IDSC of IZA Workshop:
Matching Workers and Jobs Online

Application Flows

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Outline of the Talk

I.   Rich new database that links employers, vacancy postings, applications & applicants

II.   Nine (mostly) new facts about search & hiring behavior

III.   Five implications for theoretical modelling, the two most important of which are:

(1) Intermediaries play a huge role in the matching process.

(2) Employer search is non-sequential.

The DHI Vacancy and Application Flow Database

Raw data from DHI Group, Inc., which owns and operates several online platforms for posting vacancies and attracting applications. Our data derive from the Dice.com online job board.

Employer-side clients: (a) organizations that directly hire their own workers, (b) recruitment firms that solicit applicants for third parties, and (c) staffing firms that hire workers for lease to others.

Vacancy postings: Mainly in technology sectors, software development, other computer-related occupations, engineering, financial services, business and management consulting, and a variety of other jobs that require technical skills.

High volume, granularity & frequency:

- 130 million applications to 10 million postings from 5+ million applicants from 2012 to 2017. 60,000 employer-side clients
- Second-by-second tracking of postings and applications, with identifiers for employer-side clients and applicants
- Employer side: Name, industry, size, vacancy ID, job description, city of job, compensation (if posted) and more
- Applicant side: Applicant ID, location, current job title, date-time stamp of applications and more
- 3,600 job titles with ≥ 100 distinct postings
- Broader functional categories (software developer, project manager, business analyst, etc.) and skill categories (Javascript, Oracle, Linux, etc.) that we construct from job descriptions.

Two Application Modes: Email and URL

- For each posting, the employer-side client decides whether job seekers submit applications via email on the Dice platform or via an external URL operated by the client or a third party.

- For email applications, we see the number of completed applications. For URL applications, we see how often job seekers click through to the external URL.

- We pool these two application modes in our analysis.

More about the Dice.com Platform, 1

The Pricing of Vacancy Postings

- Clients typically face a positive (shadow) price to keep a posting in active status and visible to job seekers.

- Pricing on other platforms can yield many "stale" postings.

The Job-Seeker Experience

- Can browse postings by job title, job location, company name, skill requirements and other job characteristics.

- Browsing does not require registration, but job seekers must register before applying for a job via the Dice.com platform.

- Job seekers submit applications at no charge.

- By supplying enough information, job seekers can include their profiles in a database searchable to employer-side clients.

More about the Dice.com Platform, 2

Applicant Quality Control

- High-quality applicant pools are an important part of the Dice.com value proposition to employer-side clients.

- DHI relies client complaints and other information to identify bad actors who engage in bad behaviors.

  - Example: A third party misrepresents itself to submit an application for a posting that accepts only first-party applicants.

- DHI uses machine-learning methods to develop rules for screening bad actors and bad behaviors. After verifying a rule does not generate false positives, DHI implements the rule to block "bad" applications.

- To prevent gaming of rules, "bad" actors are not informed when their applications are blocked.

- Our dataset excludes blocked applications.

Standard versus "Long-Duration" Postings, 1

80% of postings at the level of a Job ID exhibit the following pattern:

a) Client posts a vacancy on the DHI site

b) Most applications arrive within a week after posting

c) Client permanently removes the vacancy posting within one month after first posting.

For Job IDs that fit the standard pattern, we interpret each one as a unique posting for a single opening.

Standard versus "Long-Duration" Postings, 2

- Other Job IDs do not conform to this pattern; instead, they remain online for many weeks or months, and applications flow in over time.

- Based on our examination of the data and our conversations with DHI staff, the vast majority of these "long-duration" postings reflect direct hire clients with ongoing hiring needs for certain jobs and recruiting and staffing firms that more or less continuously seek applicants for certain types of jobs

Standard versus "Long-Duration" Postings, 3

How We Proceed

- If gap between a posting's first active date-time and its last active date-time is > 31 days, we regard it as a "long-duration" posting.
- We "slice" each long-duration posting into multiple postings, one for each calendar month it's active.
- We consider standard postings only in much of our analysis, so as to focus on single-position openings.

Table 1. Vacancy Postings and Applications in the DHI Database, January 2012 to July 2017

	Millions	Direct Hire Share	Recruitment and Staffing Firm Share
(1) Number of Raw Postings	7.1	24.3%	75.7%
(2) Number of Vacancies, After Slicing Long-Duration Postings	10.9	36.9%	63.1%
(3) Volume of Applications	77.3	39.7%	60.3%
(3.a) Email Applications	56.9	36.4%	63.6%
(3.b) URL Applications	20.9	48.9%	51.1%

Distributions by Full/Part Time Schedule

	Raw Postings	Applications
Full-Time	44.9%	45.7%
Part-Time	4.1%	4.9%
No Time Schedule Specified	53.9%	53.3%

Columns sum to more than 100% because some postings are for a job that can be full-time or part-time.

Percent Distributions by Firm Type, Direct Hires Only

Jan. 2012 to July 2017	Privately Held	Publicly Listed	Govt.	Other
Employer-Side Clients	93.5	3.5	2.9	0.1
Raw Job Postings	91.6	7.7	0.6	0.0
Applications	92.1	7.2	0.7	0.0

Percent Distributions by Firm Size, Direct Hires Only

Employer Size	Clients	Raw Job Postings	Applications
0 Employees	11.8	16.7	14.5
1-9	20.3	19.2	21.7
10-11	8.1	6.4	6.7
20-99	22.9	21.7	20.3
100-249	12.3	7.6	8.0
250-499	7.3	6.0	6.3
500-999	5.7	2.3	2.9
1,000-2,499	4.9	3.2	4.2
2,500-4,999	2.6	2.5	3.4
5000-9,999	1.6	2.9	3.1
10,000+	2.4	11.6	8.8

Nine Facts about Search & Hiring Behavior

1. Large, growing role for labor market intermediaries
2. **Posting** durations are short, much shorter than **vacancy** durations.
3. Posting durations are not sensitive to tightness (provisional result)
4. Most vacancy postings attract few applicants.
5. The typical applicant competes with many other applicants.
6. Job seekers target new postings for applications, strikingly so.
7. Most job seekers concentrate their applications on Day 1, i.e., their first day with positive applications on Dice.com.
8. Platform functionality greatly affects the volume and distribution of application flows to postings.
9. Seasonals (daily, weekly, monthly) are **much** stronger for application flows than for vacancy postings.

1(a). Large, Growing Role of Recruitment & Staffing Firms
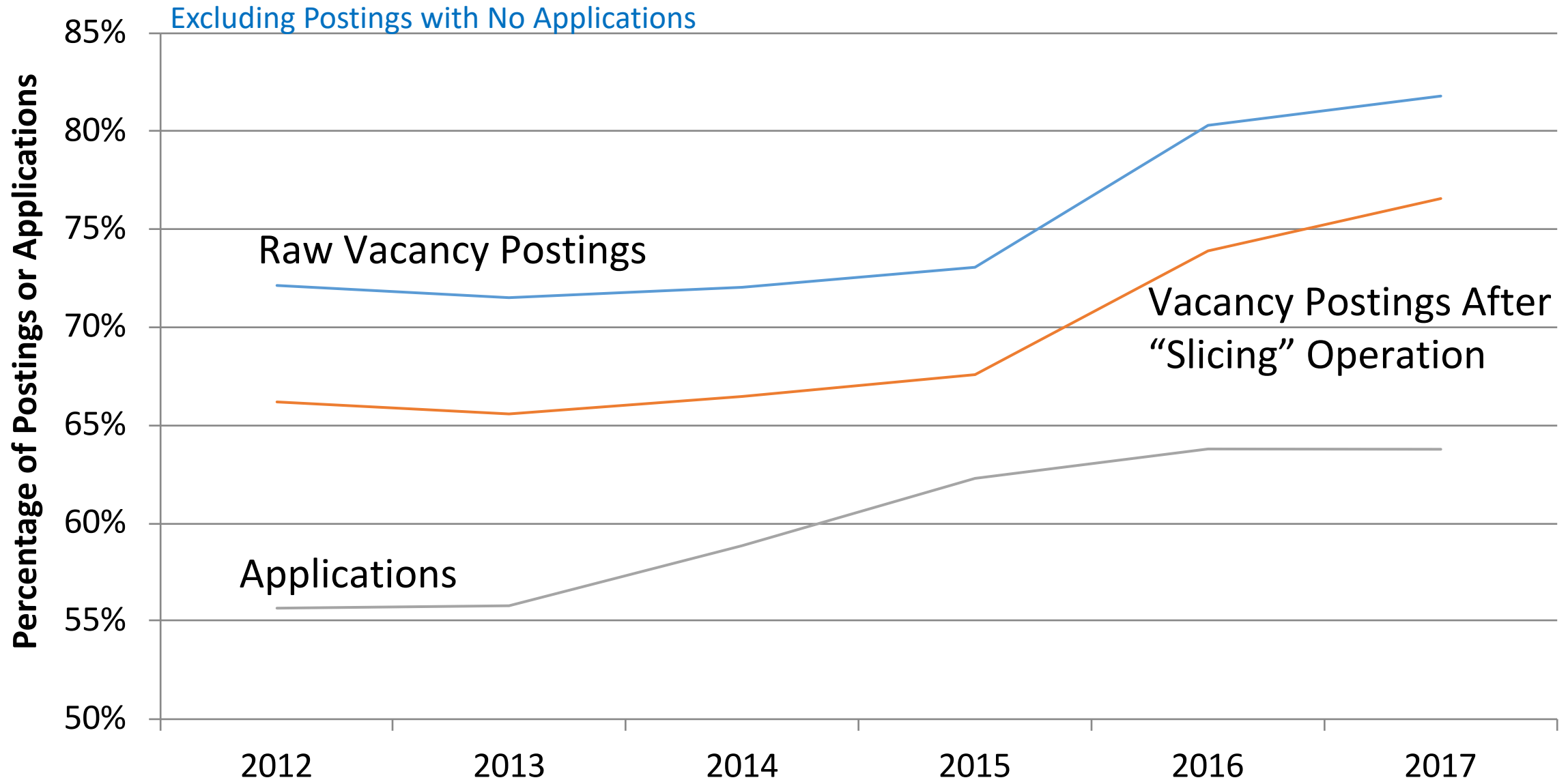
1(b). Large Role for Worker-Side Intermediaries, Too

Joint Distribution of Applications over Employer-Side and Worker-Side Types, January 2015 to July 2017

	1st Party Applications	3rd Party Applications	Not Classified
Direct Hire	12%	22%	3%
Recruitment & Staffing Firms	20%	39%	4%

88% of applications involve an intermediary on one or both sides of the matching process (in addition to platform role of Dice.com).

# Who Generates 3rd-Party Applications?

1. Staffing agencies that lease their employees to other firms submit applications in response to postings.

    - Even when staffing firms pay hourly, they have incentives to market their employees. That's how they generate (a) fees charged to employers and (b) markups on what they pay their employees.
    - Employer-side clients on Dice.com can explicitly allow or disallow such "corporation-to-corporation" applications in their postings.

2. Placement agents that respond on behalf of individuals seeking jobs that meet particular criteria.

2. Postings for single-position openings are short-lived

- The mean ***posting*** duration for single-position openings is only 9.8 days.
- In contrast, the mean ***vacancy*** duration for comparable jobs in the Job Openings and Labor Turnover Survey (JOLTS) is more than four times as long.
- Thus, the "meeting" phase of the hiring process, during which employers solicit and accept applications, is far shorter than the "selection" phase, which entails screening and interviewing applicants, selecting one for a job offer, extending an offer, negotiating terms, and waiting for an accept/reject decision.

