

Analyzing Ranking Strategies to Characterize Competition for Co-Operative Work Placements

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ABSTRACT

Co-operative education is a form of work-integrated learning that includes academic study and paid work experience. This provides new learning opportunities for students and a talent pipeline for employers, but also requires participation in a competitive job market. We study competition through a unique dataset from a large North American co-operative program, in which students and employers rank each other after a round of interviews, then a matching algorithm assigns students to jobs based on the ranks, and finally students and employers evaluate each other at the end of the workterm. Our results reveal insights about competition and its impact on decision-making and satisfaction. An analysis of common ranking patterns suggests that small employers appear to be more strongly affected by competition and consider more options in their rankings, whereas large employers often do not provide any backup options and only identify their top choice. Additionally, competition appears to affect satisfaction since employers give higher workterm evaluations when matched with their top choice.

Keywords

co-operative education, work-integrated learning, ranking

1. INTRODUCTION

Co-operative (co-op) education is a form of work-integrated learning that includes both academic study terms and paid work experience, referred to as co-op work placements, workterms or internships. Prior work has examined the benefits of co-op, such as new learning opportunities for students and a talent pipeline for employers [13]. However, recent work has also reported that the competition related to interviewing for and securing co-op placements is a source of stress for students [10]. Motivated by these findings, in this paper we take a closer look at competition in co-operative education.

Our study is based on a unique dataset from a large North American undergraduate co-operative program. In this program, the co-op employment process proceeds as follows. Employers post job advertisements, students submit applications, and employers select

students they wish to interview. After a round of interviews, students and employers rank each other. A *matching* algorithm then assigns students to jobs based on the ranks, with the goal of minimizing the sum of the student and employer ranks. For example, if the employer offering job A ranks student B one and vice versa, then the algorithm is guaranteed to assign job A to student B. In some cases, however, students and employers may be matched with their second or third choices, or not be matched at all. Finally students and employers evaluate each other at the end of the workterm.

One way to characterize competition in such a process is to identify job postings that receive the most applications. However, even entry-level or less desirable job postings may receive many applications, mainly from junior students. Instead, we turn to the ranking step of the process as a novel way to characterize competition. We investigate the following questions:

1. Do employers use different ranking strategies that reflect the level of competition they face? For example, an employer who is confident in their ability to attract top students may rank their preferred student one and not rank any other students as backup options. On the other hand, a less confident employer may rank multiple students.
2. Does competition appear to affect satisfaction? Are employers happier if they are matched with their top-ranked choices?

To answer these questions, we analyze ranking and workterm evaluation data from over 4,500 employers participating in the job matching process in three semesters, from September 2015 to August 2016. We answer the first question by mining frequent ranking patterns and identifying representative attributes of employers that use these patterns. To answer the second question, we compare the average employer evaluation scores when matched with their first choice versus a backup choice.

Related Work: Labour market competition has been studied from several angles, including improving talent recruitment by recommending resumes to job postings [11, 16], and reducing turnover by assessing personnel fit when making hiring decisions [2, 6, 3]. Further, it was found that job seekers' perceptions of hiring success, informed by their past job search success and prior knowledge of the company, motivate their decision to apply for a job and affect their decision to accept a job offer [1, 12]. In co-operative education, there has been work on student and employer satisfaction [8, 5, 4], as well as on clustering job opportunities, suggesting that junior students compete with each other for entry-level jobs and

senior students compete with each other for more advanced positions [7, 14]. To the best of our knowledge, this is the first work to characterize competition based on employer rankings in a co-op process. Access to this unique data allows us to draw new insights into competition in co-operative education that can help manage students' and employers' expectations and improve their satisfaction.

2. DATA AND METHODS

2.1 Co-operative Process Overview

We begin with an overview of the co-op process at the institution studied in this paper. Initially, participating employers submit job descriptions, and any student (enrolled in a co-op program) may apply to any job. Next, employers interview selected candidates and rank them. A rank of zero, referred to as a "No Rank", means that the employer is not willing to hire the student. A rank of one, referred to as an "Offer", indicates that the employer wishes to hire the student. Ranks two to nine, referred to as "Ranks", represent the employer's backup or shortlist options, in order of preference. In other words, the employer would consider hiring these students if the top-ranked student declines the offer. In the remainder of this paper, we use the terms "shortlisted" and "received a Rank" interchangeably. Ranks do not need to be distinct, e.g., an employer may put five students on the backup list and give all of them a rank of two. After employers have submitted their rankings, students rank employers that made them offers or shortlisted them, between one and nine, indicating their order of preference.

