

SUPPLEMENT TO “JOB SEARCH BEHAVIOR AMONG THE EMPLOYED AND  
NON-EMPLOYED”

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R. JASON FABERMAN  
Federal Reserve Bank of Chicago

ANDREAS I. MUELLER  
Department of Economics, The University of Texas at Austin, NBER, CEPR, and IZA

AYŞEGÜL ŞAHİN  
Department of Economics, The University of Texas at Austin and NBER

GIORGIO TOPA  
Federal Reserve Bank of New York and IZA

APPENDIX A: SCE JOB SEARCH SUPPLEMENT DESIGN AND ADDITIONAL DETAILS

*A.1. Job Search Supplement Design, Administration, and Representativeness*

THIS APPENDIX DESCRIBES THE JOB SEARCH SUPPLEMENT OF THE SURVEY OF CONSUMER EXPECTATIONS (SCE), administered by the Federal Reserve Bank of New York. This section details the design and implementation of the supplement, while the next section details the survey questions most relevant to our analysis. We developed the Job Search Supplement ourselves and first fielded the survey in October 2013. We have fielded the survey every October since then and use a sample that pools the 2013–2017 responses together in our main analysis.

Our Job Search Supplement draws its respondents and its sample weights from the main monthly survey of the SCE. Consequently, understanding the survey design of the monthly SCE is integral to understanding the design of the Job Search Supplement. The main SCE is a monthly, nationally representative survey of roughly 1300 *heads of households* that asks respondents their expectations about various aspects of the economy. Armantier, Topa, van der Klaauw, and Zafar (2017) described the development, design, and implementation of the monthly SCE. Perhaps the most important thing to note about the monthly SCE is that respondents remain in the survey sample for up to 12 months, giving the monthly SCE a rotating panel dimension. Since we administer the Job Search Supplement once per year, however, our survey is a series of repeated cross sections.

Both the monthly SCE and Job Search Supplement are online surveys. Individuals are paid a modest amount to take each survey. Armantier et al. (2017) reported a survey response rate in the monthly SCE of 54 percent for individuals initially contacted to participate. The response rate of incumbent respondents in subsequent months ranges between 59 and 72 percent. They also showed that the weighted monthly SCE sample matches the demographic statistics of the American Community Survey (ACS) well. In fact, the monthly SCE sample is stratified and weighted to match the ACS, so this is essentially by construction.

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R. Jason Faberman: [jfaberman@frbchi.org](mailto:jfaberman@frbchi.org)  
Andreas I. Mueller: [andimueller@utexas.edu](mailto:andimueller@utexas.edu)  
Ayşegül Şahin: [aysegul.sahin@austin.utexas.edu](mailto:aysegul.sahin@austin.utexas.edu)  
Giorgio Topa: [giorgio.topa@ny.frb.org](mailto:giorgio.topa@ny.frb.org)

TABLE AI  
SUMMARY STATISTICS, SELECTED SURVEYS.

	SCE Job Search Supplement						Monthly SCE	CPS
	2013	2014	2015	2016	2017	Pooled		
<i>Number of Sample Observations</i>								
Total in survey	1378	1217	1065	1172	1119	5951	6804	—
Total in restricted sample	1105	966	831	896	861	4659	5273	198,228
<i>Labor Force Statistics (weighted population shares)</i>								
Employment-population ratio	77.0	73.2	78.1	78.6	75.7	76.5	74.9	74.9
Unemployment Rate (CPS definition)	7.1	4.9	3.1	3.6	2.9	4.5	6.2	4.5
Unemployment Rate (job search def.)	8.9	8.4	6.2	5.1	4.6	6.8	—	—
Labor force part. rate (CPS def.)	82.9	77.0	80.6	81.6	77.9	80.1	79.8	78.4
<i>Demographics (weighted population shares)</i>								
Percent male	48.7	48.7	49.1	45.6	49.0	48.3	48.2	48.7
Pct. White, non-Hispanic	76.8	71.6	68.8	69.7	74.0	72.3	72.5	63.0
Percent married	65.5	64.4	66.8	61.8	63.8	64.5	65.4	51.0
Pct. with college degree	32.1	32.2	34.3	34.4	35.8	33.7	33.5	34.7
Percent aged 18–39	35.5	33.4	36.4	36.0	34.4	35.1	35.6	39.2
Percent aged 40–54	36.2	33.5	36.9	38.7	36.5	36.3	37.4	35.9
Percent aged 55–64	28.3	33.1	26.7	25.2	29.2	28.6	27.0	24.9

*Note:* Estimates come from authors' tabulations from the October 2013–2017 waves of each listed survey: the SCE Job Search Supplement, the SCE Monthly Survey, and the Current Population Survey (CPS). The table reports the number of total observations in each survey (and survey year for the SCE Job Search Supplement) and the total number of observations and summary statistics for the sample restricted to heads of households aged 18–64, with nonmissing demographic and labor force data.

Table AI presents basic labor force and demographic statistics for the monthly SCE, our Job Search Supplement, and the Current Population Survey (CPS). All three surveys use a sample of respondents for each October between 2013 and 2017 that are restricted to heads of households (in the CPS) aged 18 to 64. The CPS serves as a nationally representative benchmark for comparison to the two SCE surveys. We additionally report summary statistics for each year of our survey separately. The table shows that both the Job Search Supplement and the main SCE sample have labor force statistics that are comparable to the CPS.<sup>1</sup> Relative to the CPS, the Job Search Supplement has a slightly higher employment-to-population ratio and the monthly SCE has a slightly higher share of unemployed, but the estimates are otherwise very similar. In terms of demographics, the SCE Job Search Supplement and monthly SCE are nearly identical to each other. Compared to the CPS, both surveys have a notably higher share of White respondents, older respondents, and married respondents. Consequently, we control for observable demographic characteristics throughout much of our analysis, including replicating many of our estimates conditional on these characteristics in Supplemental Appendix S-B.1.

<sup>1</sup>For the Job Search Supplement, Table AI reports the “CPS” definition of unemployment, with its measurement in the other two surveys, and the “Job Search” definition of unemployment, which is a broader measure that counts active search effort regardless of whether they report wanting work. See the next section for more details.