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The Distribution of Completed Spell Durations

Standard Postings, Jan. 2012 - Jul. 2017*

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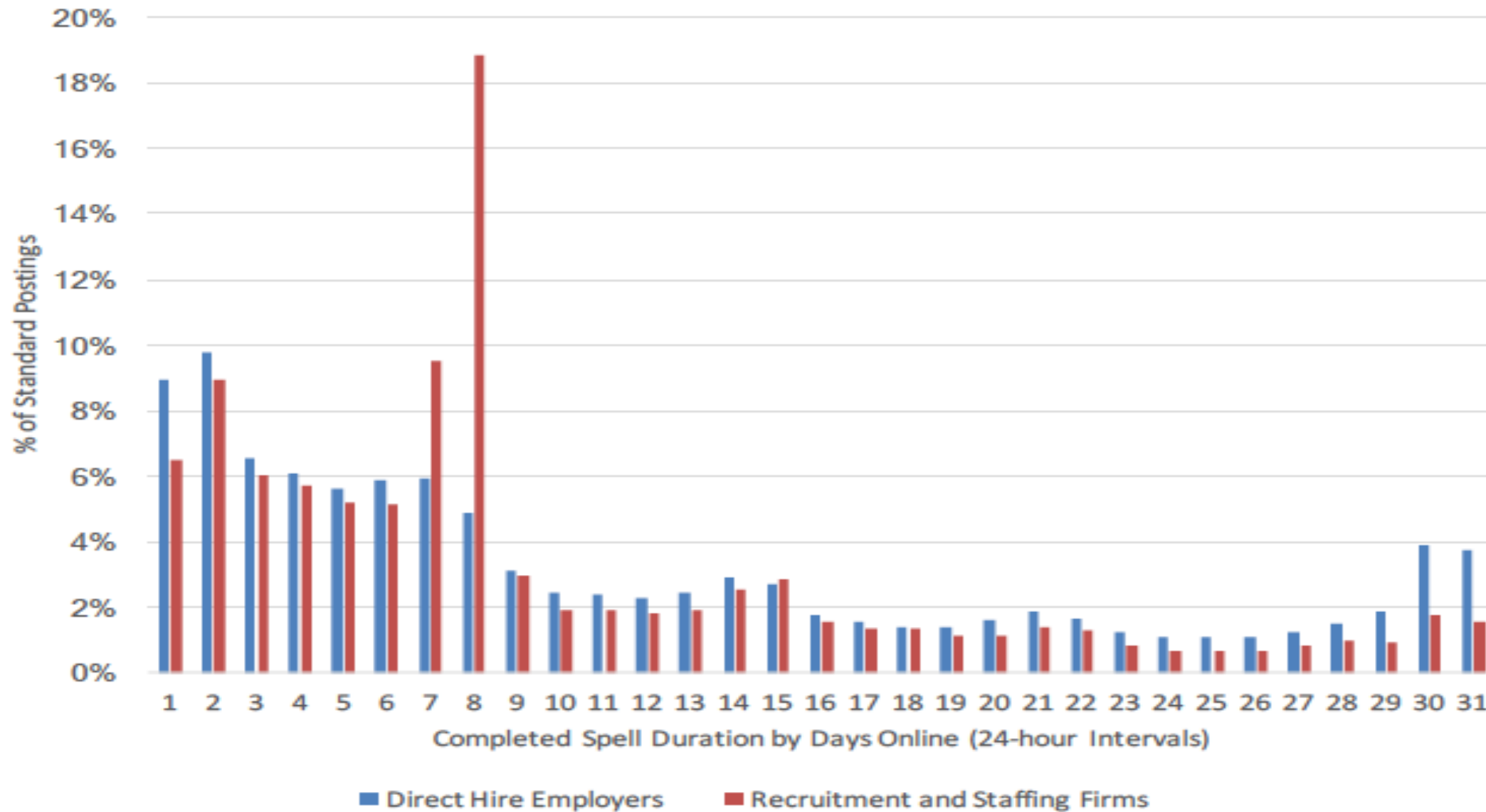
Summary Stats for Completed Posting Durations, in Days

January 2012 to June 2017		Percentile				
	Mean	10	25	50	75	90
All Standard Postings	9.80	0.91	2.66	6.78	14.70	25.12
All Job Titles with at Least 100 Standard Postings	9.80	0.91	2.67	6.79	14.71	25.13
Selected Job Types						
Developer	8.80	0.84	2.16	6.25	13.38	22.29
Project Manager	9.51	1.00	2.96	6.80	13.93	23.62
Business Analyst	9.30	0.91	2.57	6.66	13.80	23.61
Help / Support Desk	10.35	1.00	3.25	7.00	15.64	25.80
Software Engineer	12.96	1.31	4.72	10.63	20.90	29.08
Systems Administrator	11.36	1.05	3.63	8.00	17.59	27.54
Technician	9.35	0.89	2.69	6.60	13.75	24.62
Data Analyst	10.12	1.00	3.02	7.00	15.05	25.08
Database Administrator	9.81	0.94	2.77	6.77	14.58	25.41
Programmer	11.45	1.03	3.64	7.92	18.02	28.10
Quality Assurance Tester	7.83	0.83	1.79	5.45	11.01	20.58
Sales	11.89	0.81	3.23	9.66	18.70	28.16
Electrical Engineer	12.69	1.68	4.96	10.78	19.85	28.87
Mechanical Engineer	12.01	1.20	4.39	9.62	18.90	28.41
Finance Consultant	7.91	0.59	2.12	5.31	10.46	21.64

3. Posting Durations Are Not Sensitive to Tightness

Hypothesis: Employers extend posting durations when labor markets get tighter.

- To operationalize, equate tighter markets with slower applicant arrival rates.
- To investigate this hypothesis, we proceed as follows:
    - Sort postings into skill categories based on the first skill requirement specified in each posting's detailed job description.
    - Retain data in software-related skill categories with at least 500 postings → 3 million postings sorted into 54 skill categories.
    - Examples: SAP, Oracle, Java, DotNet, C, Systems, etc.
    - Calculate average posting durations and daily applicant arrival rates by category for each year from 2012 to 2017 → 324 cell-level observations.
    - Regress average posting duration on average applicant arrival rate, conditional on fixed effects for skill categories and calendar years.

3. Posting Durations Are Not Sensitive to Tightness

The chart displays annual values from 2012 to 2017 for 54 skill categories, after sweeping out year and skill-category fixed effects.
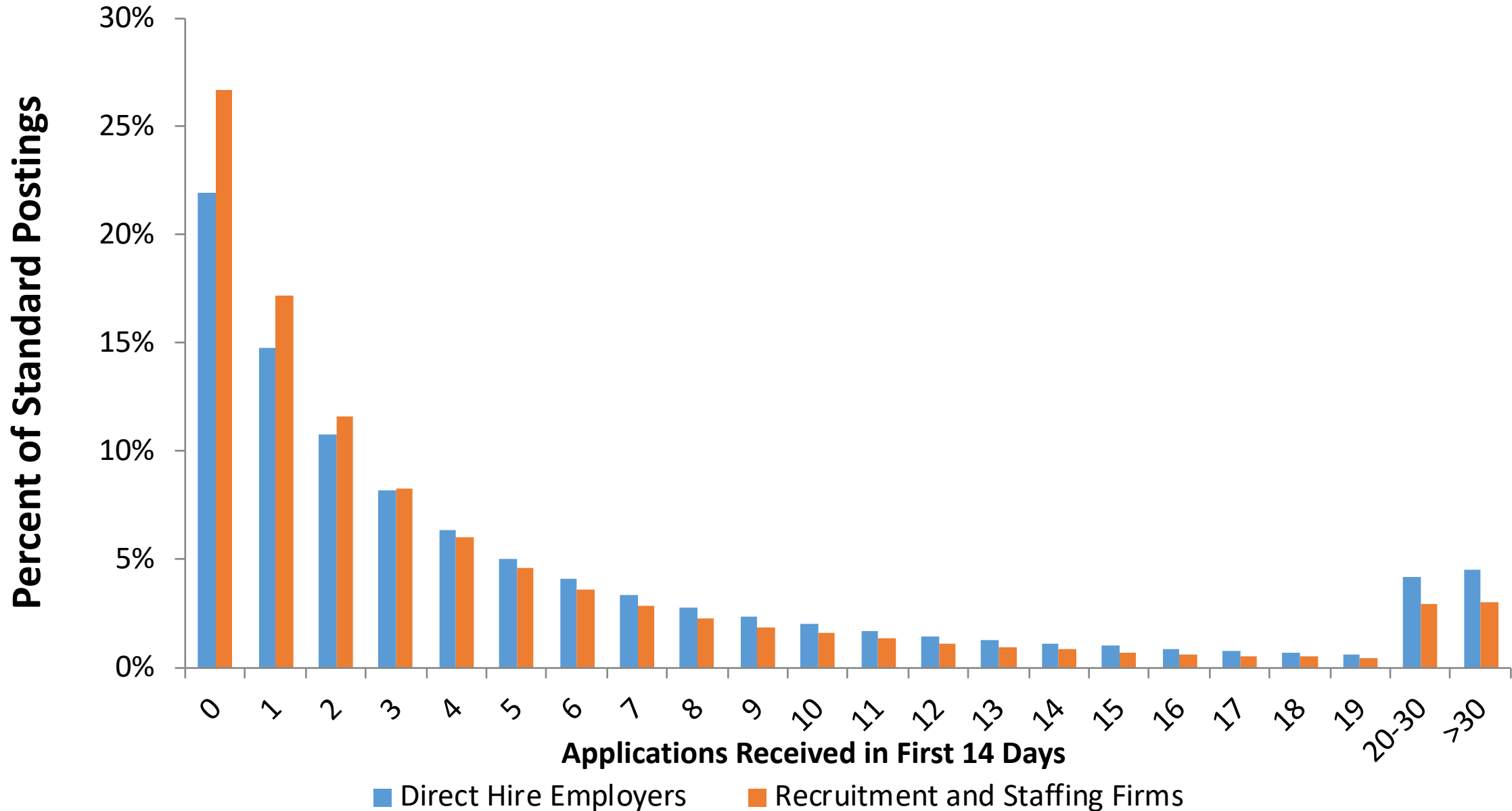
Using the cell-level mean daily application arrival rate yields a very similar pattern.

