Private Returns for Danish Five-Year University Degrees for Marginally Accepted Students

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Kraka

Overview

- Centralized admissions system for all BA's in Denmark based on high school GPA.
- Number of student places determined by government.

- Evaluate private returns of admission to ~200 BA-programmes in Denmark (1996-2004)
- RDD using the admissions threshold with GPA as running variable
- Outcome: Effect on earnings 13 years after application
- Look only at first time applicants

- Data: Danish administrative data (GPA, gender, age, application with ranked choices and admission)

Key questions

- Was the restrictions on number of students across programmes (roughly) efficient?
- Or: would there have been positive returns to expanding/decreasing the number of students admitted
  - Overall (all programmes marginally expanded)?
  - Certain fields of study?
  - Certain areas of the country?
- What (if any) link between program selectivity and returns for marginally accepted?
- What (if any) link between average earnings for degree recipients and private returns for marginally accepted students?

Key takeaways

- Average earnings for completers are uncorrelated with private returns for marginally accepted students
- Private returns for marginally accepted students uncorrelated with how selective (high GPA requirement) the programme is
- Across fields of study, returns vary – effects are modest
- Overall, the system seems to have been (roughly) efficient in the period 1996-2004
- No differences across geographic regions

The Danish institutional setting

- K-9th grade public schools (~90 %) or private schools, heavily subsidized by vouchers. Limited testing in both, GPA not important
- After lower secondary can choose either vocational programmes or academic upper secondary programmes (”High school”, i.e. 11th-13th year of schooling).
- ”High school” completion needed to be admitted to post-secondary schooling. High school GPA key in admissions process for college. Public high schools → comparable GPA’s.
- Two types of college degrees:
  - professionally oriented bachelors degree programs (ie nurses, teachers, social workers etc.).
  - BA’s in academic programmes

Institutional setting (cont'd)

- Both professional and academic BA's: Choose both institution and major (the "programme") at time of application
  - eg. "Medicine at University of Copenhagen", "Economics at University of Aarhus", "Nursing School at University College Copenhagen"
- Professional BA degrees are 2-4 years (typically 3½).
- Academic BA programmes are 3 years, but in reality serves as the first part of an integrated 5 year masters programme (90 pct. students awarded academic BA's obtain a masters degree in the field).
- Programmes are public and tuition free, and there is a state grant of approx 900 $ pr. month to cover living expences (+ additional subsidized loans if needed).

University admissions system

- Since 1977: Ministry of Education determines the maximum number of students to admitted to each programme
- Purpose: Make supply of candidates match the predicted future labor market demand (based on ? – the process is not well documented!)
- For at lot (but not all) programmes, student demand (far) exceeds supply
  - However, particularly in the STEM field, a lot of programmes unrestricted

  ➢ Need to ration admissions somehow for most programmes

- Admission based on high school GPA
  - High threshold for admission to programmes based on popularity vs. supply

University admissions system (cont'd)

- For programmes with more applicants than places: students allocated through a centralized admissions system (KOT). Based through 2 quotas
- Students apply for a particular programme through one of the quotas
- Quota 1 (~80% of places in sample period – but variation across programmes):
  - High school GPA alone (with additional minimum requirements, eg. high school math course)
  - GPA threshold for admission (cut-off) determined by number of students, number of places and the applicants GPA. All students with GPA above cut-off are admitted.
  - Students with GPA = cut-off: some are admitted, some are waitlisted for next year, some are rejected. Not randomized.

University admissions system (cont'd)

- Quota 2 (~20% of places in sample period – but variation across programmes):
  - GPA + other considerations (interviews, admission tests, work experience)
  - If GPA for a Quota 2-applicant clears the GPA threshold under Quota 1, student is admitted through Quota 1.

- Students submit application form to KOT with up to 8 programmes in ranked order (indicating Quota 1 or 2 application for each).
  - No incentive to strategically rank (unless student is uncertain about own preferences over programmes).
  - After all applications received, GPA thresholds calculated centrally, each student admitted to a maximum of one programme (highest-ranked where GPA>cut-off)
  - GPA varies within programme across time in a non-predictable manner
  - Fair number of programmes are unrestricted. Students can regret their choice and be admitted to unrestricted programme afterwards (same year), but not restricted programmes, they would have qualified for.