## A.2. Survey Format

We structured the Job Search Supplement's questionnaire into several sections, generally grouped by topic. The full supplement questionnaire is available through the Federal Reserve Bank of New York at <https://www.newyorkfed.org/microeconomics/databank.html>, and we list the specific survey questions relevant to our analysis in Supplemental Appendix S-A.1. The questionnaire starts with a section that asks basic questions on the respondent's current labor force situation, including whether or not they have looked for work in the last four weeks, and the type of work they are looking for. Many of these questions are nearly identical to labor force questions asked in the CPS. If an individual is employed, the survey follows up with a series of questions on the characteristics of their current job, including its hours, earnings, benefits, start date, industry, occupation, firm (and establishment) size, union status, and temporary/seasonal work status.<sup>2</sup> If an individual reports that they are self-employed, the survey has a set of questions on job characteristics that are tailored to self-employment. If an individual is not employed, the survey follows up with a variety of questions about the nature and duration of their non-employment spell (e.g., schooling, characteristics of any temporary layoff, etc.). It also asks about the characteristics of their most recent job (if they had one) in a similar manner to its questions about the job characteristics of the currently employed. Finally, it asks respondents to report the fraction of months over the prior five years they spent in various labor force states (employed, unemployed, in school, etc.). In our analysis, we use these variables to identify an individual's labor force status at the time of the survey interview and for various controls for job and worker characteristics, including their employment history.

For individuals who stated that they either looked for work or might take a (new or additional) job, "depending on the circumstances," the survey asks a series of questions about job search and any potential outcomes of that search. One of the main innovations of our survey relative to government-administered household surveys, like the CPS, is that we ask all individuals who meet this criterion about their job search, regardless of their current labor force status.<sup>3</sup> For the employed, the survey identifies whether their job search was for a new job or only for an additional job without leaving their current job. This section of the questionnaire begins with questions on reasons for job search and search methods used that are similar to those asked of the unemployed in the CPS. It then asks about specific metrics of search effort, namely, the number of applications sent in the previous four weeks and the hours spent searching in the seven days prior to the survey interview. From there, the survey asks a series of questions on any outcomes of this job search, including employer contacts, job interviews, and job offers. It asks several of these questions regardless of whether the respondent looked for work. When asking about job offers, the survey first asks whether the respondent received any offer in the previous four weeks. This allows us to generate a monthly offer rate to compare to other monthly labor market statistics. If there are none, the survey follows up and asks if they received any offers in the last six months. This provides us with a sufficient amount of job offers to examine since the survey is relatively small and job offers are infrequent.

For individuals who report at least one job offer, the survey asks a series of questions on the characteristics of the offer (or "best" job offer, if there was more than one). These

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<sup>2</sup>Several of these questions are only available from 2014 forward.

<sup>3</sup>Notably, we do not ask self-employed about job search since it is not clear whether job search for this group reflects the desire for a new employment transition (e.g., to formal employment), or for new business or work for their current self-employed profession.

ask about the same characteristics as those asked about the current job of the employed. The survey also asks how the job offer came about (e.g., directly contacting the employer, a referral, an unsolicited contact, etc.). It then asks respondents their labor force status at the time of the job offer. The survey then asks whether the job offer has been (or will be) accepted or rejected, and the reasons for acceptance or rejection. It also asks whether the job offer was for their current job (if currently employed). The survey follows this up with a series of questions on the job offer process (i.e., whether the respondent received a counter-offer from their current employer, whether there was any bargaining involved, and whether they had a good idea of what the potential new job paid), and also asks whether any potential offers were rejected before they could be made (i.e., whether they had any *unrealized* job offers).

The next section of the survey asks a series of questions on the respondent's reservation job values. These include eliciting a reservation wage, the respondent's desired hours worked (at their preferred wage), and how much the respondent's reservation wage would have to change to accept adverse job characteristics (relocation, longer commute, longer hours, or a lack of benefits), with an option that the respondent would "not accept such a job" with the adverse job characteristic at any wage. It asks these questions to all respondents who stated that they looked for work or might want a (new or additional) job.

For those who are employed at the time of the survey, the survey asks a series of retrospective questions about how they were hired to their current job. These include questions about the job search process similar to those asked about their recent job search (i.e., applications sent, contacts received, offers received, etc.). It also includes questions about their starting wage, their employment status at the time of hire, and a set of questions on the wages, hours, and other characteristics of their previous job (if any).

Finally, the survey asks about a variety of miscellaneous labor market and household questions. These include questions about any transfer payments received (e.g., disability or unemployment benefits), household composition, and spousal employment and income.

### A.3. *Relevant Survey Questions*

*LFS at time of survey.* We highlight several specific survey questions that are relevant for our identification of labor force status and "active" search effort. We also highlight the specific questions regarding several aspects of the job offer process. First, we define labor force status in a similar manner to the CPS. That is, an individual is employed if they worked for pay at the time of the survey. They are unemployed if they were not employed and actively looked for work in the last four weeks and respond that they are available to start work, or if they were on temporary layoff. The CPS only asks about actively looking for work if an individual states that they "want work," while our survey asks about active search regardless. Consequently, we can capture a wider definition of job search and thus unemployment than in the CPS. We evaluate how using the alternate definitions of unemployment affects our results in Supplemental Appendix S-B.

We define *active search* identically to the official BLS definition. That is, we base it on the respondent's answers to their job search methods used in the previous four weeks. If a respondent only "looked at job postings," online or elsewhere, or updated their resume, without taking any additional action to look for work, they are counted as *passively* looking for work and are therefore not counted as unemployed. Our survey has additional information on whether an individual sent a job application in the previous four weeks, which satisfies the "active search" criterion. We therefore count all individuals who sent

at least one job application as actively searching regardless of what they report for their job search methods used.

*LFS at time of offer.* The survey allows us to identify respondents' labor force status at the time they received their job offer. The survey question only asks if they were employed full-time, employed part-time, or not employed at the time of the offer. From 2014 forward, the survey follows up and asks if they were looking for work at the time of the offer. As it turns out, nearly all of the non-employed report looking for work at the time of the offer. Given this, along with the fact that we do not have additional information on "active search" and availability for these respondents, we consider them as unemployed at the time of the offer for most of our analysis.

*Search effort.* The survey's questions on search effort are straightforward and directly ask about what we consider an *intensive* margin of search intensity. With regard to job applications, the survey asks all individuals excluding the self-employed, "*How many potential employers, if any, did you apply to for employment within the LAST 4 WEEKS?*" The survey makes clear that the respondent should include all formal applications, including those made online or in person. With regard to time spent on job search, the survey asks all individuals that report engaging in some job search within the last four weeks, "*And within the LAST 7 DAYS, about how many TOTAL hours did you spend on job search activities?*" We use the answers to these questions as the direct measures of search effort in our analysis.