Mean Duration (days)

Median Daily Application Arrival Rate
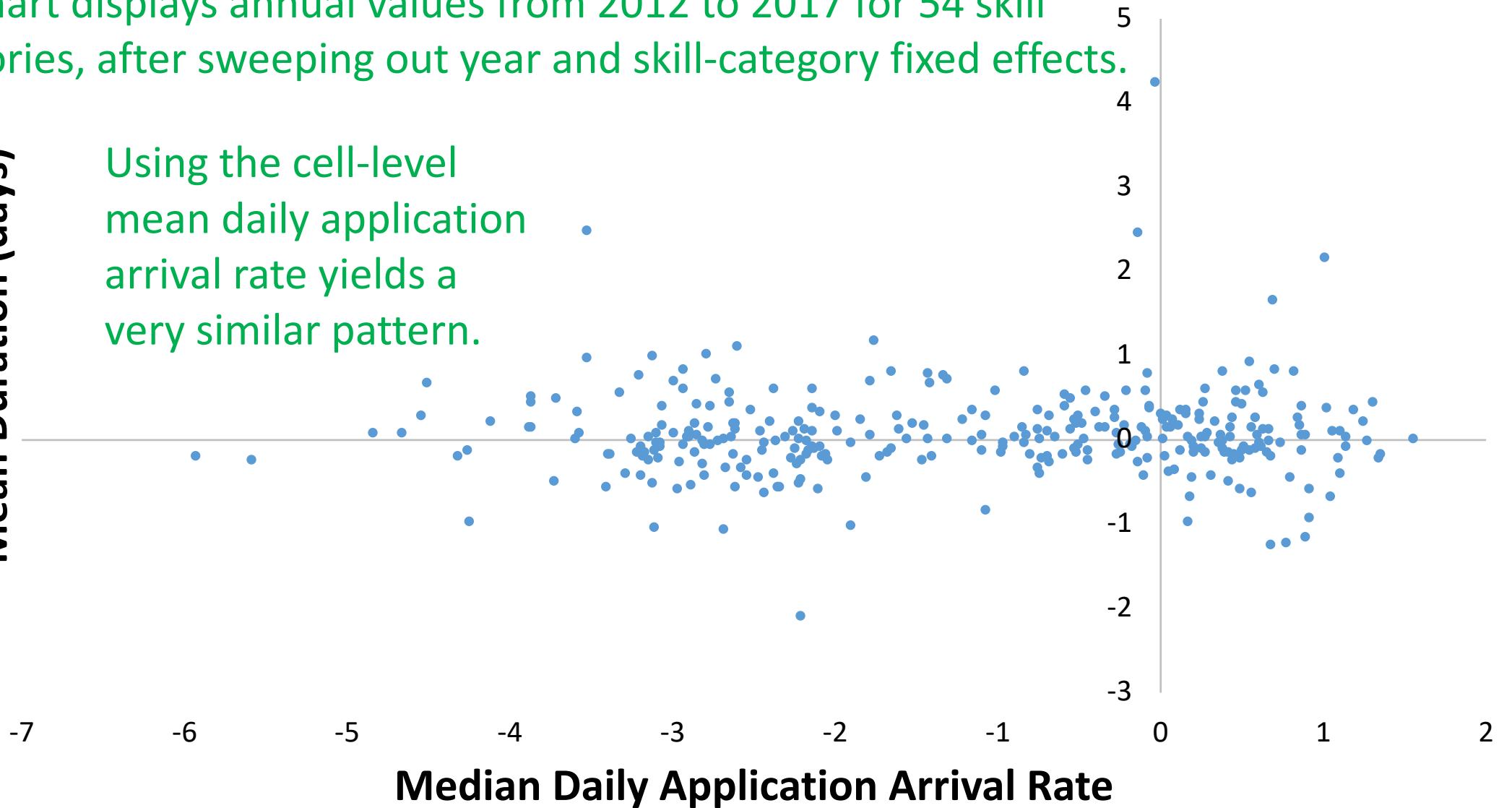
3. Posting Durations Are Not Sensitive to Tightness

- This result is provisional, and there's more we can do to evaluate the hypothesis stated above.
- Thus far, however, we find no evidence that posting durations respond to market tightness, as measured by the arrival rate of applicants.
- Put differently, we find no evidence that the duration of the meeting phase lengthens as labor markets get tighter.

4. Most Postings Attract Few Applicants

Y-axis: Percent of Standard Postings

X-axis: Applications Received in First 14 Days

Categories: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20-30, >30

Legend: ■ Direct Hire Employers ■ Recruitment and Staffing Firms

Applications Per Vacancy Posting, Completed Spells, Standard Postings from January 2012 to December 2017

How it looks to employers and recruiters

	(1)	Mean Applications per Completed Spell		Median Applications per Completed Spell	
		(2)	(3)	(4)	(5)
	No. of Postings	Equal Weights	Application Weighted	Equal Weights	Application Weighted
Job Titles with 100+ Postings	5,396,822	11.03	90.58	3	40
Job Titles with 1,000+ Postings	5,189,803	11.11	91.60	3	41
Frequently Appearing Combinations of Skills and Job Functions	5,362,744	11.03	90.72	3	40
Selected Job Functions					
DEVELOPER	1,248,269	15.98	143.36	3	76
ENGINEER	669,690	7.46	65.49	2	30
ADMINISTRATOR	408,444	10.30	59.29	4	32
ANALYST	345,556	9.76	68.12	3	32
ARCHITECT	299,085	5.90	32.66	2	17

Why Not More Applicants Per Posting?

1. Most postings on Dice.com have demanding technical qualifications such as Java developer, software engineer, systems administrator, SAP consultant, LINUX administrator, data scientist and electrical engineer.

2. Dice.com job listings are also concentrated in occupations with relatively rapid demand growth in recent years, potentially outstripping the pace of skill adjustment on the supply side of the labor market.

Points 1 and 2 suggest that skill scarcities are more prevalent for the jobs covered by the DHI database than for the economy as a whole.

3. DHI blocks certain IP addresses and User IDs with "bad" behaviors or a history of excessive application volumes, and from certain foreign sources. These blocking actions are part of DHI's efforts to provide high-quality applicant pools to its employer-side clients.

5. The Typical Applicant Competes Against Many Others

How it looks to job seekers

	(1)	Mean Applications per Completed Spell		Median Applications per Completed Spell	
	(1)	(2)	(3)	(4)	(5)
	No. of Postings	Equal Weights	Application Weighted	Equal Weights	Application Weighted
Job Titles with 100+ Postings	5,396,822	11.03	90.58	3	40
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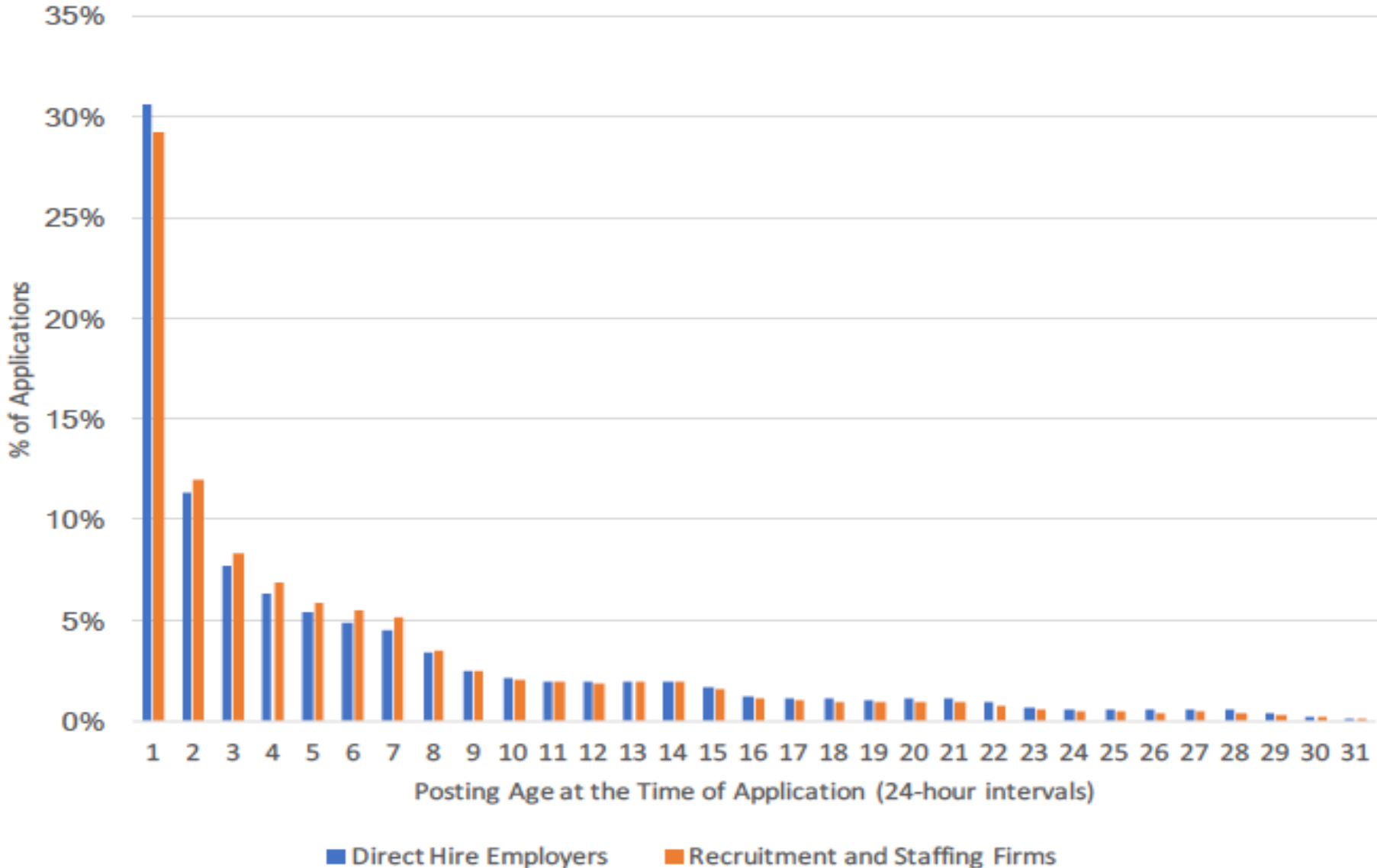# On Application Flows Per Vacancy Posting

- The typical applicant faces many rivals for each sought-after job, even as employers face small applicant pools for most openings.

- Mechanically, this pattern reflects a highly uneven distribution of applications over postings.

- In terms of economics, this pattern fits two somewhat different interpretations:

  - A modest share of vacancies is highly attractive to many job seekers because of high compensation, good working conditions, high job security or other desirable attributes.

  - Skill or locational mismatch is an important phenomenon that curtails the size of applicant pools for a large share of vacancies.

6. Job Seekers Target New Vacancy Postings

- 41% of applications flow to postings < 48 hours old

- 56% flow to postings < 96 hours old.

- Daily applications fall as postings age, sharply so over the first days.

- These patterns are pervasive across job functions and skill types.

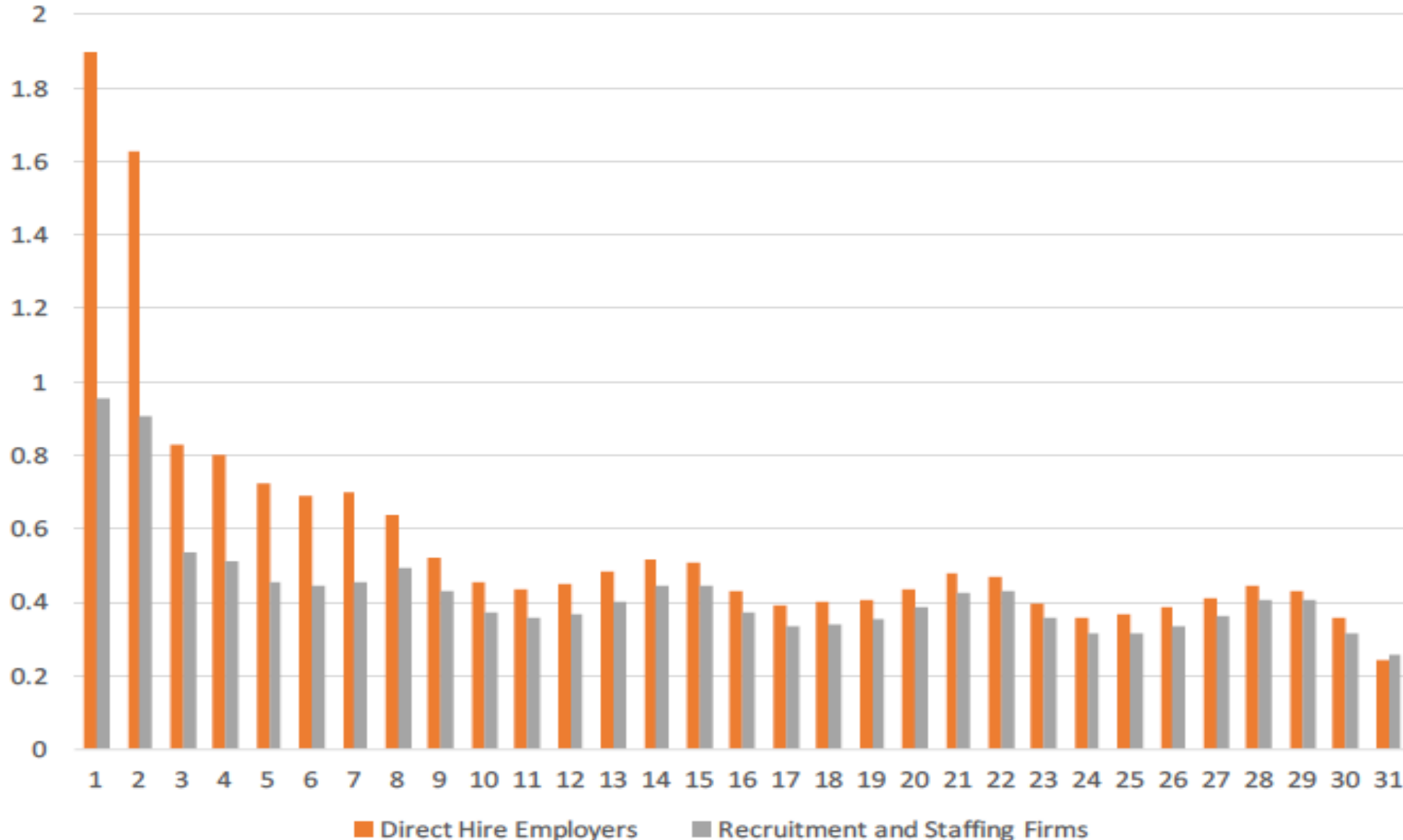- Third-party applications show a greater propensity to target young postings.