Key questions

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Litterature

- Huge litterature on returns to an extra year of schooling (Mincer 1974).
- Instrument-based approach, eg. Card(1999), Carneiro, Heckman & Vytlacil (2011), Meghir & Rifkin (2011) etc. Drawback: What is the instrument actually picking up?
- RDD-based approach: Öckert (2010), Zimmerman (2014). Give effects for marginally accepted students.
- Returns to acceptance at a particular institution: Hoekstra (2009). All US institutions (!) Hoxby (2018).
- Effect of admission into most-preferred program (Denmark) – Heinesen(2018).

Litterature (cont'd)

- Hastings, Neilson & Zimmerman (2013): Private returns of acceptance to university programs in Chile.
  - Administrative data
  - Evaluate ~1100 programs
  - Generally positive returns
  - …with big differences across fields of study
  - …and big differences across selectivity

Litterature (cont'd)

- Kirkeboen, Leuven & Mogstad (2016):
  - Returns to degree completion within in a field of study.
  - Norwegian administrative data, earnings 8 years after first-time application
  - Returns are relative to students next-best field – estimation based only on students, who (on the margin) cross over from one field to another.
  - Find considerable variation across fields
  - …small effects of institution selectivity
  - …results consistent with students preferring fields in which they have comparative advantage
- Heinesen & Hviid (2018): Same setup, but using Danish data. Earnings after 13 years. Results indicate this additional time is important for results.

Data

- Danish administrative data containing earnings, gender and age, high school GPA.
- Also contains application form (ie. the full ranking of up to 8 programmes) and admission status from the centralized admissions system (KOT)
- Can construct link between programme and education code for comleters (ie. map programme into a field of study using ISCED-classification).
- First time applicants 1996-2004.
- Earnings 13 years later (CPI-deflated and winzorised at 1% level).
- 194 programmes in the period restricted at least one year

Estimation

- Estimate private returns (earnings 13 years after first-time application) of being marginally accepted vs. marginally rejected in a programme
- Evaluate 194 programs *separately* (each pooled over the years 1996-2004)
- RDD with GPA as running variable
- ”Fuzzy” – because
  - Quota 1 & 2 - system allows some students who do not meet GPA threshold to be admitted
  - A few students above threshold do not meet other requirements - rejected

Estimation (2)

- Estimate:

$$y_{ip} = f_p(d_{ip}) + \Delta_p A_{ip} + \gamma_p X_i + \varepsilon_{ip}$$

- where
  - y_{ip} is person *i*'s total earnings (excluding transfers) 13 years after applying to programme *p*
  - d_{ip} is the GPA distance to the threshold for programme *p* (running variable)
  - $f_p(d_{ip})$ is a function of the distance (in the application: linear)
  - A_{ip} is a dummy for admission
  - X_i contains gender and age at time of application
  - Δ_p is the parameter of interest

Estimation (3)

- Fuzzy design, so need to instrument admission with a dummy for having GPA above the threshold: $Z_{ip} = 1[d_{ip} \geq 0]$
- First stage:

$$A_{ip} = \rho_{1p} Z_{ip} + g_p(d_{ip}) + \rho_{2p} X_i + \epsilon_{ip}$$

- Estimate by 2SLS
- ”Donut”-design – leave out applicants where GPA = threshold
- Discrete running variable → cluster stnd. errors on values of d_{ip} (Lee & Card (2008))
- Bandwidth +/- 1.2 grade points (relatively broad, in line with Heinesen (2018), Heinesen & Hviid (2018))

Estimation (4)

- Each applicant can enter the estimation for either zero, one or two programs
- Only in estimation if marginally accepted or rejected, ie.
  - GPA is within the bandwidth
  - Applicant was admitted to the programme (highest ranked programme, where GPA > cut-off)
  - Lowest ranked programme, applicant was rejected from
- 86.730 unique applicants in final estimation data (across 194 programmes)

Interpretation of estimates

- Estimates are local average treatment effects of being admitted to the program (not completion). Alternatively view them as intent-to-treat for completion.
- They are private returns
- They do not directly measure the value of expanding the programme
- Measured with big standard errors – but should be unbiased
- Returns are not relative to ”no BA”…