*Job offers.* The survey asks a variety of questions on the characteristics of any job offer received. The questions are the same regardless of whether the offer was received in the previous four weeks or the last six months. Since surveys that ask about job offers are rare, we describe our questions regarding job offers in detail. First, the survey asks about the number and timing of any job offers received, as well as the respondent's labor force status at the time of the offer. Then it asks a series of questions on basic job offer characteristics. These are essentially identical to the job characteristics questions asked of the currently employed. It also asks whether the respondent has accepted or rejected (or will accept or reject) the job offer; it asks the respondent to identify the reasons for acceptance or rejection; and it asks about the search methods related to how the offer came about. For the latter, the survey offers an option for an unsolicited job offer (i.e., the offer came through an "*unsolicited contact by potential employer, recruiter, or headhunter*"). Finally, the survey asks a series of questions on the bargaining process. These questions are tailored to address facets of job offer acceptance characterized in many models of labor market search, such as wage bargaining and counter-offers by a job seeker's current employer, that have previously had little guidance from the data (e.g., Cahuc, Postel-Vinay, and Robin (2006), among others). Specifically, the survey asks respondents if they had a "good idea" of what the job paid prior to receiving the offer, with possible answers ranging from "knew exactly" what the job would pay to having "no idea" what it would pay. The survey also asks if there was any *bargaining* over the job offer's pay, or if the potential employer instead made the respondent a "take-it-or-leave-it offer." For those who were employed at the time of the offer, the survey asks about any actual or potential counter-offers. Specifically, it asks if their current employer either did or would have matched the wage offered by the potential employer, with a followup to ask if the respondent was able to secure any "*promotion, pay increase, or increase in benefits*" as a result of the outside job offer. Finally, the survey asks about what we refer to in the main text as *unrealized* job offers potentially made to the respondent. Specifically, the survey asks if "*In the LAST 4 WEEKS, have any employers indicated that they would be willing to make you a job offer, but you indicated that you were not interested?*" We consider any individuals who respond "Yes" to this question as receiving an unrealized job offer.

## APPENDIX B: MEASURING LABOR FORCE STATUS IN THE PRIOR MONTH

## B.1. Prior Month's Labor Force Status Based on the SCE Labor Supplement

This appendix details our methodology for determining labor force status in the prior month and evaluates our measure along several comparable dimensions. We derive a labor force status for individuals four weeks prior to their survey interview using a range of survey responses from the SCE Job Search Supplement. We use this measure in our model calibration because it treats the search effort and offer arrivals reported in the survey as subsequent outcomes based on this initial labor force status. This timing is consistent with most models of labor market search and addresses time aggregation and related selection issues.

Figure B1 details how we assign individuals to one of three states—employed ( $E$ ), unemployed ( $U$ ), or out of the labor force ( $N$ )—for their labor force status four weeks prior. As the figure shows, we draw from multiple survey questions to identify their labor force status. For reference, the figure notes the specific survey questions, as labeled in the Job Search Supplement's online questionnaire, used at each stage of the identification process.<sup>4</sup> We first check to see if an individual received an offer in the four weeks prior to

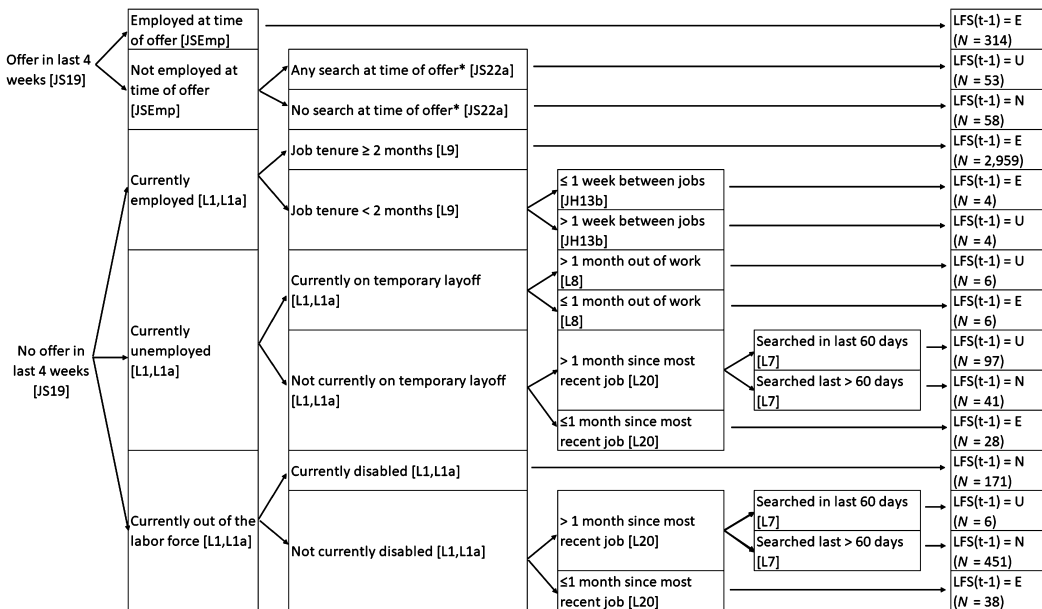


FIGURE B1.—Measuring labor force status in the prior month. *Notes:* The figure details our methodology for identifying labor force status four weeks prior to the SCE Job Search Supplement survey. Individuals are identified as either employed ( $E$ ), unemployed ( $U$ ), or out of the labor force ( $N$ ), as noted in the rightmost boxes of the figure. The number of observations identified by each branch of the methodology is shown in parentheses. Codes in brackets refer to the question identifier in the SCE Job Search Supplement questionnaire (available at: <https://www.newyorkfed.org/microeconomics/databank.html>). \*For the 2013 survey wave, question JS22a was not asked, so we use a slightly different identification approach. See the text for details.

<sup>4</sup>The complete survey questionnaire for the SCE Job Search Supplement is available online through the Federal Reserve Bank of New York at <https://www.newyorkfed.org/microeconomics/databank.html>. Appendix A of the Supplemental Material has additional detail on selected questions, and we list all questions used in Supplemental Appendix S-A.

the survey. If so, we assign the labor force status at the time they received their job offer (employed or non-employed). This approach assumes that labor force status did not change between the time they received their job offer and four weeks prior to the labor supplement survey. We believe this is a reasonable assumption given the relatively short time interval. From 2014 forward, we have additional information on whether the respondent was actively searching at the time they received their offer. If so, we count them as unemployed, and if not, we count them as out of the labor force. For those in the 2013 wave, we make some modest assumptions to determine whether the respondent was unemployed or out of the labor force. If the respondent was employed at the time of the survey, we assume that they were actively searching and count them as unemployed. If they were unemployed at the time of the survey and have been searching for over four weeks, we also count them as unemployed. Otherwise, we count them as out of the labor force in the previous month. We identify 9 percent of the prior month's labor force status through their labor force status at the time of a job offer.

For the remaining individuals, we determine their prior month's labor force status starting with their labor force status at the time of the survey. The vast majority of respondents are currently employed with a job tenure greater than two months, and we identify these individuals as employed in the same job in the prior month. We identify the remaining handful of those employed at the time of the survey as either employed (via a job-to-job transition) or unemployed based on the time spent between their current and previous job.