The co-op matching system then removes student-employer rank pairs that add to zero (i.e., No Ranks) and applies a matching algorithm to assign students to jobs. The objective of the algorithm is to minimize the sum of the ranks of the resulting student-job assignment. Note that the lowest sum of ranks is two, and occurs when an employer offers a job to a student and the student gives a rank of one to this job. In this case, the student is guaranteed to be matched with this job¹. In other cases, students or employers may not be matched with their second, third, or lower choice, or may not be matched at all. Finally, at the end of a workterm, students and employers who were matched with each other evaluate each other.

2.2 Data

We analyzed one year of data, from September 2015 to August 2016, corresponding to 4,851 co-op job postings for students enrolled in co-op engineering programs:

- **Job Postings**, containing a job ID, job title, and employer name.
- **Employer Rankings**, containing a job ID and the distribution of ranks. Figure 1 shows an example with five employers, one per row. The first row indicates that employer (whose job ID is) E1 gave two ranks of zero (#R0) and no other ranks, i.e., E1 interviewed two students and was not willing to hire either of them. The second row indicates that E2 interviewed two students, rejected one (#R0), and put one on the shortlist with a rank of two (#R2), and so on.
- **Employer Evaluations**, containing a job ID, the rank the employer gave to the student who was hired, and the employer's evaluation of the student (on a 7-point scale: unsat-

¹If a student were to give a rank of one to multiple Offers, the algorithm would randomly select one of these Offers.

	#R0	#R1	#R2	#R3	#R4	#R5	#R6	#R7	#R8	#R9
E1	2	0	0	0	0	0	0	0	0	0
E2	1	0	1	0	0	0	0	0	0	0
E3	4	2	0	0	0	0	0	0	0	0
E4	3	1	1	0	0	0	0	0	0	0
E5	1	1	1	1	1	1	0	0	0	0

Figure 1: Sample of employer ranking data

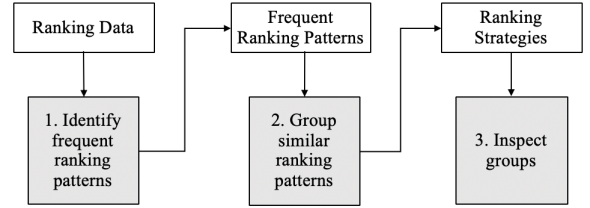


Figure 2: Summary of methods

isfactory, marginal, satisfactory, good, very good, excellent, outstanding).

2.3 Methods

Given that the matching algorithm is designed to minimize the sum of the ranks of the student-job assignments, employers may use different ranking strategies depending on the perceived level of competition. For example, employers may extend one or more offers but not shortlist any students if they are confident that their offer(s) will be accepted (i.e., that those students will reciprocate with a student rank of one). On the other hand, less confident employers may shortlist multiple students, and, to maximize their chances of hiring someone, they may give a rank of two to all shortlisted students instead of ranking them in order of preference.

The goal of this paper is to identify these kinds of ranking strategies and use them to describe the level of competition faced by different groups of employers. Our methodology, consisting of three steps, is summarized in Figure 2 and explained below.

1. **Identify frequent ranking patterns:** For employers, we identify commonly used *sets* of ranks. For example, an employer set of ranks of {0, 1} corresponds to employers who give only No Ranks (0) and Offers (1), and do not shortlist any students (ranks 2-9).
2. **Group similar ranking patterns:** Informed by the previous step and by the nature of the matching process, we group together similar sets of ranks. We refer to these as ranking strategies. For example, we may group employer rank sets of {0,1,2}, {0,1,2,3} and so on and label these as employers who make a shortlist (in addition to making some offers and rejecting some students). This step partitions employers according to their ranking strategies.
3. **Inspect groups:** We compare groups of employers with different ranking strategies based on their a) characteristics and, b) consequences on matching and evaluation. To identify differences among employers who use different ranking strategies, we inspect employer names and job titles. To understand the consequences of ranking strategies on matching