Distribution of Applications by Posting Age
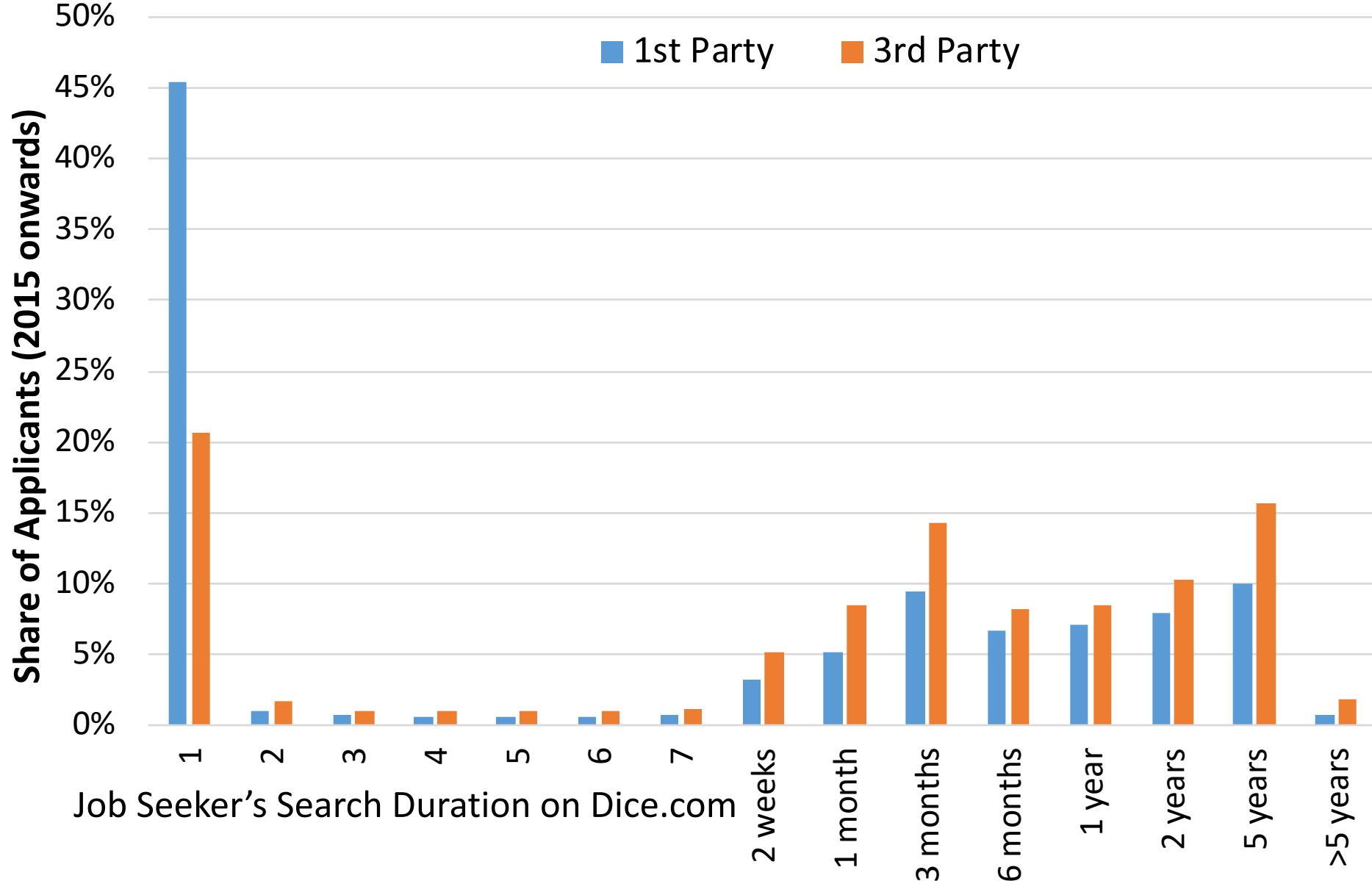

Standard Postings, Jan. 2012- Jul.2017

Posting Age at the Time of Application (24-hour intervals)

% of Applications

■ Direct Hire Employers   ■ Recruitment and Staffing Firms

Mean Daily Applications Per Active Posting

Standard Postings, Jan. 2012- Jul.2017

■ Direct Hire Employers ■ Recruitment and Staffing Firms

7. Most Job Seekers Concentrate Their Applications on Day 1

- 45% of 1ˢᵗ party job seekers submit no applications after Day 1, where "Day 1" = job seeker's first day with one or more applications on Dice.com.

- For persons who continue to search on Dice.com (as indicated by at least one later application):
  - The average job seeker applies to multiple jobs on Day 1.
  - The average daily application rate for job seekers drops off very sharply after Day 1.
  - Nevertheless, Day-1 applications make up a minority of applications.

- Kudlyak et al. (2014) and Faberman & Kudlyak (2016) also find an individual's application rate tends to fall with search duration, as measured by time active on the platform. ghe33

Distribution of Job Seekers by Search Duration on Dice.com

■ 1st Party ■ 3rd Party

Share of Applicants (2015 onwards)

Job Seeker's Search Duration on Dice.com

x-axis labels: 1, 2, 3, 4, 5, 6, 7, 2 weeks, 1 month, 3 months, 6 months, 1 year, 2 years, 5 years, >5 years

"Search Duration" measured by time elapsed between the job seeker's first and last application to a Dice.com posting. The 1 Day duration bin includes persons who apply to only 1 posting on Dice.com.
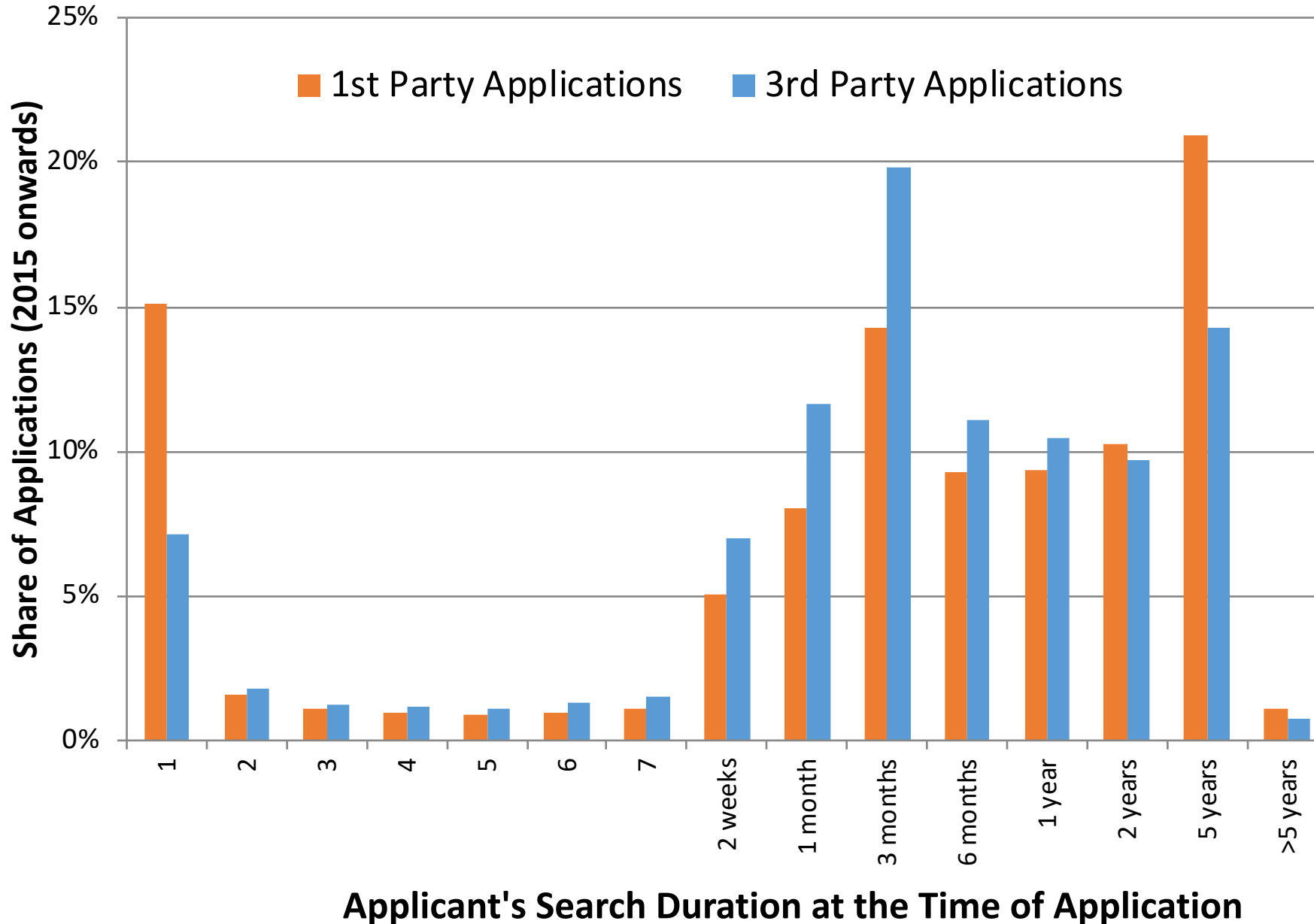
The current version of this chart makes no adjustment for person who have long spells (months or years) in between applications.