If the respondent was unemployed at the time of the survey and did not receive an offer in the last four weeks, we first separate them based on whether or not they are on temporary layoff. We only have 12 respondents on temporary layoff in our sample. We assign them a labor force status based on their reported time out of work, with those out for less than a month counted as employed in the prior month (i.e., recent layoff) and those out for more than a month counted as unemployed in the prior month. We assign the prior month's labor force status for the remaining unemployed based on their time out of work and reported amount of time looking for work. For those out of work for less than a month, we assign them as employed in the prior month (recent job loser). For the remaining, if they have looked for work for at least 60 days, we assign them as unemployed, and if they report looking for less than that (including not at all), we assign them as out of the labor force. Just over half of all those unemployed at the time of the survey have looked for at least 60 days. We identify just under a quarter as out of the labor force in the prior month, and just over 15 percent as recent (permanent) job losers.

Finally, if the respondent was out of the labor force at the time of the survey and did not receive an offer in the last four weeks, we separate them based on whether they reported that they were disabled at the time of the survey (in which case we assume they were disabled last month), and if not, we identify them based on the length of their non-employment spell and whether they looked for work in the last 60 days. These account for about one-quarter of all those currently out of the labor force. If an individual was not disabled but only out of work for one month or less, we identify them as employed four weeks prior. For the remainder, we count them as employed if their current non-employment spell is one month or less. We count them as unemployed if their current non-employment spell is greater than a month but they reported looking for work for at least 60 days—this represents only a handful of observations, however. The remainder are those whose non-employment spell is greater than a month and did not look for work in the last 60 days (if at all), and therefore counted as out of the labor force in the prior month. These represent the bulk of those who were out of the labor force at the time of the survey (68 percent) and a large portion of the full sample (just under 10 percent).

TABLE BI  
MONTHLY LABOR MARKET TRANSITION RATES BY LABOR FORCE STATUS.

	Transition Probability to		
	Employment	Unemployment	OLF
(a) SCE Job Search Supplement			
Labor Force Status in Prior Month			
Employed	0.969	0.009	0.022
Unemployed	0.196	0.526	0.277
Out of the Labor Force	0.016	0.045	0.939
(b) Current Population Survey			
Labor Force Status in September			
Employed	0.961	0.011	0.028
Unemployed	0.243	0.521	0.237
Out of the Labor Force	0.044	0.023	0.933

*Note:* The top panel reports the labor force transition rates using the October 2013–2017 waves of the SCE Job Search Supplement. It uses the methodology described in the appendix to determine the previous months' labor force status and uses the CPS definition of unemployment for labor force status at the time of the survey. The bottom panel reports the labor force transition rates from the CPS using data matched across September and October of 2013–2017.

### B.2. Evaluation of Imputation of Prior Month's Labor Force Status

Evaluation of this approach suggests that our methodology produces a sensible measure of the prior month's labor force status along several dimensions. First, our estimates imply an employment-to-population ratio of 0.779, an unemployment rate of 4.8 percent, and a labor force participation rate of 81.8 percent. All are very close to the current-month estimates for the pooled SCE Job Search Supplement, and are roughly comparable to the monthly SCE and CPS estimates in Table AI of Appendix A of the Supplemental Material.

Second, Table BI shows that the monthly transition rates we obtain using our imputed prior-month labor force status and the labor force status at the time of the survey are comparable to those estimated from the CPS over the same period (i.e., between September and October in 2013 through 2017). The job-separation rates into unemployment and out of the labor force are nearly identical. Our sample has a slightly lower job-finding rate for the unemployed and a notably lower job-finding rate for those out of the labor force.<sup>5</sup> Transitions between unemployment and being out of the labor force are roughly comparable between the two surveys.

Third, we can compare the results we obtain on search outcomes using our imputed labor force status in the prior month with the prior month's labor force status implied by the monthly SCE data we have for the respondents in our sample. There is a timing issue with this approach because individuals may respond to the SCE Job Search Supplement anywhere from a few days to nearly two months after their most recent monthly SCE interview. To deal with this, we assign a prior month's labor force status to individuals in the labor supplement based on the timing between the Job Search Supplement and their September monthly SCE interview. If the gap between interviews is 22 days or

<sup>5</sup>Note that these rates differ somewhat from the transition rates used in the main analysis. These rates are based on whether the respondent reports being employed at the time of the survey, while the rates we use in our analysis are the product of job offer rates and acceptance rates. Timing differences and respondent inconsistencies account for the small differences.



TABLE BII  
SEARCH OUTCOMES BY PRIOR MONTH'S LABOR FORCE STATUS, BASED ON MONTHLY SCE.

	Employed	Unemployed	OLF
<i>Labor Force Status in August/September, Monthly SCE</i>			
<i>Search Outcomes</i>			
Fraction with at least one offer	0.113 (0.006)	0.266 (0.036)	0.088 (0.011)
Fraction with at least one unsolicited offer	0.033 (0.003)	0.026 (0.013)	0.024 (0.006)
Fraction with at least one offer, including unrealized offers	0.157 (0.007)	0.284 (0.037)	0.107 (0.011)
<i>Search Outcomes, Ignoring Offers for Additional Jobs</i>			
Fraction with at least one offer	0.090 (0.005)	0.266 (0.036)	0.088 (0.011)
Fraction with at least one unsolicited offer	0.029 (0.003)	0.026 (0.013)	0.024 (0.006)
Fraction with at least one offer, including unrealized offers	0.132 (0.006)	0.284 (0.037)	0.107 (0.011)
<i>N</i>	2954	149	725

*Note:* Estimates come from authors' tabulations from the October 2013–2017 waves of the SCE Job Search Supplement, using respondents' labor force status reported in either the August or September waves of the monthly SCE survey, for all individuals aged 18–64, excluding the self-employed. Standard errors are in parentheses.

more, we use their September labor force status from the monthly survey. If the gap is 21 days or less, or if the September data are missing, we use their August labor force status. We adjust all estimates of search outcomes so that they can be interpreted as monthly rates.

Table BII replicates the bottom panels of Table IV of the main text using prior month's labor force status based on the monthly SCE data. The table shows that the estimates are very similar to those estimated using our imputed prior month's labor force status. Offer rates are somewhat lower for the unemployed using the monthly SCE measure, but otherwise, the two measures produce nearly identical estimates for search outcomes.

#### APPENDIX C: SEARCH EFFORT ESTIMATES IN THE SCE AND ATUS

In this appendix, we compare our estimates of the time spent searching for work to estimates from the time diaries of the American Time Use Survey (ATUS). The ATUS is a *time use survey* which was designed to measure how people divide their time among various activities. ATUS statistics are based on interviews of individuals who are randomly selected from a subset of households that have completed their eighth month of interviews for the Current Population Survey (CPS). ATUS respondents are interviewed only one time about how they spent their time on the *prior day*, while the SCE respondents report their search activity for the *prior week*. In this section, we generate comparable weekly job search estimates from the ATUS.