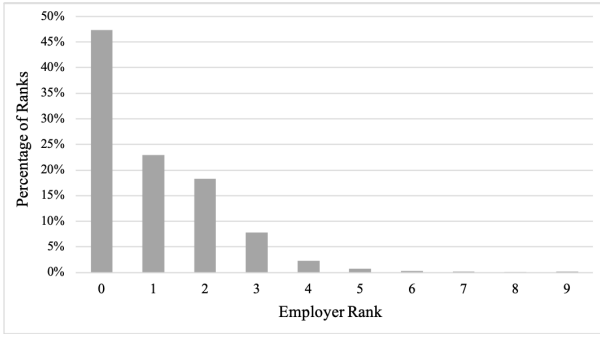


Figure 3: Distribution of employer ranks

Table 1: Most frequent sets of ranks given by employers

Set of Ranks	%
{0, 1, 2}	24
{0, 1}	19
{0, 1, 2, 3}	14
{1}	8
{0}	5
{1, 2, 3}	4
{1, 2}	4
{0, 1, 2, 3, 4}	4
{0, 2}	2
{1, 2, 3, 4}	2

and evaluation, for each group of employers who use a given ranking strategy, we calculate, a) the percentage who were not matched (represented as %NoMatch), b) the percentage who were matched with their first choice (represented as %MatchR1), and c) the percentage who were matched with their >1 choice (represented as %MatchR>1). Finally, we report the average evaluation scores that the employers gave to the students they matched with at the end of the workterm.

3. RESULTS

Section 3.1 analyzes the rankings given by 4,851 employers to identify frequent ranking patterns (Step 1 of Figure 2), group them into ranking strategies (Step 2 of Figure 2), and distinguish between employers with different ranking strategies (Step 3 of Figure 2). Section 3.2 analyzes the effects of ranking strategies on matching and satisfaction (Step 3 of Figure 2).

3.1 Employer Ranking Strategies

Figure 3 shows the distribution of ranks given by employers to students they have interviewed. Recall that rank 0 or “No Rank” indicates that the student was interviewed but not considered for the job, rank 1 represents an offer, and ranks 2-9 represent employers’ shortlists in order of preference. As seen in Figure 3, nearly half the ranks are zero, a quarter are offers, and ranks lower than three are rare.

Next, Table 1 shows the most frequent *sets* of ranks given by employers. Many employers reject at least one student (rank 0), make at least one offer (rank 1), and shortlist at least one student, usually with ranks of 2 and/or 3. 19% of employers make offers without shortlisting anyone (second row: {0,1}).

Using Figure 3 and Table 1, we group employers with similar rank-

ing patterns (Step 2 of Figure 2). Table 2 summarizes the groups. The first column, Label, describes each group. For example, the first group corresponds to employers that do not make any offers and do not shortlist (Rank) any students – that is, they only give zero ranks, meaning that they are not willing to hire any students they interviewed. The second and third columns indicate whether the employers in the given group gave any Offers and Ranks, respectively (we define *Top Ranks* to be ranks of two or three). The next column shows the percentage of employers assigned to each group (e.g., the first row indicates that 5% of employers did not give any Ranks or Offers). The next column reports the percentage of employers that were *not* matched with any students by the algorithm, labelled “%NoMatch”; clearly, employers who did not give any ranks or offers have no-match rate of 100%. The next column, “%MatchR1”, shows the percentage of employers that were matched with their first choice and the average evaluation score the employers gave to these students (higher is better). Finally, the last column, “%MatchR>1”, shows the percentage of employers that were matched with a student who was not their first choice and the average evaluation score the employers gave to those students. We will discuss the percentages further in Section 3.2.

Note that the sum of the percentages reported in the last three columns – “%NoMatch” plus “%MatchR1” plus “%MatchR>1” – is 100 for each row. In other words, there are three possible options for employers: does not match with any student, matches with their first choice, or matches with their not-first choice.

To characterize employers with different ranking strategies, we inspected their names and job titles (Step 3 of Figure 2). We found that employers who gave:

- “No Offer/s or Rank/s” (first row of Table 2) consisted of companies of all sizes and industries, mainly offering “analyst” and “assistant” positions.
- “Only Rank/s” (second row) were mainly business units of the institution, and mostly offered “analyst”, “support”, and “intern” positions.
- “Only Offer/s” (third row) consisted of large well-known technology and manufacturing companies, offering “software developer” and “design” positions.
- “Offer/s and Top Rank/s” (fourth row) consisted of (a) medium-sized companies offering positions in “software development” and “data science”, (b) large companies with positions such as “application development”, “UI designer”, “quality assurance”, and “process improvement”, and (c) companies with specialized jobs in the fields of electrical engineering, hardware, medical engineering, banking, etc.
- “Offer/s and Other Rank/s” (fifth row) consisted of small to medium-sized companies with job titles including “quality assurance”, “software testing”, “support technician”, and “systems administrator”.