Mean Daily Applications Per Applicant by Days Since First Application, Jan 2012 to July 2017,
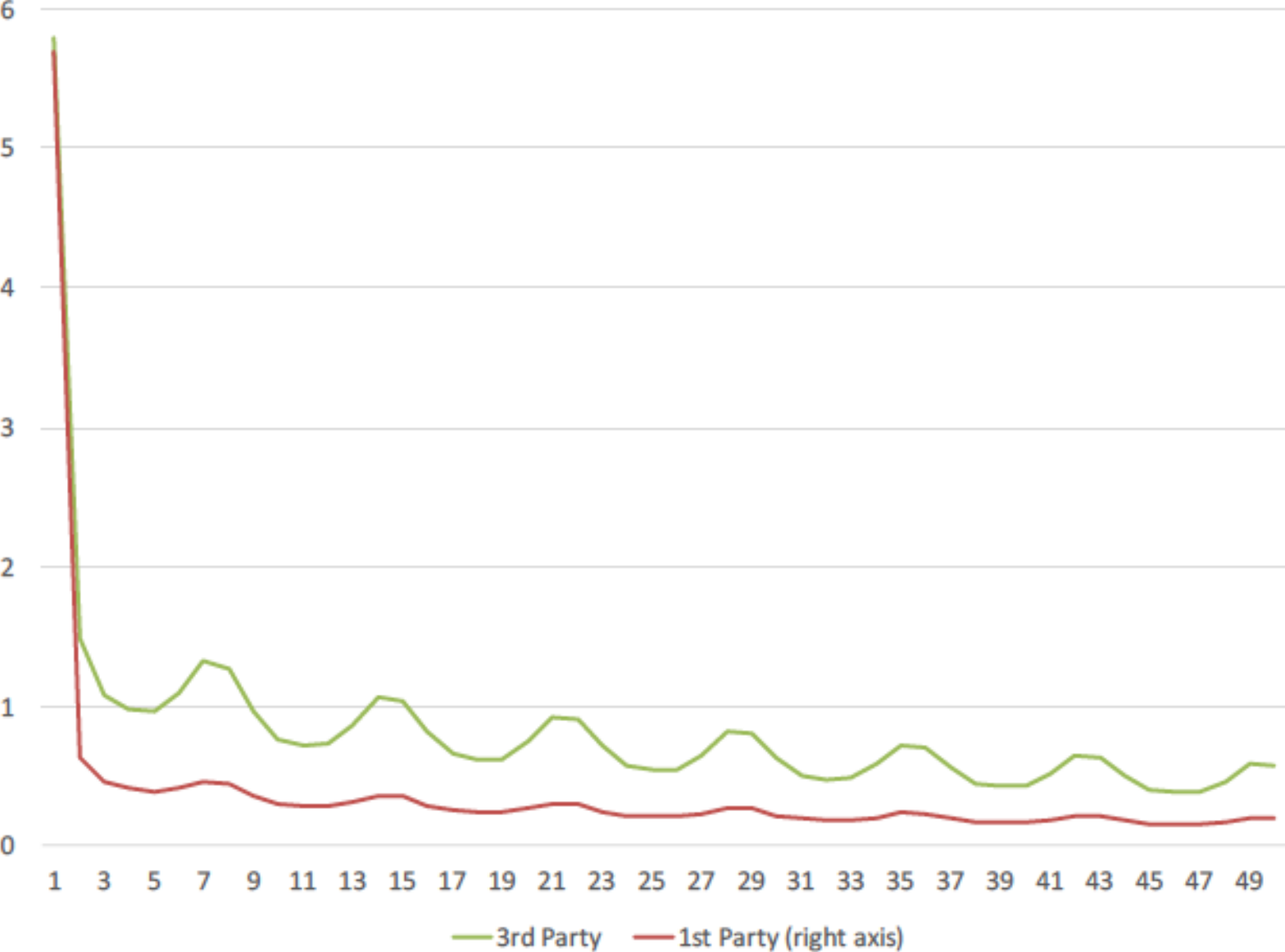
For each "Day," (24-hour period), we restrict the sample to persons who apply to at least one job on Dice.com on a later day. In this way, we condition on persons who continue as active searchers.

Distribution of Applications by Applicant's Search Duration

The current version of this chart makes no adjustment for person who have long spells (months or years) in between applications. Thus, it overstates the mass in the right tail of the search duration distribution, probably to a large degree.

We will address that issue.

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8. Platform Functionality Greatly Affects the Volume And Distribution of Applications to Postings

Key changes to the Dice.com platform in December 2014:

1. DHI streamlined the registration and application process for job seekers.

2. It improved the search engine available to job seekers.

3. It enabled employer-side clients to search over registered jobseekers on Dice.com and solicit applications from particular individuals.

4. It removed information from Dice.com postings that, in some cases, had facilitated applications off platform.

Applications per Vacancy-Day by Firm Size, Annual Averages, Standard Postings by Direct-Hire Employers

Major changes to Dice.com platform functionality in December 2014
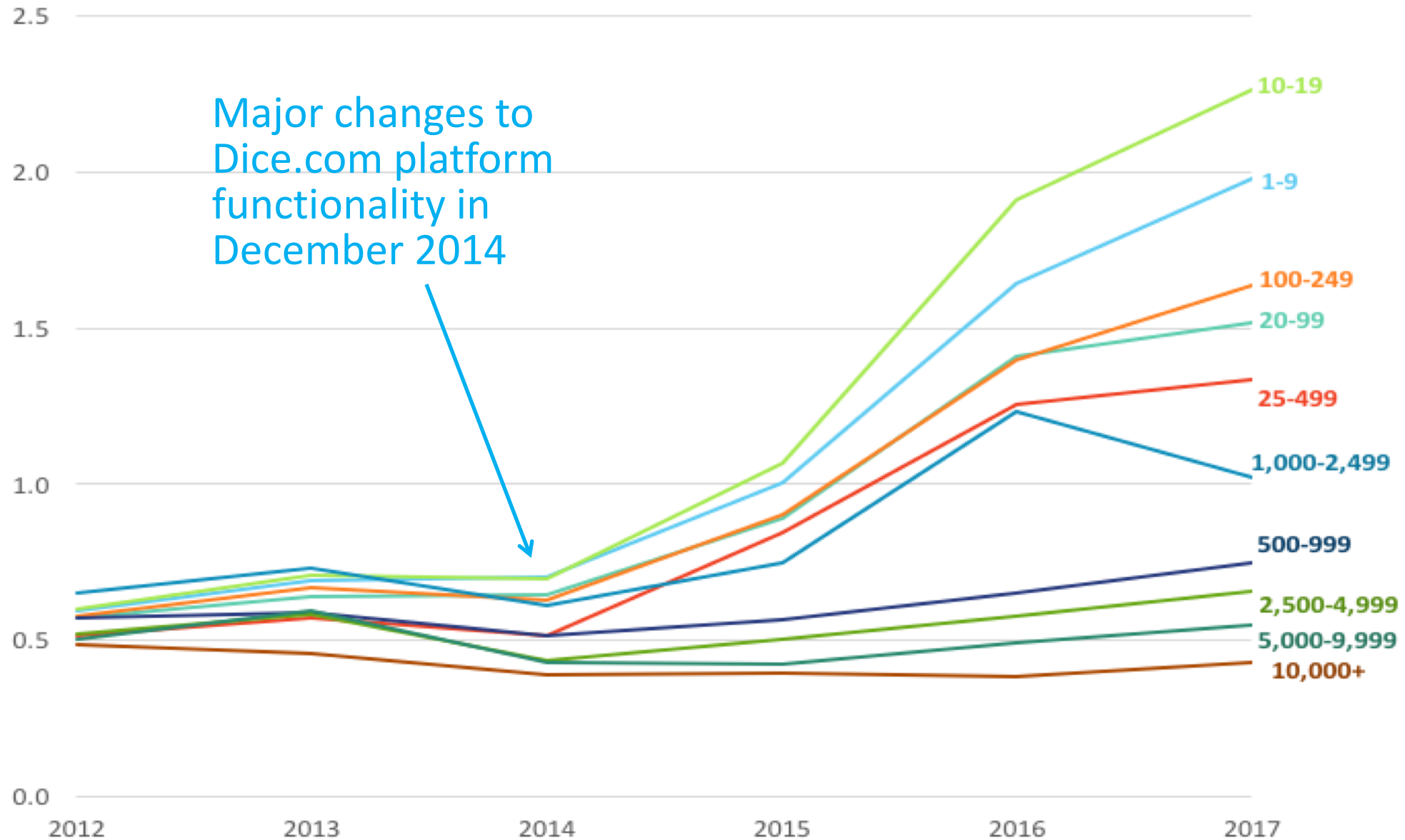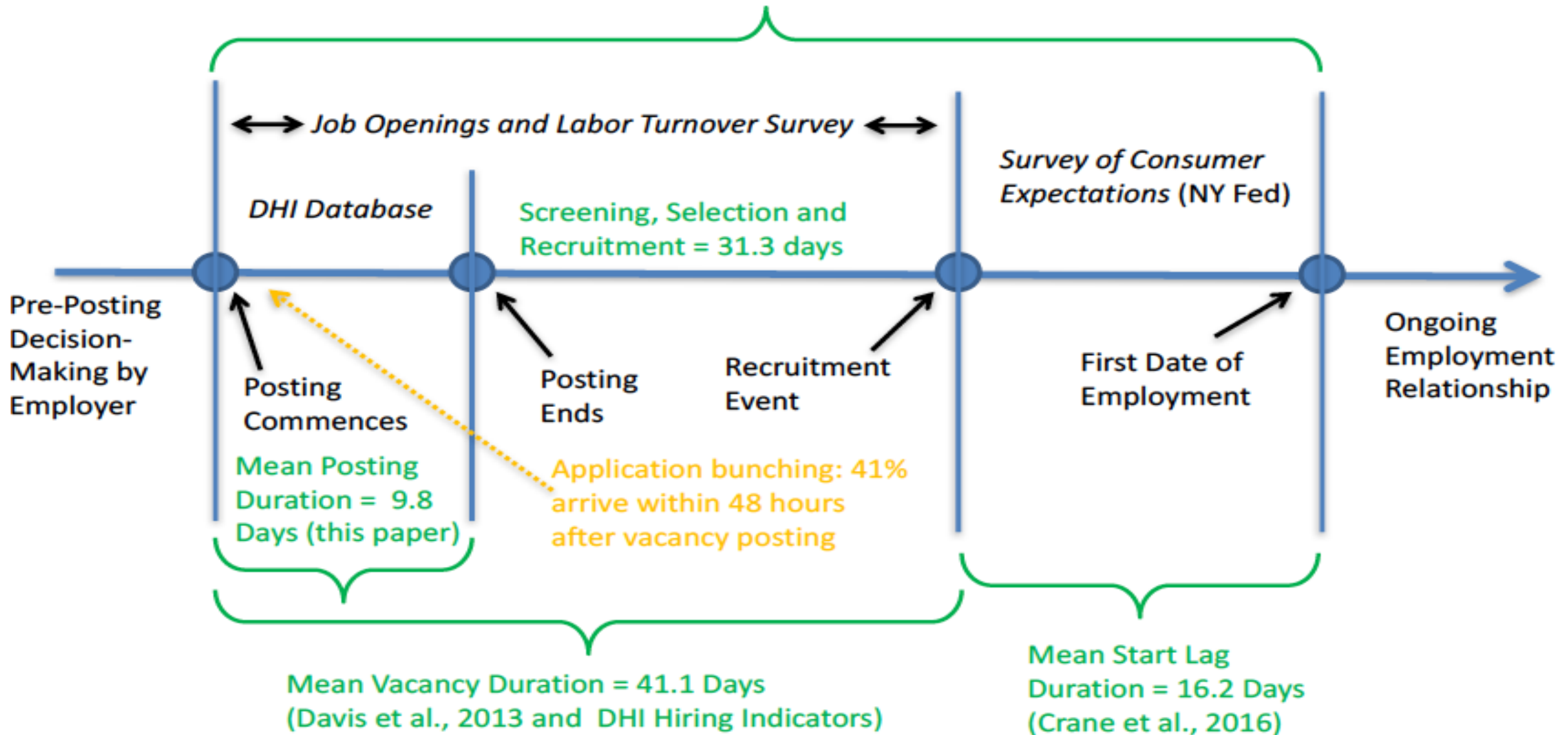
Taking Stock

