated payoffs from these fields are biased upwards.*

MP: I'm also not sure what happens if different subjects have different drop-out rates (or transition rates to other subjects with different probabilities). I think their IV estimate is clean if there is non-compliance between first- and second choice, but if there are effects on dropout or on completing other subjects then I'm not sure if this is a violation of their IV assumption (that everything works through the major).

DR: Consider an IV model using assignment to instrument completion. This IV regression should measure the returns to completion for those 'compliers' who complete the field if and only if they are assigned to it. It's an unbiased measure for these 'compliers', so IV 'works'. However, the returns to compliers may differ from the average returns, and 'compliers' in more difficult fields are likely to be stronger students than compliers in easier fields, so comparing the returns across fields is difficult!

DR: Note that they have scaled back some of the claims, *and refer more narrowly to their estimator in this QJE version vs the 2014 NBER WP;*

e.g. "For example, by choosing Science instead of Humanities, individuals almost triple their earnings early in their working career. By comparison, choosing Science instead of Engineering or Business has little payoff" – the latter sentence was removed

II Instrumental variables in unordered choice models (model for identifying payoffs to field)

Consider choice between three fields $d \in 0, 1, 2$.

Let d_j indicate 'completed field j'.

Consider:

Regression estimates (or hypothetical linear projection) of observed earnings as a function of completing each field:

(Equation 1)

$$y = \beta_0 + \beta_1 d_1 + \beta_2 d_2 + \varepsilon \tag{1}$$

Groups : $Z \in 0, 1, 2$, z_j indicates assigned group.

... "instrument that shifts the cost or benefit of choosing field j"

DR: In t context, do the ins ments shift cost/benef Is it that if does not assigned must try a next year or 'infin costly'? makes think 'choosing' they n 'entering'.

Potential outcomes:

$$d^z;\, y^{d,z}$$

d^z : field chosen [or completed?] if assigned group z

$y^{d,z}$: Outcome (for an individual) if assigned group z and entering field d ... (below we assume this is independent of z)

Assumptions: Exclusion, independence, full rank (standard IV assumptions, treatment context)

$$\begin{aligned} y^{d,z} &= y^d \,\forall\, d, z \qquad (2)\\ y^d, d^z &\perp Z \,\forall\, d, z \qquad (3)\\ E[z'd] &\;\; full\,rank \qquad (4) \end{aligned}$$

- So outcome depends on *field completed* not on assigned group (instrument, lottery assignment, etc)
- Assigned group unrelated to *potential* outcomes for 'choices (of field) for each assignment' and for outcomes of interest (income)
- "Norwegian data provides us with i) one instrument for every field"

Cf: we ***d*** *have this each ins tion in DUO lot I don't ur*

→Model allows payoffs to differ by 'which fields compared' ($y^1 - y^0$ vs. $y^2 - y^0$), and by individuals ($y^1 - y^0$ may differ for everyone).

Model linking observed to potential outcomes
1. Field completion → outcome:

$$y = y_0 + (y^1 - y^0)d_1 + (y^2 - y^0)d_2$$

2-3: 'Choice equations' (assignment→ field completion [or entry?] at 1, 2 respectively)

$$d_1 = d_1^0 + (d_1^1 - d_1^0)z_1 + (d_1^2 - d_1^0)z_2$$

...where dummies represent d_1^0: choose 1 if $z = 0$', d_1^1 : 'choose 1 if $z = 1$' etc.

$$d_2 = d_2^0 + (d_2^1 - d_2^0)z_1 \ldots$$

Assumption 4: Monotonicity

$$d_1^1 \geq d_1^0,\ d_2^2 \geq d_2^0 \tag{5}$$

...assignment weakly increases probability of field completion (no 'defiers')

Note: Independence of Irrelevant Alternatives not assumed

OLS estimation of payoffs to field of study (→standard selection bias (+ a 'comparison issue'))