Interpretation of estimates (cont'd)

- Think of the model from Hastings et. al. (2013)

$$y_{ip} = \mu_i + \theta_p + \phi_{ip} + \omega_{ip}$$

  - earnings as a result of an individual effect μ_i, a programme average effect θ_p relative to the outside option of no BA, an "ability in programme" effect ϕ_{ip} and an error term ω_{ip}
- Then the estimated effect can be interpreted as

$$\mathrm{E}(\Delta_p) = \left(\theta_p - \sum_q \pi_{pq}\theta_q\right) + \left(\sum_q \pi_{pq}\, E\left(\phi_{ip} - \phi_{iq} \middle| i \in I_{pq}\right)\right)$$

- where
  - π_{pq} is the probability of a marginally rejected student at programme *p* being accepted into programme q.

Interpretation of estimates (cont'd)

- Estimated effect $\boldsymbol{\Delta_p}$ is the surplus relative to (a weighted average of) the returns of other programmes.
- Does not say anything about value of moving someone without a BA into the programme (need information on $\boldsymbol{\theta_p}$ and – depending on assumptions – distribution of $\boldsymbol{\phi_{ip}}$ for non-BA recipients).
- Only under strong assumption of $\boldsymbol{\phi_{ip} = 0, \forall i, p}$ do our estimates give information about value of programme relative to other programmes ("quality").

Combining estimates

- To get information about overall private returns across all programmes (or across fields), use inverse-variance weighted averages:

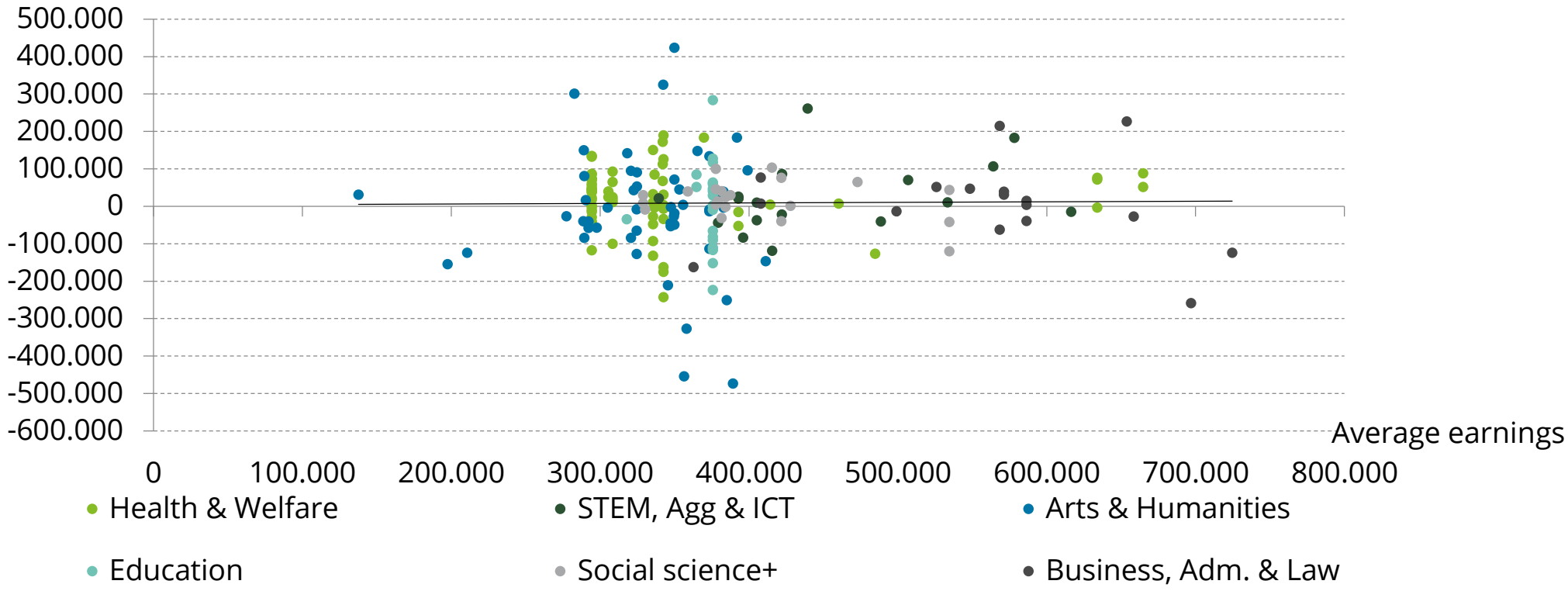
$$\Delta^{\mathrm{G}} = \sum_{\mathrm{p}\in G} \frac{\omega_{\mathrm{p}}}{\sum_{\mathrm{p}\in \mathrm{G}} \omega_{\mathrm{p}}} \Delta_{\mathrm{p}}$$