We first report the extensive and intensive margins of search activity by labor force status in the ATUS and the SCE in Table CI without adjusting ATUS's daily estimates into weekly statistics. Specifically, the first panel reports the ATUS statistics that are based

on time use during the *prior day* and the second panel reports the SCE-based statistics for job search activity that respondents report for the *prior week*. In principle, the daily versus weekly nature of the two surveys should not lead to any differences averages of search time at the group level, as daily differences average out across individuals and should add up to the same weekly time use (i.e., if multiplied times 7). However, the distinction between daily and weekly time use statistics is more difficult when comparing the extensive margins of job search in the ATUS and the SCE, as it is not clear whether job seekers who searched on one day of the week also searched on the other days of the week or whether job seekers concentrate their search activity on a given day of the week. We compare the intensive and extensive margins of search in the ATUS and SCE carefully and devise a simple model to provide comparable weekly statistics for the ATUS.

Table CI reports that only 0.6 percent of the employed report any time spent searching on a given day in the ATUS, but 21.3 percent of the employed report searching within

TABLE CI  
TIME SPENT SEARCHING FOR WORK, ATUS AND SCE JOB SEARCH SUPPLEMENT.

	Employed	Unemployed	OLF
<i>I. ATUS, prior-day estimates</i>			
% reporting time spent searching for work, prior day	0.61	16.45	0.73
Average mins spent searching, prior day, all	0.95	26.92	1.29
Average mins spent searching, prior day, only searchers	157.0	163.6	177.3
Relative search intensity	0.035	1	0.048
<i>II. SCE, search in last 7 days</i>			
% reporting time spent searching for work, last 7 days	21.3	97.4	8.9
Average mins spent searching, last 7 days, all	69.6	687.9	36.1
Average mins spent searching, last 7 days, only searchers	326.5	706.2	406.8
Relative search intensity	0.101	1	0.052
<i>III. ATUS, range of weekly estimates (no adjustment for secondary activities)</i>			
% reporting time spent searching for work	0.6 to 4.3	16.5 to 100	0.7 to 5.1
Average mins spent searching, all	6.7	188.4	9.0
Average mins spent searching, only searchers	157.0–1099.0	188.4–1145.3	177.3–1241.1
Relative search intensity	0.036	1	0.052
<i>IV. ATUS, imputed weekly estimates based on UK data (no adjustment for secondary activities)</i>			
% reporting time spent searching for work	3.7	80.9	NA
Average mins spent searching, all	6.7	188.4	NA
Average mins spent searching, only searchers	181.1	232.9	NA
Relative search intensity	0.036	1	NA
<i>V. ATUS, imputed weekly estimates based on UK data (with adjustment for secondary activities)</i>			
% reporting time spent searching for work	4.4	91.4	NA
Average mins spent searching, all	8.0	212.9	NA
Average mins spent searching, only searchers	181.1	255.7	NA
Relative search intensity	0.038	1	NA

*Note:* Estimates come from authors' tabulations from the 2013–2017 waves of the American Time Use Survey (top panel) and the October 2013–2017 waves of the SCE Job Search Supplement (bottom panel), for all individuals aged 18–64, by labor force status. The SCE estimates use the BLS definition of unemployment for determining labor force status. The estimates for the UK are based on the United Kingdom Time Use Survey, 2014–2015 (UKTUS).

the last *seven* days in the SCE. While these statistics are not comparable due to the different time frame of the two surveys, comparison of the unemployed in the two surveys reveals an important feature of job search. By definition, unemployed respondents in the ATUS report having searched for work in the last four weeks. However, only 16.5% of them report searching for work in the previous day in their time diary. This observation suggests that even unemployed individuals search for work intermittently. This contrasts with activities done with regularity, such as sleeping or eating.

Table CI also reports the average weekly search time for both surveys. The ATUS estimates are substantially lower than the SCE estimates. For example, the ATUS daily estimates imply that the employed on average spend 6.7 minutes per week searching for work, while the SCE weekly estimates imply that on average the employed spend 70 minutes per week searching for work. If we restrict our attention to those with positive search time, in the ATUS the employed spend 157 minutes (2.6 hours) per day on job search, and in the SCE the employed spend 327 minutes (5.5 hours) per week on job search.

Imputing weekly estimates of the extensive margin of job search in the ATUS depends on whether the same group of job seekers look for work every day or if they do so less frequently. In light of these observations, we provide an interval for the implied weekly extensive and intensive margins for the ATUS in the third panel of Table CI. There are two extremes that define the interval. In one extreme, we assume that all who report looking for work are *steady searchers*. That is, the same group of individuals look for work every day of the week. In this case, 0.6% of the employed search every day, with an average weekly search time of 1099 minutes, while 16.5% of the unemployed search every day, with an average weekly search time of 1145 minutes. In the other extreme, we assume that those who report looking for work are *intermittent searchers*. That is, they search only once per week, so that daily search estimates represent a different group of individuals each day. In this case, 4.3% of the employed search each week with a weekly search time of 157 minutes and 100% of the unemployed search each week with a weekly search time of 188 minutes. Note that intermittent nature of job search does not affect the average weekly minutes of search, but it affects the extensive margin of search at the weekly horizon and the average minutes searching *conditional* on searching at the weekly horizon.

The actual weekly amount of time spent searching for work implied by the ATUS time diary responses likely lies somewhere between these extremes, with some job seekers *steadily* looking for work and other job seekers searching *intermittently*. There is no survey that interviews respondents in seven consecutive days for us to elicit information about their frequency of their job search for the United States. However, the United Kingdom Time Use Survey (UKTUS) repeats its time-use interview over two consecutive days, providing some information on respondents' job search behavior that helps identify the prevalence of steady and intermittent job seekers.<sup>6</sup>

*Evidence from the UKTUS.* According to the UKTUS, only 16.7 percent of the employed who looked for work on the first day of the interview subsequently reported looking for work on the second day in 2014–2015. Among the unemployed, 35.0 percent of respondents who searched on the first day also searched on the second day. These observations further support that job search is intermittent, even more so for the employed.

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<sup>6</sup>The UKTUS is a large-scale household survey that provides data on how people aged 8 years and over in the UK spend their time. Similarly to the ATUS, it is based on a time diary instrument in which respondents record their daily activities. This document uses the Multinational Time Use Study, Centre for Time Use Research, University College London 2019 at <http://www.timeuse.org/mtus/reference.html>.

Moreover, the ATUS only records a respondent's time spent on their *primary activity*. Thus, if an individual is literally searching while on the job or searching while engaging in some other primary activity, it will likely not show up as search time. The UKTUS asks respondents about primary and secondary activities: around 0.5% of the employed report searching for a job as a primary activity, and adding individuals who search as their secondary activity increases this by 20 percent to 0.6%. For the unemployed, job search as a secondary activity increases the fraction of searchers from 17.7% to 20.0% in the UKTUS.