(Naive) OLS (estimate of β_2) yields the sample analogue of...

$$E[y|d=2] - E[y|d=0] = \underbrace{E[\Delta^2|d=2]}_{Payoff} + \underbrace{E[y^0|d=2] - E[y^0|d=0]}_{Selection\ bias} \tag{6}$$

where $\Delta^2 := y^2 - y^0$ (individual payoff from 2 instead of 0*; payoff (ATT?) for those choosing d=2)*

1. Need to correct for selection bias (recognized in most papers); $E[y^0|d=2] \neq E[y^0|d=0]$
2. Individuals who choose same (fields) may differ in their next-best alternative (NBA), but we typically observe only the chosen field. This causes another comparison issue [previously they called it an 'interpretation bias']

Letting $d_{/j}$ denote an individual's NBA:

$$E[\Delta^2|d=2] = \underbrace{E[\Delta^2|d=2, d_{/2}=0]}_{ATE\ where\ NBA=0} Pr(d_{/2}=0|d=2) + \underbrace{E[\Delta^2|d=2, d_{/2}=1]}_{ATE\ where\ NBA=1} Pr(d_{/2}=1|d=2) \tag{7}$$

So even if there is no selection bias (e.g., all get the same return to d=0), β_2 estimates a weighted average of payoffs to choosing 2 instead of 0 across groups with different NBAs.

[However this estimate still might be policy-relevant, e.g., as a measure of the return to expanding spaces in field 2.]

The above bracketed ATEs will differ if the returns to 2 versus 0 vary across individuals and they rank their choices based on this (presumably, those where NBA=0 get more from 0 than the second group and thus, ceteris paribus, will have a smaller ATE.)
[5]

[5] As an example, we can have that:

- Payoffs to 2 versus 0 exceed the payoffs to 1 versus 0 across all of those choosing 2 and 1 as first choices respectively, i.e., $E[\Delta^2|d=2] > E[\Delta^1|d=1]$ *but*
- ...the opposite holds for those at the "relevant choice margins", those choosing 2 and 1 as first choices and 0 as a second choice: $E[\Delta^2|d=2, d_{/2}=0] < E[\Delta^1|d=1, d_{/1}=0]$
  - *DR: But for which question are these the 'relevant margins', i.e., what is the relevance of the above comparison? (maybe relevant for comparative advantage measures?)*

OLS estimates of the payoffs to field of study can vary [*vary across ??*] either because of selection bias, differences in potential earnings across fields, or differences in weights across the next-best alternatives. ...To address selection bias, it is sufficient to have instruments that satisfy Assumptions 1-4.

DR: doesn't this leave out the possibility that payoffs to a field could also vary because of different potential outcomes between those who choose different fields as first choices?

IV estimation of payoffs to field of study

Consider an IV regression

- With a valid instrument for each field (or other choice)
- but without (using) information about individuals' rankings

Uses moment restrictions:

$$E[\epsilon z_1] = 0, \; E[\epsilon z_2] = 0, \quad E[\epsilon] = 0$$

Rewriting residuals in potential outcome format:

$$\epsilon = (y^0 - \beta_0) + (\Delta^1 - \beta_1)d_1 + (\Delta^1 - \beta_2)d_2$$

$$= (y^0 - \beta_0) + (\Delta^1 - \beta_1)\underbrace{\left(d_1^0 + (d_1^1 - d_1^0)z_1 + (d_1^2 - d_1^0)z_2\right)}_{d_1\text{: all situations where 1 chosen}}$$
$$+(\Delta^2 - \beta_2)\underbrace{\left(d_2^0 + (d_2^1 - d_2^0)z_1 + (d_2^2 - d_2^0)z_2\right)}_{d_2\text{: all situations where 2 chosen}}$$

Restating the moment conditions (and using the independence assumption $y^d, d^z \perp z$):

$$E\big[(\Delta^1 - \beta_1)(d_1^1 - d_1^0) + (\Delta^2 - \beta_2)(d_2^1 - d_2^0)\big] = 0$$
$$E\big[(\Delta^1 - \beta_1)(d_1^2 - d_1^0) + (\Delta^2 - \beta_2)(d_2^2 - d_2^0)\big] = 0$$

Solving for β_1 and β_2 yields Prop. 1.