- Quantitative Sketch of the Hiring Process
- Alternative Employer Search Strategies
- Five Implications for Theoretical Modeling
- Additional Remarks on Sequential vs. Non-Sequential Search Strategies

Stages of the Hiring Process: A Quantitative Sketch

Mean Duration from Date of First Posting to Start of Employment = 57.3 Calendar Days

Job Openings and Labor Turnover Survey

DHI Database

Survey of Consumer Expectations (NY Fed)

Screening, Selection and Recruitment = 31.3 days

Pre-Posting Decision-Making by Employer

Posting Commences

Posting Ends

Recruitment Event

First Date of Employment

Ongoing Employment Relationship

Mean Posting Duration = 9.8 Days (this paper)

Application bunching: 41% arrive within 48 hours after vacancy posting

Mean Vacancy Duration = 41.1 Days (Davis et al., 2013 and DHI Hiring Indicators)

Mean Start Lag Duration = 16.2 Days (Crane et al., 2016)

Alternative Employer Search Strategies

Sequential Search Strategy: Employer screens each applicant on arrival and immediately offers a job if expected match surplus > 0. Factors that favor a sequential strategy include**:**
- Low applicant arrival rate
- High cost of screening another applicant
- Absence of scale economies in screening

Non-Sequential Search Strategy: Employer gathers a pool of applicants, screens the pool, selects one or more, then extends job offer(s). Factors that favor a non-sequential strategy include:
- High applicant arrival rate
- Bunching of applications shortly after posting
- Scale economies in screening applicants

Five Implications for Theory

1. **Labor market intermediaries play a huge role**: 88% of all applications on Dice.com involve an employer-side or worker-side intermediary, or both. Of course, all of our applications flow through Dice.com, another type of intermediary.

   - Few theoretical models of hiring activity consider intermediaries. Bull et al. (1987) – an early exception – stress that recruitment firms can screen in advance and thereby enable firms with stochastic hiring needs to fill vacancies more quickly.

   - Gautier (2002) stresses that intermediaries reduce duplicative screenings, thereby lowering aggregate screening costs and mitigating congestion externalities under non-sequential worker search.

   - Arnosti et al. (2015) show that meeting cost reductions due to the rise of online platforms can lower welfare by raising screening costs.

Five Implications for Theory

2. **Employer search is non-sequential:** Employers/recruiters collect multiple applications w/ short-lived postings (mean duration of 10 days). They take much longer (31 days) to screen, select and recruit.

    - In contrast, the dominant models of labor market matching and hiring presume sequential search behavior.

    - Theoretical models that feature non-sequential search in an equilibrium setting include Gautier (2002) and Wolthoff (2018).

- We are not the first to argue that much hiring behavior is inconsistent with sequential search. In a small sample of 1900 Dutch establishments with 670 vacancies, Van Ours and Ridder (1992) find that almost all hires take place from a pool of applicants formed shortly after vacancy posting.

- Van Ommeren and Russo (2008) reject the hypothesis of sequential search by Dutch employers who rely on advertising or employment agencies to recruit workers, which constitute nearly half the hires in their sample. When they consider vacancies filled through social networks (e.g., employee referrals), they cannot reject the hypothesis of sequential search by employers.

3. **Application bunching shortly after posting favors a non-sequential search strategy, whereby an employer first collects a batch of applications, then screens them and potentially selects one (or more) for an offer**.

- See Gal, Landsberger and Levykson (1981), Morgan (1983) and Morgan and Manning (1985)

- Application bunching is prominent in our data: 41% of applications arrive within 48 hours of posting, and 56% arrive within 96 hours.

- Thus, observed applicant behavior favors non-sequential employer search, according to theory. And we find evidence of non-sequential employer search.

4.   **Non-sequential employer search creates incentives for job seekers to also adopt a non-sequential strategy, applying to many job openings at the same time.**

- Non-sequential employer search creates a delay between the submission of an application and the employer's selection of a recruit. Thus, it makes sense for job seekers to apply for multiple job openings simultaneously while awaiting call-backs and offers, unless applications themselves are very costly to submit.
- See Morgan and Manning (1985) and Gautier (2002) on this point.
- We find evidence that many or most job seekers engage in this form of non-sequential search. See, also, Abbring and Van Ours (1994) and

5.   Stock-flow matching?

- Our evidence that job seekers favor newly posted vacancies lends support to the empirical relevance of stock-flow matching. For other evidence that points to stock-flow matching, see Andrews et al. (2017) and Carillo-Tudela and Hawkins (2017).

- But our results point to an important role for screening, potentially within a stock-flow matching framework. Recall:
  - The typical posting attracts multiple applications.
  - Mean posting duration < one-fourth of mean vacancy duration.
  - One quarter of our postings have completed spells < 2.2 days!

- In this respect, our findings are at odds with models that feature sequential search in a stock-flowing matching framework, e.g., Coles and Smith (1998), Gregg and Petrongolo (2005) and Ebrahimy and Shimer (2010).

More on Sequential vs. Non-Sequential Search

- The non-sequential perspective has been overshadowed by theories in the mold of Diamond (1982), Mortensen (1982), Pissarides (1985) and Mortensen and Pissarides (1994), which postulate sequential search by employers and workers.

- Prevailing treatments of frictional unemployment, job-finding rates, vacancy dynamics, wage dispersion with search frictions, and job creation incentives in settings with search frictions have been dominated by the sequential search perspective.

- Leading examples include Burdett & Mortensen (1998), Pissarides (2000), Postel-Vinay & Robin (2002), Mortensen (2003), Hall (2005), Shimer (2005), Hornstein, Krusell and Violante (2011) and Davis, Faberman & Haltiwanger (2013).

- It strikes us as problematic to rely on sequential search models for quantitative assessments of market outcomes and policy interventions, when the hiring process in these models is so sharply at odds with actual hiring behavior.

- Example: The duration of the "meeting" phase in the hiring process is unlikely to vary with tightness in the same way as the duration of the "screening & selection" phase or the "bargaining & recruitment" phase. Hence, quantitative non-sequential search models have the potential to improve our ability to explain job-finding and vacancy-filling rates.

  - On a related note, Crane et al. (2016) find: (a) The mean "start lag" is 40% of the mean vacancy duration. (b) Start lags are mildly countercyclical, but vacancy durations are strongly pro-cyclical.

- Theories of non-sequential search date to Stigler (1961). Gal et al. (1981), Morgan (1983) and Morgan and Manning (1985) theoretically analyze the choice between sequential and non-sequential search strategies.

- Labor market environments with non-sequential search involve a different set of externalities than environments characterized by sequential search. See Gautier (2002), Albrecht, Gautier and Vroman (2006) and Wolthoff (2018).

- We see our evidence as strong motivation for greater attention to non-sequential search models in which both job seekers and employers simultaneously contact multiple potential partners with whom to initiate an employment relationship.

# 9. Strong seasonals in application flows but not in postings

Application Flows in December and January Relative to the Preceding October

	2012	2013	2014	2015	Mean
Ratio of December-to-October	0.67	0.65	0.71	0.74	0.69
Ratio of January-to-October	1.16	1.04	1.10	1.07	1.09
Ratio of January-to-December	1.73	1.59	1.54	1.45	1.58

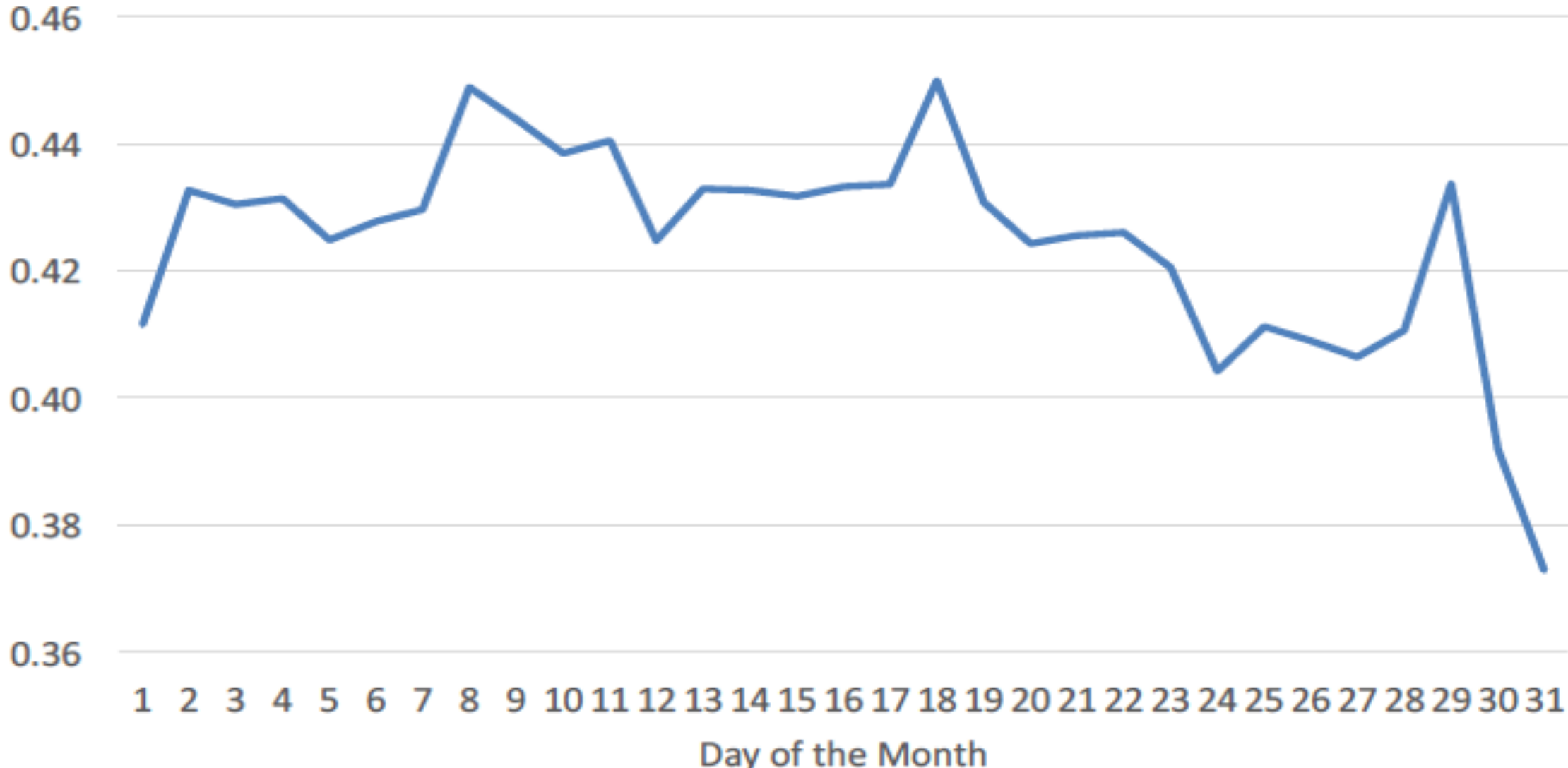## Daily Applications Per Vacancy Posting Relative to the Preceding October

	2012	2013	2014	2015	Mean
Ratio of December-to-October	0.64	0.68	0.69	0.76	0.69
Ratio of January-to-October	1.23	1.14	1.02	1.12	1.13
Ratio of January-to-December	1.91	1.68	1.47	1.45	1.63