*A model of daily and weekly participation in job search.* We use the additional moments from the UKTUS along with the ATUS data to derive estimates of weekly job search activity assuming that job search behavior is similar in the two surveys.<sup>7</sup> The underlying assumptions are: (i) there are two types of searchers: *steady* or *intermittent* job seekers; (ii) individuals observed searching two days in a row are *steady* job seekers who search every day; (iii) individuals who do not search two days in a row are *intermittent* job seekers who search only once per week and could therefore be randomly observed looking for work on any day of the week.

Let  $\pi_j^{\text{day}}$  be the fraction of people in labor force status  $j$  who search on a given day (and similarly for  $\pi_j^{\text{week}}$ );  $s_j^{\text{day}}$  be the average daily search time for labor force status  $j$ , conditional on active search (and similarly for  $s_j^{\text{week}}$ ); and  $\mu_j^{\text{uk}}$  be the fraction of steady searchers in state  $j$ . Our assumptions on the distribution of steady and intermittent searchers imply that the fraction of individuals who look for work over a weekly interval is

$$\pi_j^{\text{week}} = \mu_j^{\text{uk}} \pi_j^{\text{day}} + 7(1 - \mu_j^{\text{uk}}) \pi_j^{\text{day}}. \quad (\text{C1})$$

Using this formulation with the daily ATUS statistics implies that 3.7% of the employed and 80.9% of the unemployed looked for work each week. Given the average weekly search time,  $\bar{s}_j^{\text{week}} = 7\bar{s}_j^{\text{daily}}$ , we compute the average weekly search time conditional on active search as  $s_j^{\text{week}} = \frac{\bar{s}_j^{\text{week}}}{\pi_j^{\text{week}}}$ , which amounts to 181 minutes for the employed and 233 minutes for the unemployed.

The fifth panel of Table CI also adjusts the extensive margin of individuals actively looking for work to account for (unreported) job search as a secondary activity. Using the statistics on secondary activities from the UKTUS increases the daily fraction of those actively looking from 0.61% to 0.73% for the employed and from 16.5% to 18.6% for the unemployed. Using equation (C1) with these estimates implies that 4.4% of the employed and 91.4% of the unemployed look for work each week.<sup>8</sup> The average search time per week for all searchers also increases to 8 minutes for the employed and 213 minutes for the unemployed.

We conclude that while the aggregation from daily to weekly statistics closes the gap between the two surveys for the extensive margin for the unemployed, the ATUS still fails to match the extensive margin of on-the-job search we observe in the SCE. On the intensive margin, the ATUS underestimates search activity relative to the SCE for both the employed and unemployed. As a result, the differences in average search time (i.e., extensive and intensive margins combined) are even larger, especially for the employed due to the large extensive margin differences.

<sup>7</sup>Note that UKTUS statistics that are based on primary day only are very close to the ATUS statistics.

<sup>8</sup>Our results are also consistent with Braun (2021) who assumes that all searchers are intermittent and finds that about 16.7 percent of the employed engage in job search over a *month*.

*Relative search intensity.* The ATUS also gives biased estimates of the relative search intensity of the employed to the unemployed. Indeed, we find that the ATUS estimates of job search imply that the employed search only around 3.8 percent as intensely as the unemployed, while the SCE estimates of job search imply that they search 10.1 percent as intensely as the unemployed. This difference matters for the composition of aggregate search effort in the economy. Let us define  $S^T$  as the total aggregate efficiency units of job search, which is computed by weighting individuals in each labor force state  $E$ ,  $U$ , and  $N$  by their search intensity relative to the unemployed,  $s^e$  and  $s^u$  (with  $s^u = 1$  by definition). Aggregate efficiency units of job search in this case are  $S^T = s^e E + U + s^u N$ . If we consider the time period we analyze, there were 149 million employed, 9 million unemployed, and 93 million out of the labor force, on average over the 2013–2017 period. If we combine these numbers with the relative search intensities from the ATUS, they imply that on-the-job search makes up only 29 percent of aggregate search effort, while search among the unemployed accounts for 46 percent. If we instead use the relative search intensities from the SCE data, it implies that on-the-job search makes up 52 percent, and search by the unemployed makes up 31 percent of aggregate search effort. Thus, our broader and more direct measure of search intensity suggests not only a greater level of on-the-job search, but also a greater degree of *relative* search effort for the employed. If one wants to calculate effective labor market tightness taking into account the search intensity of employed and nonparticipants—such as in [Eeckhout and Lindenlaub \(2019\)](#) and [Abraham, Haltiwanger, and Rendell \(2020\)](#)—our estimates provide a direct estimate.

To summarize, there are two important measurement differences between the ATUS and the SCE with regard to job search. First, time use surveys do not prompt participants to report their search activity, but instead simply ask participants to report how they spent their previous day, which may lead respondents to under-report smaller episodes of job search. This seems particularly relevant for the employed and may account for the large discrepancy in the extensive margin for the employed between the ATUS and the SCE. Second, the ATUS does not account for job search activity unless it is the respondent's primary activity, which again is somewhat more relevant for the employed. Overall, we conclude that the survey mode and to a lesser extent the absence of secondary activities is likely to lead to a downward bias in estimates of average search activity in the ATUS and this particularly so for the employed. This is also consistent with the literature on time use surveys, which emphasizes the difficulty of accurately assessing the prevalence and intensity of intermittent and secondary activities in the context of home production.<sup>9</sup> Given these issues, we believe that our estimates of search effort provide a more comprehensive and reliable measure than the ATUS.

#### APPENDIX D: MODEL APPENDIX

In this section, we provide additional details regarding the model. First, we simplify the value functions and provide the first-order conditions. Second, we define the stationary equilibrium. Third, we show the details of how we solve for the equilibrium and compute the model moments for the calibration exercise. Finally, we provide a robustness analysis and additional results.

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<sup>9</sup>See for example, [Floro and Miles \(2003\)](#) who argued that the time spent on activities such as childcare and housework, which are also performed secondary activities, is seriously underestimated in the time use surveys.