- with the inverse variance given as $\omega_p = \frac{1}{se(\Delta_p)^2}$
  - Δ^G is the average effect for a group of programmes *G*
  - Δ_p is the estimated effect for programme *p*
  - $se(\Delta_p)$ is the standard error of estimat Δ_p
- Standard error of the weighted group estimate is

$$se(\Delta^G) = \sqrt{\frac{1}{\sum_{p\in G} \omega_p}}$$

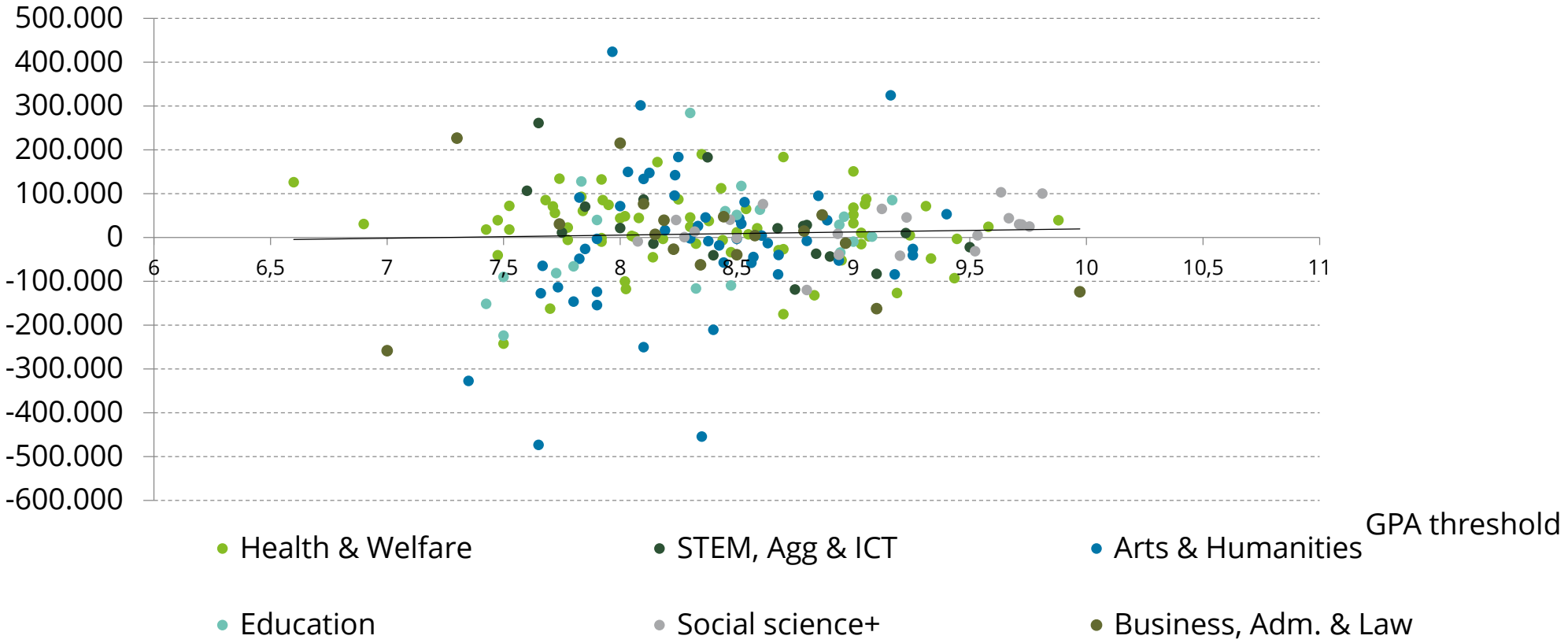
Result #1:

- No correlation between average earnings for all degree recipients and private returns for marginally accepted students



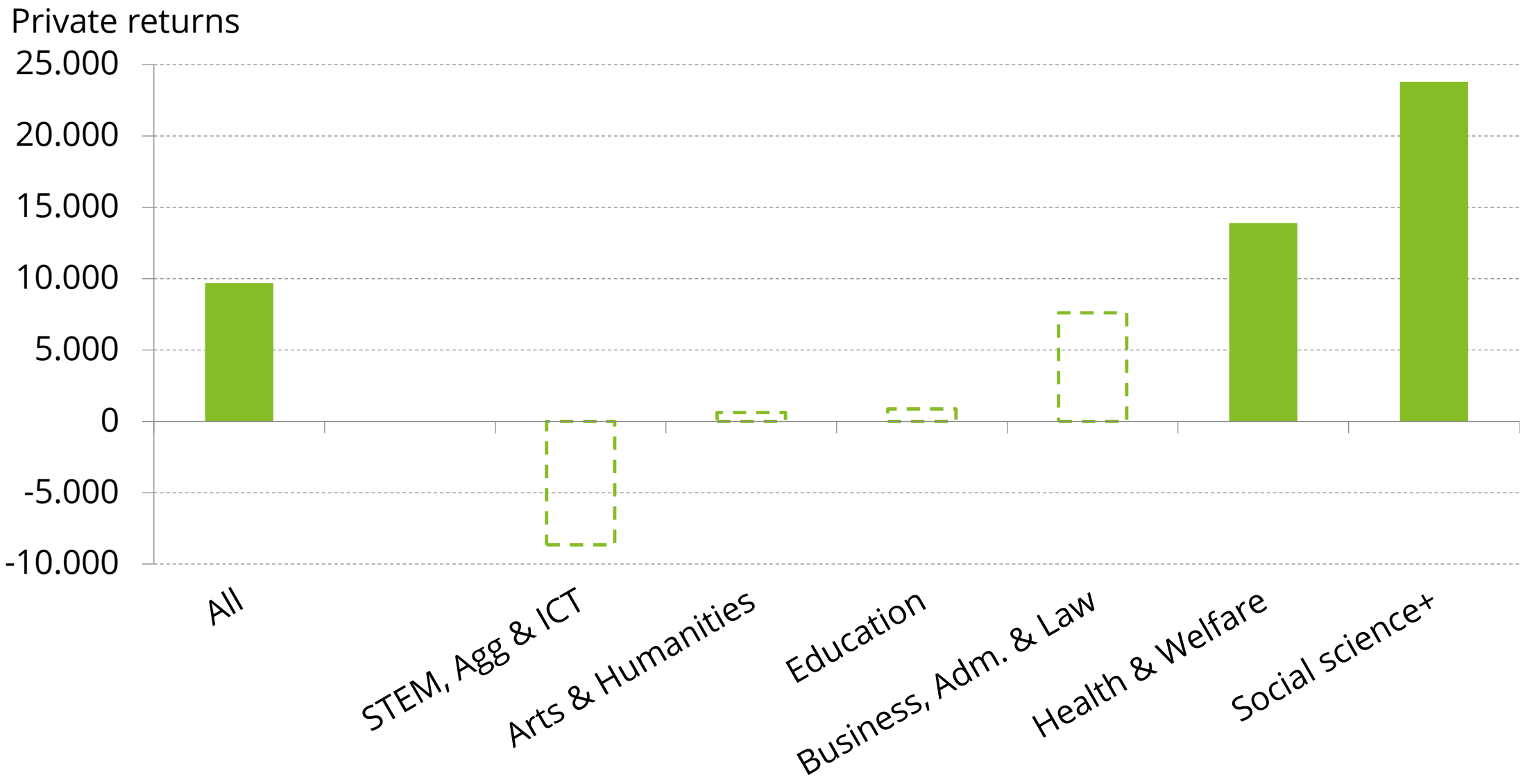
Result #2

- No correlation between programme selectivity (GPA threshold) and private returns for marginally accepted students