Distribution of Posting Days by Day of the Month
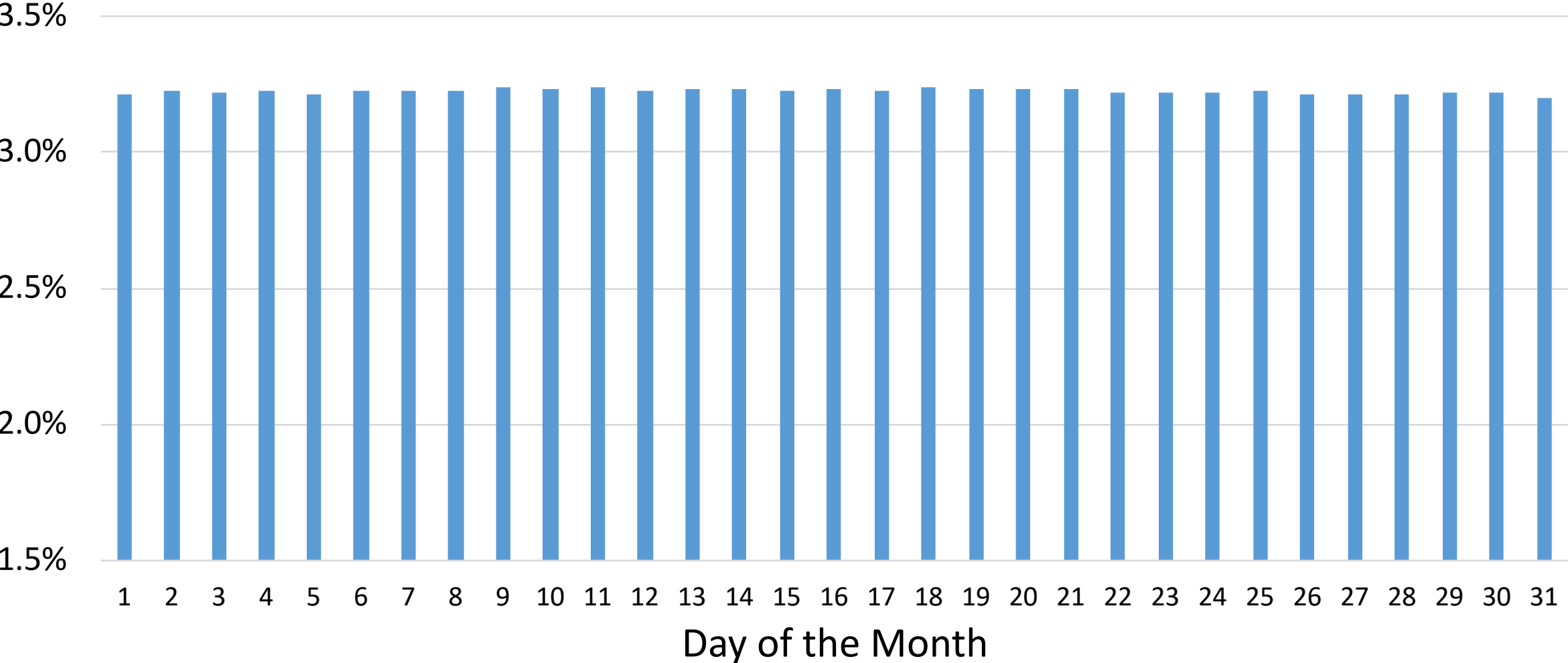
Using data from January 2012 to November 2016

Figure 7. Average Daily Applications Per Vacancy by Day of the Month, January 2012 to November 2016

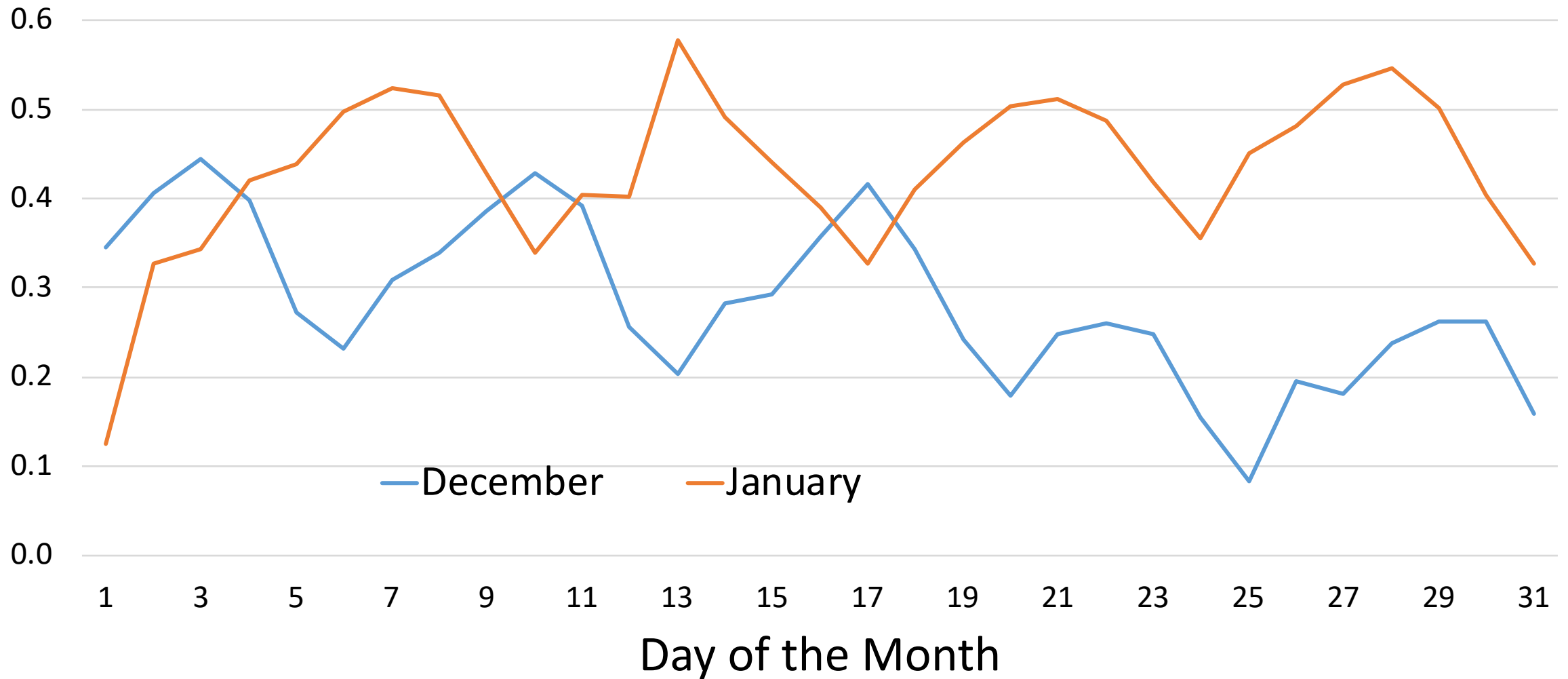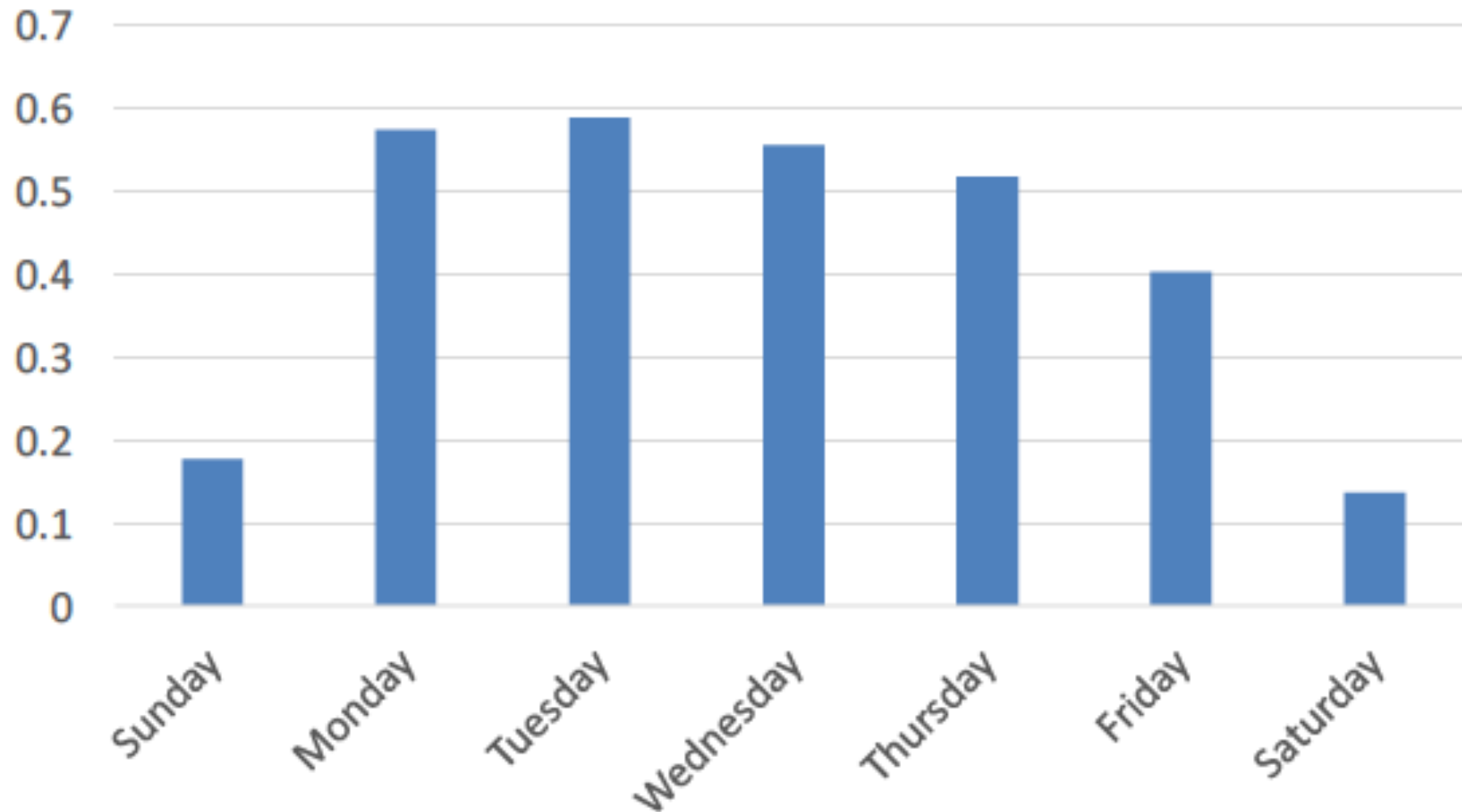Daily Applications per Vacancy by Day of the Month

Figure 8. Average Daily Applications Per Vacancy by Day of the Week, January 2012 to October 2016

Similarly, Krueger and Mueller (2010) find that job search activity is concentrated on weekdays. See Kudlyak et al. (2014) as well.

Concluding Remarks

1. The search and matching process, as documented here and in other recent research, differs sharply from the process embedded in leading theoretical models. In particular:

   - Employer-side search is non-sequential in nature.
   - Worker-side search also exhibits important aspects of non-sequential behavior.
   - There are important elements of stock-flow matching.
   - Recruitment firms, placement agents and staffing agencies play a large and growing role in the matching process.
     - For the software-related and technology-oriented jobs studied here, these intermediaries are involved in the the vast majority of "meetings."

2. Our evidence provides strong motivation for greater attention to models with non-sequential search, whereby job seekers and employers contact multiple potential partners before making decisions about whether, and with whom, to initiate an employment relationship.