## D.1. Value Functions and First-Order Conditions

Using the Nash-bargaining solutions in the paper (equations (4) and (5)), one can simplify the value functions as follows. The joint value of a match can be rewritten as

$$\begin{aligned}
K(y, x) = & \max_{\tilde{s}_e \geq s \geq 0, R_\delta, R_e} \left\{ pyx - c_e(s)x \right. \\
& + \frac{1}{1+r} \left[ K(y, x) - [\delta(x) + \tilde{\delta}_0(x, \theta)](K(y, x) - U(x) - V) \right. \\
& + \tilde{\delta}_0(x, \theta) \int_{R_\delta} \tau_u(K(n, x) - V - U(x)) dF(n) \\
& \left. \left. + \tilde{\lambda}_e(s, x, \theta) \int_{R_e} [\tau_e(K(n, x) - K(y, x)) + (1 - \tau_e)V] dF(n) \right] \right\}. \quad (D1)
\end{aligned}$$

The value of unemployment can be rewritten as

$$\begin{aligned}
U(x) = & \max_{\tilde{s}_u \geq s \geq 0, R_u} \left\{ bx - c_u(s)x \right. \\
& \left. + \frac{1}{1+r} \left[ U(x) + \lambda_u(s, \theta) \int_{R_u} (\tau_u(K(n, x) - U(x) - V)) dF(n) \right] \right\}. \quad (D2)
\end{aligned}$$

The value of a vacancy can be rewritten as

$$\begin{aligned}
V = & -c + \frac{1}{1+r} \left[ V \right. \\
& + q(\theta) \sum_x \pi(x) \left( \frac{u(x)}{S} \lambda_u(s_u(x)) \int_{R_u(x)} (1 - \tau_u)(K(n, x) - U(x) - V) dF(n) \right. \\
& + \frac{1 - u(x)}{S} \tilde{\delta}_0(x) \int_{R_\delta(x)} (1 - \tau_u)(K(n, x) - U(x) - V) dF(n) \\
& + \frac{1 - u(x)}{S} \int \tilde{\lambda}_e(s_e(\hat{y}, x), x) \int_{R_e(\hat{y}, x)} (1 - \tau_e) \\
& \left. \left. \times (K(n, x) - K(\hat{y}, x) - V) dF(n) dG(\hat{y}|x) \right) \right]. \quad (D3)
\end{aligned}$$

Given these simplified value functions, the first-order condition w.r.t.  $s$  for employed and unemployed individuals, respectively, are

$$\begin{aligned}
(1+r)c'_e(s_e(y, x))x = & \tilde{\lambda}_e^s(s_e(y, x), x, \theta) \\
& \times \int_{R_e(y, x)} [\tau_e(K(n, x) - K(y, x)) + (1 - \tau_e)V] dF(n), \quad (D4)
\end{aligned}$$

$$(1+r)c'_u(s_u(x))x = \lambda_u^s(s_u(x), \theta) \int_{R_u(x)} \tau_u[K(n, x) - U(x) - V] dF(n), \quad (D5)$$

and the first-order conditions for the reservation productivities are

$$K(R_\delta(x), x) = U(x) + V, \quad (\text{D6})$$

$$K(R_u(x), x) = U(x) + V, \quad (\text{D7})$$

$$K(R_e(y, x), x) = K(y, x) - \frac{1 - \tau_e}{\tau_e} V. \quad (\text{D8})$$

Together with the zero-profit condition, this implies that  $R_e(y, x) = y$  and  $R_\delta(x) = R_u(x)$ .

### D.2. Stationary Distribution and Equilibrium

For a given type  $x$ , the steady-state unemployment rate,  $u(x)$ , is pinned down by equalizing the inflow and outflows as follows:

$$u(x)\lambda_u(s_u(x), \theta)[1 - F(R_u(x))] = (1 - u(x))[\delta(x) + \tilde{\delta}_0(x, \theta)F(R_\delta(x))]. \quad (\text{D9})$$

For a given type  $x$ , the steady-state distribution of workers across  $y$ ,  $G(y|x)$ , is pinned down by equating employment inflows and outflows as follows:

$$\begin{aligned} & u(x)\lambda_u(s_u(x), \theta)[F(y) - F(R_u(x))] + (1 - u(x))\tilde{\delta}_0(x, \theta)[F(y) - F(R_\delta(x))] \\ &= (1 - u(x))[\delta(x) + \tilde{\delta}_0(x, \theta)]G(y|x) \\ &+ (1 - u(x)) \int^y [1 - F(\max\{R_e(\hat{y}, x), y\})] \tilde{\lambda}_e(s_e(\hat{y}, x), x, \theta) dG(\hat{y}|x), \end{aligned} \quad (\text{D10})$$

which shows the mass of workers who get an acceptable job offer equal to  $y$  or lower on the left-hand side and the mass of workers who either lose the job due to a separation shock or leave the job because they accept a better offer that is above  $y$ .

**DEFINITION 1:** A stationary equilibrium is defined as the search efforts  $s_u(x)$  and  $s_e(y, x)$ , the reservation productivities  $R_u(x)$ ,  $R_\delta(x)$ , and  $R_e(y, x)$ , the unemployment rates  $u(x)$ , the distributions  $G(y|x)$ , the labor market tightness  $\theta$ , and the value functions  $K(y, x)$ ,  $U(x)$ , and  $V$ , that for all  $x$  and  $y$  satisfy equations (D1)–(D3), the first-order conditions (D4)–(D8), the steady-state conditions (D9) and (D10), and the zero-profit condition  $V = 0$ .

The stationary equilibrium is independent of the offered values  $W(n, \cdot, x)$  and  $J(n, \cdot, x)$  and thus does not require us to solve for the wage contracts. This considerably simplifies the equilibrium solution. Given the Nash-bargaining solution, it is easy to solve for the offered values. In Supplemental Appendix S-C, we derive the wage functions,  $w(n, \cdot, x)$ , implied by these offered values.

### D.3. Solving for the Equilibrium

*Solving for the Value Functions.* One can solve for the stationary equilibrium as follows. Taking the derivative of  $K(y, x)$  w.r.t.  $y$ , imposing  $V = 0$ , and rearranging, gives

$$K^y(y, x) = \frac{(1 + r)px}{D(x, \theta) + \tau_e \tilde{\lambda}_e(s(y, x), x, \theta)(1 - F(y))},$$

where  $D(x, \theta) = r + \delta(x) + \tilde{\delta}_0(x, \theta)$ . Using integration by parts, one gets

$$\int_y (K(n, x) - K(y, x)) dF(n) = \int_y K^y(n, x)(1 - F(n)) dn.$$

Plugging this into the FOCs for search effort of the employed and unemployed, we get

$$\frac{c'_e(s_e(y, x))}{\lambda_e^s(s_e(y, x), \theta)} = \tau_e \int_y \frac{p(1 - F(n))}{D(x, \theta) + \tau_e \tilde{\lambda}_e(s_e(n, x), x, \theta)(1 - F(n))} dn, \quad (\text{D11})$$

$$\frac{c'_u(s_u(x))}{\lambda_u^s(s_u(x), \theta)} = \tau_u \int_{R_u(x)} \frac{p(1 - F(n))}{D(x, \theta) + \tau_e \tilde{\lambda}_e(s_e(n, x), x, \theta)(1 - F(n))} dn. \quad (\text{D12})$$