Result #3, #4 (and #5)

- Positive average returns, but modest size (~10.000 DKK, ~1.500 USD in yearly marked-based earnings).
- Variation across fields (ISCED-groups)
  - Note: lot of STEM programmes are not restricted access
  - STEM categori merged with Aggriculture, Forestry, Fisheries & Veterinary, Engineering, Manufacturing & Construction and Information and Communication Technologies.
- No significant differences across geographic locations (not shown)


Private returns
25.000
20.000
15.000
10.000
5.000
0
-5.000
-10.000
All
STEM, Agg & ICT
Arts & Humanities
Education
Business, Adm. & Law
Health & Welfare
Social science+

Total private returns

- If we expand number of student places in one programme, effects will ”trickle down”
- Say you expand ”Medicine at University of Copenhagen” by one student (high GPA requirement). Then one more student is admitted here, opening up a space somewhere else, eg. at ”Law at University of Copenhagen” if the marginally ”extra” medical student would otherwise have studied law. This extra slot at the law school opens up a space in economics – but the chain stops here, since, economics is not a restricted program.
- Since we know the ranking of programmes in all applications (not just admission), we can calculate a ”total private returns” of expanding medicine by one extra place.

Total private returns - method

- Solve

$$V_p = \Delta_p + \sum_q \pi_{pq} V_q$$

- where
  - V_p is the value of marginally expanding programme *p* (holding all other programmes constant).
  - Δ_p is the estimated private return for programme *p* from before
  - π_{pq} is the probability for a marginally rejected student from program *p* to instead apply for and be admitted into programme *q*. This is just data.
- Note: Not dynamic – still based on first time applicants and what they alternatively do that same year

Total private returns – method (2)

- Stack the equations and get matrix notation

$$V = \Delta + TV$$

- Based on 194 + 1 programmes, where the extra one is the outside option of not being admitted the same year (return for this is 0)
- Note: T (the probabilities of second-best) has zeroes in the diagonal → $(I - T)$ has full rank.
- Can solve by simply calculating