- In contrast, leading equilibrium models of the search and matching process presume sequential search behavior.
- How much does the modelling choice between sequential and non-sequential search matter? And for which questions?
- We know already that labor market environments with non-sequential search involve a different set of externalities than environments characterized by sequential search. See Gautier (2002), Albrecht, Gautier and Vroman (2006) and Wolthoff (2018).

3. The "meeting" phase of the hiring process, during which employers solicit and accept applications, is far shorter than the "selection" phase, which entails screening and interviewing applicants, selecting one for a job offer, extending an offer, negotiating terms, and waiting for an accept/reject decision.

- Leading equilibrium models of search and matching focus on the meeting phase of the hiring process. The selection phase is instantaneous in the models and often involves only trivial decisions.
- Our preliminary evidence suggests that the strong procyclicality of vacancy durations reflects variation in length of the selection phase. We find no evidence of cyclicality in the length of the meeting phase.
- It appears that we don't really understand the mechanisms whereby market tightness determines the duration of vacancies.

4. Staffing agencies, recruitment firms and placement agents play major roles in the matching process. These intermediaries warrant study:

- Why are they so prevalent? (At least for the types of hard-skill jobs that predominate on Dice.com.)
- What economic functions do they perform? How do they add private value?
- What are their implications for matching efficiency?

5. Platform design can greatly affect the volume of meetings and their distribution over employers.

- When DHI improved the functionality of its Dice.com platform in December 2014, it led to large increases in the flow of applications to smaller employers but little or no change in the flow to larger employers.

- Thus far, labor economists have paid little attention to how platform design affects the search and matching process.

- They have also paid little attention to competition among platforms.

Extra Slides

Table 4. Summary Statistics for Frequently Posted Job Titles in the DHI Database

January 2012 to November 2016

(1) Minimum Posting Frequency	(2) Number of Job Titles	(3) Share of Job IDs	(4) Share of Vacancy IDs	(5) Share of Applications
250 Job IDs	1,580	66.6%	66.3%	73.6%
100 Job IDs	3,680	70.7%	70.2%	76.9%
50 Job IDs	7,122	73.8%	73.1%	76.9%

Figure 3. Mean Applications per Vacancy by Employer Size

Panel A. Direct Hire, All Standard Postings, Equal Weights
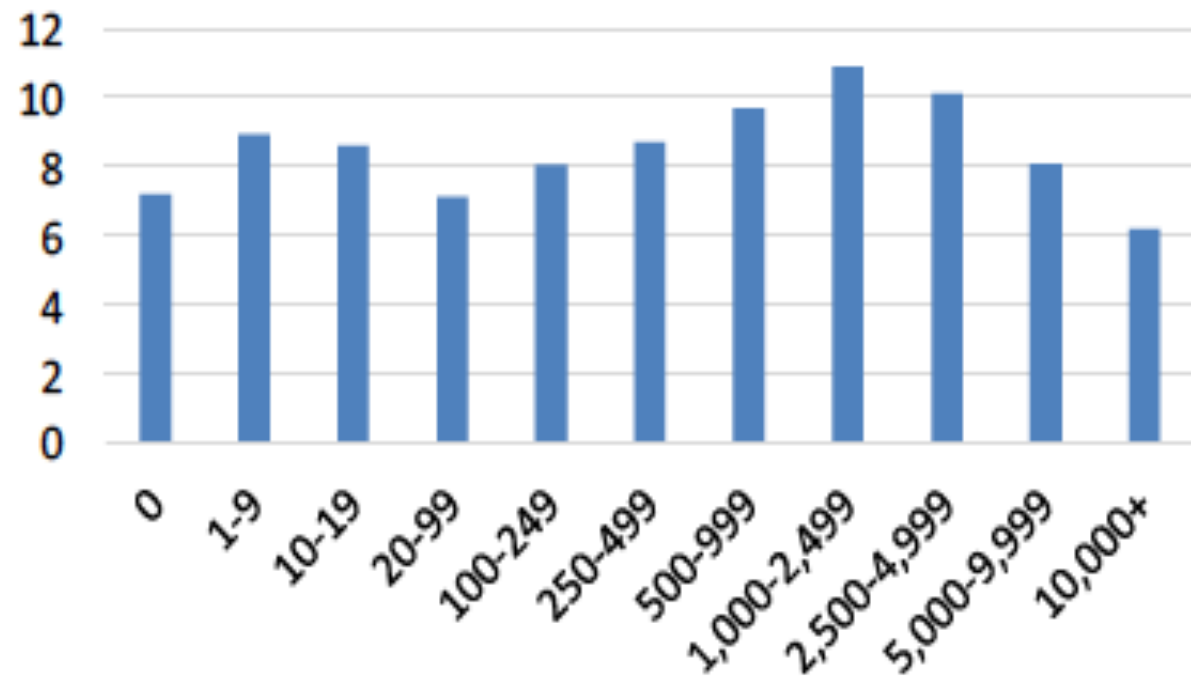
Panel B. Direct Hire, All Standard Postings, Weighted by Application Flows
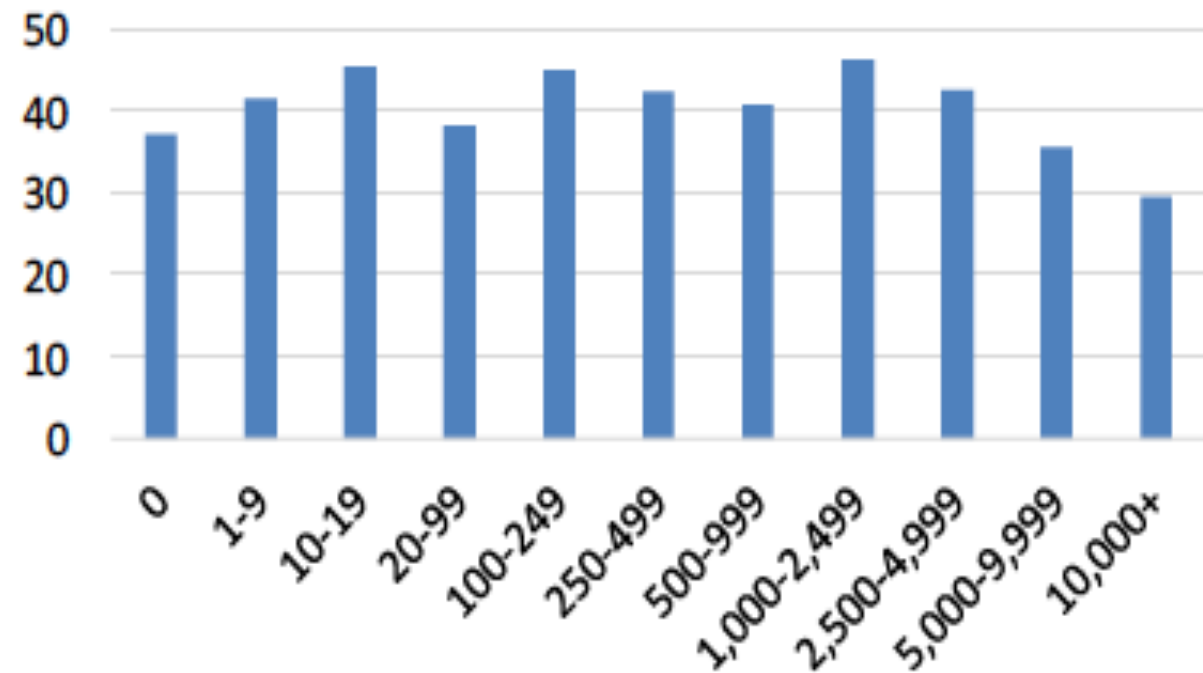
Applications Per Completed Posting Spell
54 Software-Related Skill Categories

	No. of Postings	Mean Applications per Completed Spell		Median Applications per Completed Spell	
	(1)	(2)	(3)	(4)	(5)
		Equal Weights	Application Weighted	Equal Weights	Application Weighted
Standard Postings with Frequently Required Skills	3,097,722	11.8	102.3	3	45
Selected Skills					
COBOL	10,248	18.1	46.2	11	31
HADOOP	19,022	28.8	111.1	10	78
SSIS	6,341	26.7	120.0	9	79
INFORMATICA	30,106	20.7	91.4	9	51
ABAP	2,222	17.0	52.7	9	35
ETL	42,649	20.6	90.2	8	53
COGNOS	17,749	13.4	45.9	7	29
SQL	98,961	18.9	100.8	6	60
SAP	200,146	11.3	38.1	6	24
SALESFORCE	58,242	20.3	105.0	5	73

	Mean Applications per Completed Spell			Median Applications per Completed Spell	
	(1)	(2)	(3)	(4)	(5)
	No. of Postings	Equal Weights	Application Weighted	Equal Weights	Application Weighted
BIGDATA	16,364	15.0	61.4	5	42
ORACLE	190,389	12.0	60.2	5	33
JAVA	318,005	21.0	196.9	4	114
DOTNET	195,973	18.3	165.8	4	96
IOS	22,535	16.9	74.9	4	60
SHAREPOINT	56,903	11.5	55.3	4	36
DATA	149,481	10.9	53.3	4	32
SAS	16,528	9.7	34.6	4	23
WINDOWS	44,251	8.60	37.87	4	22
HYPERION	12,342	8.49	27.68	4	19
LOTUS	2,797	5.55	13.54	4	10
USER INTERFACE	49,310	26.4	199.5	3	149
LINUX	41,383	10.6	72.4	3	48
MOBILE	38,349	10.4	63.7	3	39
C	67,934	9.37	81.87	3	30
UNIX	23,898	8.00	52.75	3	28
TIBCO	12,598	7.46	28.87	3	18
WEBSPHERE	19,996	7.30	35.58	3	21

	No. of Postings	Mean Applications per Completed Spell		Median Applications per Completed Spell	
	(1)	(2)	(3)	(4)	(5)
	No. of Postings	Equal Weights	Application Weighted	Equal Weights	Application Weighted
SYSTEMS	263,608	7.18	41.24	3	21
SOA	9,560	6.91	34.92	3	17
DATABASE	65,311	6.64	38.56	3	18
PEOPLESOFT	59,869	6.21	25.00	3	14
ABINITIO	6,070	5.63	24.83	3	13
PYTHON	16,702	10.3	50.8	2	37
JEE	10,886	10.3	101.6	2	56
CLOUD	27,347	9.8	86.9	2	41
NET	5,782	9.6	62.9	2	40
NETWORK	170,200	9.47	76.71	2	43
FINANCE	8,760	8.63	63.88	2	32
WEB	107,092	7.96	82.23	2	42
CISCO	20,067	6.52	66.72	2	27
PHP	23,850	6.48	34.10	2	23
SOFTWARE	205,712	6.45	45.97	2	21
DRUPAL	7,142	6.30	29.77	2	22

	No. of Postings	Mean Applications per Completed Spell		Median Applications per Completed Spell	
	(1)	(2)	(3)	(4)	(5)
	No. of Postings	Equal Weights	Application Weighted	Equal Weights	Application Weighted
VISUALBASIC	**11,497**	**6.22**	**43.99**	**2**	**17**
USER EXPERIENCE	20,221	5.81	49.19	2	18
IBM	21,383	5.64	29.86	2	16
APPLICATIONS	109,415	5.24	29.81	2	15
SECURITY	100,852	4.56	25.25	2	12
PERL	4,361	4.49	31.37	2	12
SOLUTION	44,042	4.48	22.78	2	11
DELPHI	861	3.95	15.04	2	8
MATLAB	502	3.60	15.53	2	8
RUBY	11,908	5.58	40.11	1	24