Proposition 1

Given assumptions 1-4 and solving the above for β_1 and β_2 (the terms the estimators will converge to), each β is a linear combination of:

1. Δ^1: Payoff of field 1 compared to 0
2. Δ^2 : Payoff of field 2 compared to 0
3. $\Delta^2 - \Delta^1$: Payoff of field 2 compared to 1

Proposition 2 (the big one)

(Given assumptions 1-4, solving for β's)

1. With constant effects: If Δ^1 and Δ^2 are common across all individuals, then $\beta_1 = \Delta^1$, and $\beta_2 = \Delta^2$
2. With restrictive preferences: If $d_2^1 = d_2^0$ and $d_1^2 = d_1^0$ (i.e., whether I'm assigned to 1 or 0 doesn't impact whether I choose 2; similarly, being assigned 2 versus 0 doesn't affect whether I choose 1) then $\beta_1 = E[\Delta^1 | d_1^1 - d_1^0 = 1]$ (because the share choosing 2 is unaffected by this instrument) and similarly for β_2...

Here we subtracting the 'true' individual tr ment ef from the mated/pre effects to tain the r ual for individual. Note that this repres a projec of *actual* comes, are only serving field ch where pe actually w choose t fields g their ch sets (see a choice e tions). we plug t in to get: Multiply element of above by or z_2 or and take expectation which know to zero by

3. **The big one**: Irrelevance and next-best alternative: If

   - "$d_1^1 = d_1^0 = 0 \Rightarrow d_2^1 = d_2^0$" :
     - Someone who will not enter 1 when assigned to 0 or 1 will enter the same field (either 2 or 0) whether they are assigned to 0 or 1. E.g., no one chooses 0 if assigned to 0 but chooses 2 if assigned to 1.
   - "$d_2^2 = d_2^0 = 0 \Rightarrow d_1^2 = d_1^0$":
     - Someone who will not enter 2 when assigned to 2 or 0 will enter the same field (either 0 or 1) whether they are assigned to 2 or 0. E.g., no one chooses 1 if assigned to 2 but chooses 0 if assigned to 0
   - "and we condition on $d_1^0 = d_2^0 = 0$"
     - *(?look at the set of people who would choose 0 if assigned to 0 – how do they identify this set? People who put 0 as their first choice?)*

DR: *Matthias, any ideas this?*

... then

$$\beta_1 = E[\Delta^1 | d_1^1 - d_0^1 = 1,\ d_2^0 = 0]$$

$$\beta_2 = E[\Delta^2 | d_2^2 - d_0 = 0,\ d_2 = 0]$$

Proposition 2, part 3 is their maintained assumption; *we can find reasonable exceptions to this assumption (see question above)*

> "[e.g., in Mogstad context] if crossing the admission cutoff to field 1 does not make an individual choose field 1, it does not make her choose field 2 either."

DR: Here does 'crossing the admission cutoff to field 1' make it harder for her to enter field 0 ... relative to the case where d=0, or are these ordered in some way?

DR: I t there is ordering; each f institution combinatic has a n mum n threshold, although t differ f year to yea

Specifics of identification strategy and estimation

RD (fuzzy):

> For courses with excess demand, ... applicants scoring above a certain threshold are much more likely to receive an offer for a course they prefer as compared to applicants with the same course preferences but marginally lower application score. This creates credible instruments from discontinuities which effectively randomize applicants near unpredictable admission cutoffs into different fields and institutions.
>
> ... therefore think of the baseline estimates as measures of earnings gains from completing one field of study as compared to another, with the understanding that these gains may not necessarily arise only from field specific human capital. [could include institutional differences] .... we extend the baseline 2SLS model to include a full set of indicator variables for both field and institution of study and use the admission cutoffs to instrument for these endogenous variables.