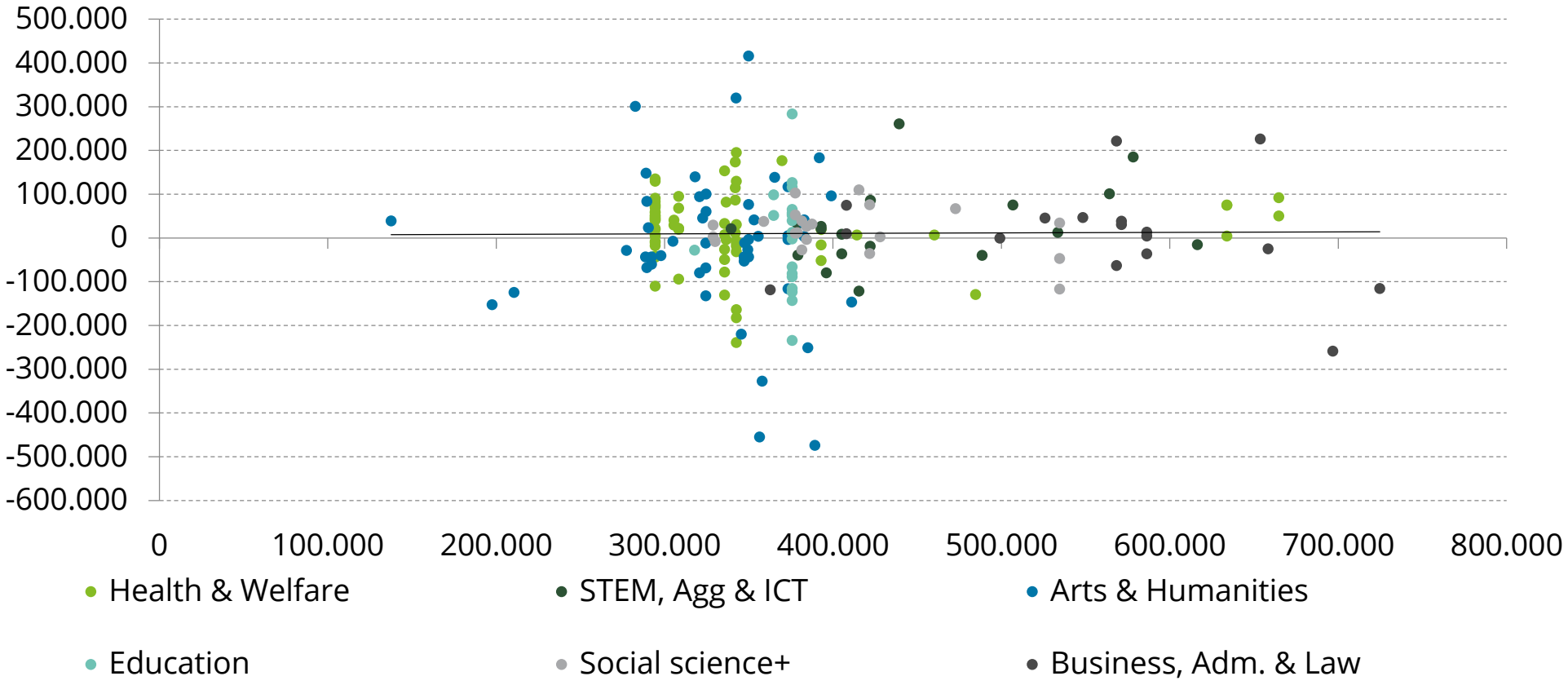
$$V = (I - T)^{-1} \Delta$$

- Note: Results do not take uncertainty of π_{pq} aka. T into consideration – treated as fixed for now.