3.2 Consequences of Employer Ranking Strategies

This section analyzes how ranking strategies used by employers affect their chances of finding a match and whether employers with different ranking strategies evaluate their matches differently at the end of the workterm. To provide context, we start by reporting the

Table 2: Employer ranking strategies

Label	Offer/s	Rank/s	%	%NoMatch	%MatchR1 (Avg(Eval))	%MatchR>1 (Avg(Eval))
No Offer/s or Rank/s	No	No	5	100	-	-
Only Rank/s	No	Yes	9	81	-	19 (5.9)
Only Offer/s	Yes	No	27	48	52 (6.1)	-
Offer/s & Top Rank/s	Yes	Yes (all $r \leq 3$)	48	31	46 (6.1)	24 (5.9)
Offer/s & Other Rank/s	Yes	Yes (some $r > 3$)	11	20	48 (6.2)	32 (5.9)

matching percentage and evaluation scores averaged across all the employers who participate in the ranking process (i.e., those who give at least one non-zero rank).

Overall, 39% of employers who participate in the ranking process do not find a matching student. Out of the 61% who find a match, 75% match with their first choice (i.e., with a student to whom they gave an Offer), and 25% match with their >1 choice. On average, employers who match with their first choice evaluate their students slightly higher (6.1) than those who match with their >1 choice (5.9). This difference is statistically significant at a p-value of 0.05.

Next, we analyze the consequences of employer ranking strategies on matching and evaluation. Recall that Table 2 shows the percentage of employers with different ranking strategies who do not find a match, match with their first choice (i.e., with a student to whom they gave an Offer), and match with their >1 choice. For each ranking strategy, we also show the average evaluation scores given by employers to their students. Among employers who make offers, those who provide more backup options (Offers and Ranks) have a higher matching rate, with a greater proportion matching with their backup choice. Additionally, one-fifth of the employers who “Only Rank” (i.e., do not make any offers and only use ranks of two and above) find a match.

On average, regardless of the ranking strategy used, employers who match with their first choice evaluate their students similarly and so do employers who match with their >1 choice. In addition, irrespective of the ranking strategy used, employers who match with their first choice evaluate their students slightly higher than those who matched with their >1 choice. Therefore, while employer ranking strategy affects their chances of finding a match, employers with different ranking strategies do not evaluate their students differently.

4. DISCUSSION AND CONCLUSIONS

In this paper, we proposed a new way of characterizing competition in a co-operative job market by studying how employers rank students after a round of interviews. Based on a dataset from a large co-operative education program, we identified ranking strategies, studied the characteristics of employers who use different strategies, and analyzed the effects of ranking strategies on matching and workterm evaluation. Our main findings are as follows.

Ranking strategies characterize competition: Ranking strategies may be used to characterize the extent of competition in the co-op job market; employers appear to be aware of the competition they face and rank accordingly.

Large employers are less likely to provide backup options. Thus, it appears that these employers are confident in their ability to hire their top choices, and if their top choices decline the offers, these

employers are willing to risk not hiring any students from this university. Small to medium companies, especially those offering entry-level positions, are more likely to provide backup options, perhaps as a consequence of perceived competition for their top choices. Therefore, an employer’s popularity and quality of job they offer appear to be correlated with the ranking strategy they use. Similar observations were made in many competitive environments, including supply chains and legal contracting, where parties with more bargaining power leverage their reputation when negotiating with others [9, 15].

Rank of match affects satisfaction: Regardless of the ranking strategy, employers who match with their first choice evaluate their co-op students slightly higher on average than those who match with their backup choices. In other words, satisfaction only seems to depend on the rank of the match and not on the strategy used to obtain the match.

These results should be interpreted carefully since they are based on data from a single institution. However, the methodology we presented in this paper may be used by others to reflect the extent of competition in their institutions through ranking patterns. In addition, this study is limited to identifying frequent patterns in the data, but not cause-and-effect relationships. This provides a starting point for further study: interviewing students and employers about the competition they face in the co-op market is an interesting direction for future work. Nevertheless, we believe that our findings will be of interest to students, employers and the institution. We provide several examples of actionable insights below.

1. Our results can help students understand how co-op employers rank their options in various situations. This may inform students’ strategies and decision-making during applications and ranking, in turn, increasing their chances of finding a suitable co-op job.
2. Our results can inform new employers about the extent of competition in the co-op market, which in turn can help them decide how to rank their options given the competition they are likely to face.
3. Our findings indicate that some employers are confident in their ability to hire their top choices, indicating that such jobs are highly sought after by students. The institution may consider recruiting more such employers. On the other hand, the institution may recommend smaller employers to less-experienced students to increase their chances of finding a match.
4. Our findings suggest that employers who match with a backup choice are less satisfied with their co-op students. This suggests a need for methods to help manage the expectations of employers and students in this situation.

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