DR: Note that they are willing to allow for combined or 'reduced form' effects, at least in the baseline specification

In our baseline 2SLS model, however, we abstract from differences in institutional quality, recognizing that changing field could involve changes in institution of study. Indeed, the baseline estimates of the payoffs to field of study will capture any effect that is linked to the change in fields because of crossing the admission cutoff between his preferred field and next-best alternative. We therefore think of the baseline estimates as measures of earnings gains from completing one field of study as compared to another, with the understanding that these gains may not necessarily arise only from field specific human capital. To examine the role of institutional quality in explaining the estimated payoffs, we take several steps. In particular, we extend the baseline 2SLS model to include a full set of indicator variables for both field and institution of study and use the admission cutoffs to instrument for these endogenous variables.

Baseline 2SLS model (section VI)

They estimate the following system; separately for individuals with 'next best field k (in the local course ranking)':

DR: By ' best' I ass they mean stated ch that fol the choice

$$y = \sum_{j \neq k} \beta_{jk} d_j + x' \gamma_k + \lambda_{jk} + \epsilon_k$$

$$d_j = \sum_{j \neq k} \pi_{jk} z_j + x' \psi_{jk} + \eta_{jk} + \epsilon_k$$

d_j: Completed field j
z_j: predicted offers for field j (i.e., =1 if j is preferred field and she exceeds the admissions cutoff)

Estimating this

- Not enough data to do local nonparametric estimation, so include controls: for running variable (linear application score), preferences (λ_{jk} and η_{jk}).
- *Important:* "To gain precision, we estimate the system of equations (14)– (15) jointly for all next-best fields, allowing for separate intercepts for preferred field and for next-best field ..." and robust-check this to allow "separate intercepts for every interaction between preferred and next-best field."
- Control for predetermined covariates "to reduce residual variance"
- →We obtain a matrix of the payoffs to field j compared to k for those who prefer j and have k as next-best field.
  - Following Imbens and Rubin (1997) and Abadie (2002), we also decompose these payoff estimates into the complier average potential earnings with field j and the complier average potential earnings with field k.

  "By comparing Figure VII to Figure I, we can see that the compliers to our instruments are fairly similar to non-compliers in terms of their preferred and next-best fields."
- ***DR**: What are 'compliers' in their context? Those who would complete the preferred course if their score exceeds the threshold, but would complete the NBA otherwise? How do they use the 1st stage estimates to weight 'compliers'? This seems important: how does it relate to their key assumption about irrelevance?*

  Second, we control for individuals' preferences by adding fixed effects for preferring field j and having k as the next-best field (in the local course ranking)...

...

Crucial but confusing points about identification and what they claim to estimate

> despite the local nature of our estimates, the payoffs among the compliers to our instruments are informative about policy that (marginally) changes the supply of slots in different fields. In Kirkeboen, Leuven, and Mogstad (2014), we show that the effect of a policy that changes the field people choose depends inherently on the next-best alternatives, both directly through the next-best specific payoffs, and indirectly through the fields in which slots are freed up.

Defining our estimates in the Mogstad framework

We are mainly estimating the payoffs to an individual's first ranked (≈ first preference) institution over the 'institution assigned given all other ranks', averaged over all individuals, and over demographic subsets.

Our instrument should mimic random assignment (do we need to worry about the LATE stuff about the instrument over-representing certain margins?), which should eliminate the 'selection bias term' [define here].