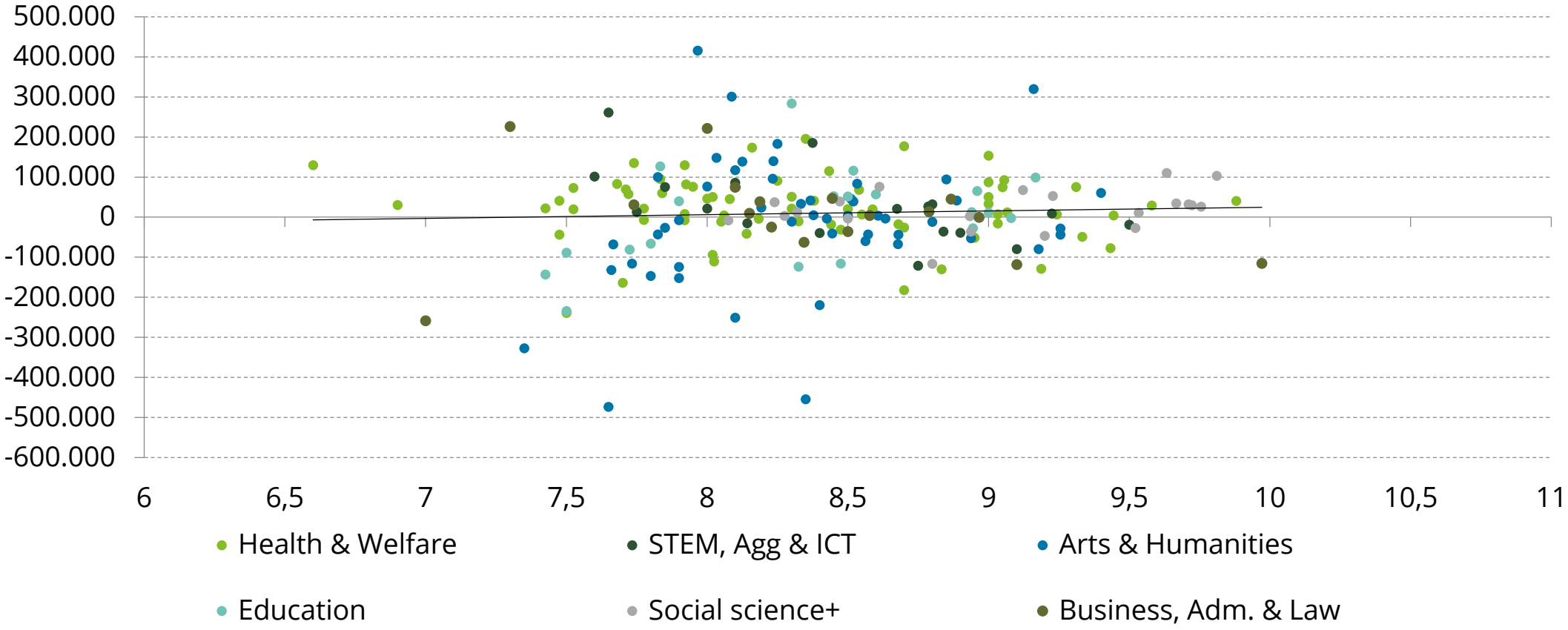
Total private returns - results

- Probably more correct way of evaluating a policy of expanding programmes
- Results don't change (much) – due to non-dynamic view (not looking at rejected applicants who take a gap year and are applying for / admitted to something else the year after).
- Still no correlation btw. average earnings for degree recipients and total private returns by expanding program
- Still no correlation btw. selectivity of program (GPA threshold) and total private returns of expanding program
- Expanding all programs marginally has slightly higher positive effect – still modest.

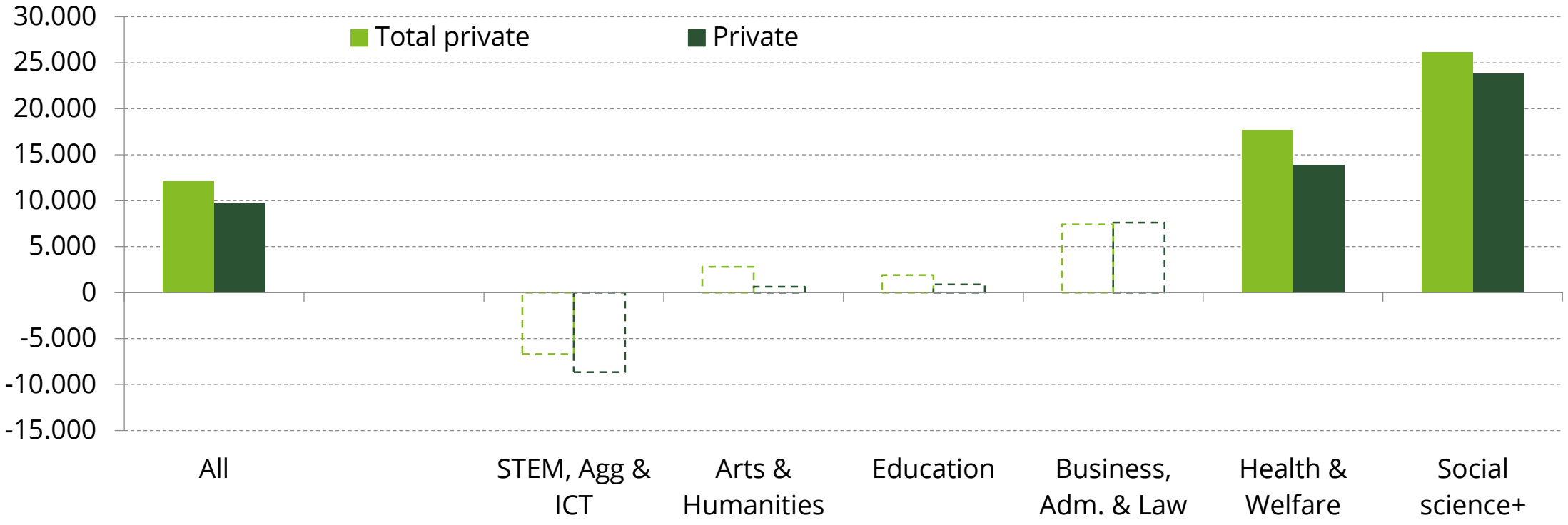
Total private returns #1 (vs. avg. earnings)



Total private returns #2 (vs. GPA)



Total private returns #3 and #4



Litterature (1/2)

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Litterature (2/2)

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