DR: If we
estimating
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(MP?)
DR: Thi

What they actually estimate

Replicating approach of Mogstad et al

1. Estimate treatment effects (impact of attending each institution or field) separately for all second choices, using 2sls
   (a) $\rightarrow$ matrix of payoffs as in Mogstad table 5
   (b) 'estimate this jointly to gain precision'
   (c) Also estimate 'complier weights of next best alternatives (NBAs)' (?from first stage)
   (d) New endogenous variable: dummy for completion
   (e) Include indicators for *predicted* institution in first and 2nd stage
   (f) control for predicted peer quality
   (g) control for predicted experience level
2. Test difference between the treatment of pooled measures versus measures conditional on NBA $\approx$ second choice sets
   (a) Plot these estimates against one another
   (b) Test restrictions on preferences of Beghal (sp) et al, 2013

Establishing comparative advantage

Notion of Comparative Advantage (CA) from Sattinger (1978): Individual 1 has a CA in subject j relative to k if return to j (relative to k) is larger than for individual 2.

$$\log y_1^j - \log y_1^k > \log y_2^j - \log y_2^k$$

DR: note
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if 1 has a
in j relativ
k relative
individual
then 2
have a CA
k relative
j relative
individual

Procedure:

1. Estimate matrix of payoff coefficients. [DR: can you clarify this?] [matrix of first and second preferences, payoff (log outcomes) to winning first preference relative to second preference?]
2. Compute difference (return j over k for those who prefer j, minus return t over k for those who prefer k). Hypothesis is that this difference is positive.
3. Show using histogram, plotting the distribution of $(\log y_1^j - \log y_1^k) - (\log y_2^j - \log y_2^k)$.

DR - Roy model, background:

Individual chooses fields of study j over k whenever "her relative productivity advantage in field j (q_{ij}/q_{ik}) exceeds the relative prices (f_{ik}/f_{ij})"

Additional notes on Mogstad (discussion)

"field of study drives the heterogeneity in the payoffs to post-secondary education ... little evidence of significant gains in earnings to graduation from a more selective institution once we hold field of study fixed"

Caveats:

" it is important to emphasize the local nature of our results ... since our instruments are admission cutoffs, the pick of individuals who are at the margin of entry to particular fields"

"... might be specific to the Norwegian context"

Note that they give a fairly detailed description of the admissions process in its multiple rounds, and give some hypothetical examples in tables.

They argue it is a truth-revealing mechanism. In some ways it is rather similar to the Netherlands, but in other ways not (NL has weighted random draws not thresholds, also may not yield strategy-proof choices, Norwegian students can rank multiple fields and can rank any combination of fields and institutions)

Data

Subsetting:

- ***Important*** “All applicants who apply for at least two broad fields of study, where the most preferred field needs to have an admission cutoff, and the next-best alternative must have a lower cutoff (or no binding cutoff).”
- Limit to those who complete post-secondary ed (testing for sensitivity to this)

Earnings:

- from Norwegian tax registers 1998-2012. ... every cohort is observed for at least eight years after their application. The measure of earnings encompasses wage income, income from self-employment, and transfers that replace such income like short-term sickness pay and paid parental leave (but excludes unemployment benefits).

  “Relating the moment at which we measure earnings to the year of application (rather than year of completion) avoids endogeneity issues related to time to degree. Another advantage is that by positioning earnings 8 years after applying most individuals will have made the transition to work.”

Statistics presented:

- They give descriptive statistics for estimation sample and for overall pool of applicants
- Most common NBA’s by field (should we do anything comparable?)
- They present scatterplots of earnings by institution for institutions with more than 1000 students (we cannot do this)
- Statistics on strength of RD instrument: share received preferred offer, completed preferred field just below and above thresholds
  - *Why not 0/1 for preferred offer? “Some slots are reserved for special quotas and there may be some ad-hoc conditions unrelated to academic requirements (e.g. if an applicant has been ill during the last part of upper secondary), thus we have some measurement error in the cutoffs. Also, some applicants do not choose to remain on the waiting list after the first set of offers are sent out and thus do not get an offer, even though they are above the application threshold.”*
- Check for balance/randomness: ’earnings predicted by covariates’ around the threshold.
  - *DR: We should do this version for our instrument!*