Taking the difference between equations (D1) and (D2), imposing  $U(x) = K(R_u(x), x)$ , and evaluating at  $y = R_u(x)$ , gives

$$\begin{aligned} R_u(x) - \frac{c_e(s_e(R_u(x), x))}{p} \\ = \frac{b - c_u(s_u(x))}{p} + [\tilde{\delta}_0(x, \theta)\tau_u + \tilde{\lambda}_e(s_e(y, x), x, \theta)\tau_e - \lambda_u(s_u(x), \theta)\tau_u] \\ \times \int_{R_u(x)} \frac{1 - F(n)}{D(x, \theta) + \tau_e \tilde{\lambda}_e(s_e(n, x), x, \theta)(1 - F(n))} dn, \end{aligned} \quad (\text{D13})$$

which implicitly defines the reservation productivity level  $R_u(x)$ . Similarly, rearranging equation (D3), simplifying, and imposing zero profits, we get

$$\begin{aligned} \frac{c}{q(\theta)} = p \sum_x \pi(x) x \left[ (1 - \tau_u) \frac{u(x)\lambda_u(s_u(x)) + (1 - u(x))\tilde{\delta}_0(x)}{S} \right. \\ \times \int_{R_u(x)} \frac{1 - F(n)}{D(x, \theta) + \tau_e \tilde{\lambda}_e(s_e(n, x), x, \theta)(1 - F(n))} dn \\ \left. + (1 - \tau_e) \frac{1 - u(x)}{S} \int_{R_u(x)} \tilde{\lambda}_e(s_e(j, x), x) \right. \\ \left. \times \left( \int_j \frac{1 - F(n)}{D(x, \theta) + \tau_e \tilde{\lambda}_e(s_e(n, x), x, \theta)(1 - F(n))} dn \right) dG(j|x) \right]. \end{aligned} \quad (\text{D14})$$

Taken as given  $R_\delta(x) = R_u(x)$  and  $R_e(y, x) = y$ , one can define the stationary equilibrium as follows:

**DEFINITION 2:** A stationary equilibrium is defined as the search efforts  $s_u(x)$  and  $s_e(y, x)$ , the reservation productivities  $R_u(x)$ , the unemployment rates  $u(x)$ , the distributions  $G(y|x)$ , and the labor market tightness  $\theta$  that for all  $x$  and  $y$  satisfy equations (D11)–(D14) and the steady-state conditions (D9) and (D10).

This definition of the equilibrium is useful because it is not only independent of the wage functions but also does not rely on solving for the value functions.



*Solution Algorithm.* To solve for the equilibrium, we proceed as follows:

1. For each type  $x$ , we choose 68 grid points for  $y$  on an interval  $[0, \bar{y}]$  and linearly interpolate  $s_e(y, x)$  for points in between grid points. We start by imposing  $s_e(\bar{y}, x) = 0$ , which approximately holds true for  $\bar{y}$  large enough. We then solve equation (D11) for the grid point below  $\bar{y}$  and so on, until we have solved for  $s_e(y, x)$  for all 68 grid points.
2. For each type  $x$ , we define a function  $s_u(R, x)$ , which defines unemployed workers' search effort for a given reservation productivity  $R$ . We choose 68 grid points for  $R$  on an interval  $[0, \bar{R}]$  and linearly interpolate  $s_u(R, x)$  for points in between grid points. Given the solution for  $s_e(y, x)$ , we solve equation (D12) for  $s_u(R, x)$  for all 68 grid points.
3. For each type  $x$ , we replace  $s_u(R_u(x), x)$  for  $s_u(x)$  in equation (D13) and solve for  $R_u(x)$ . Given  $R_u(x)$ , we get  $s_u(x) = s_u(R_u(x), x)$ .
4. For each type  $x$ , we use equation (D9) to solve for the steady-state unemployment rate  $u(x)$  and equation (D10) to solve for the steady-state distribution of workers across match types  $y$ ,  $dG(y|x)$ . For the latter, we choose 100 grid points for  $y$  on an interval  $[R_u(x), \bar{y}]$  and linearly interpolate for points in between grid points. We first solve equation (D10) for  $dG(R_u(x)|x)$  and then solve equation (D10) for the grid point above  $R_u(x)$  and so on.
5. For each type  $x$ , we solve the offer values  $W(n, \cdot, x)$  and wage functions  $w(n, \cdot, x)$  as described in Supplemental Appendix S-C.

Note that throughout, we normalize  $\theta = 1$ , and in a final step use the zero-profit condition to find the value of the vacancy posting cost  $c$  that rationalizes this value of  $\theta$ .

*Calibration.* In our baseline model, the following 15 parameters are calibrated internally:  $\gamma$ ,  $\tau_u$ ,  $\kappa_u$ ,  $\kappa_e$ ,  $\alpha_u$ ,  $\alpha_e$ ,  $\beta_u$ ,  $\beta_e$ ,  $\chi_u$ ,  $\chi_e$ ,  $\sigma_x$ ,  $b$  (or  $z$ ),  $\delta_0$ ,  $\delta$ , and  $\delta_x$  (where  $\delta(x) = \delta - \delta_x \ln(x)$ ). We target a total of 15 parameters as listed in Table VIII in the paper and, while most moments depend on the values of several parameters, it is straightforward to see which parameter is identified by which moment (see Table IX). Hence, our model is exactly identified.

Given the large number of parameters, it is difficult to use an equation solver to solve for all 15 parameters simultaneously. Moreover, we can solve for the set of moments that do not depend on wages (see the Supplemental Appendix for more details), whereas for wage moments we rely on simulated moments (based on 100,000 individuals simulated for 1000 months). To match all targeted moments, we start by guessing values for  $\gamma$ ,  $\kappa_u$ ,  $\sigma_x$ , and  $\delta_x$  and then proceed as follows:

1. (Inner loop) We solve for the 11 parameters  $\kappa_u$ ,  $\kappa_e$ ,  $\alpha_u$ ,  $\alpha_e$ ,  $\beta_u$ ,  $\beta_e$ ,  $\chi_u$ ,  $\chi_e$ ,  $b$  (or  $z$ ),  $\delta_0$ ,  $\delta$  as a function of the 11 non-wage moments listed in Table IX. Using an equation solver in Matlab that minimizes the squared difference of the deviation of the model moments from the targeted moments, this inner loop converges relatively quickly.
2. (Outer loop) We simulate the remaining 4 wage moments and update the guesses for  $\gamma$ ,  $\tau_u$ ,  $\sigma_x$ , and  $\delta_x$ . We go back to [1.] and iterate until all moments in the model match their empirical counterparts. We use the bisection method to find  $\delta_x$  and choose  $\gamma$ ,  $\tau_u$ , and  $\sigma_x$  to match the targeted moments.

#### D.4. Additional Results and Robustness

In this section, we report additional results for our baseline quantitative analysis and provide alternative specifications to examine the robustness of our quantitative findings.

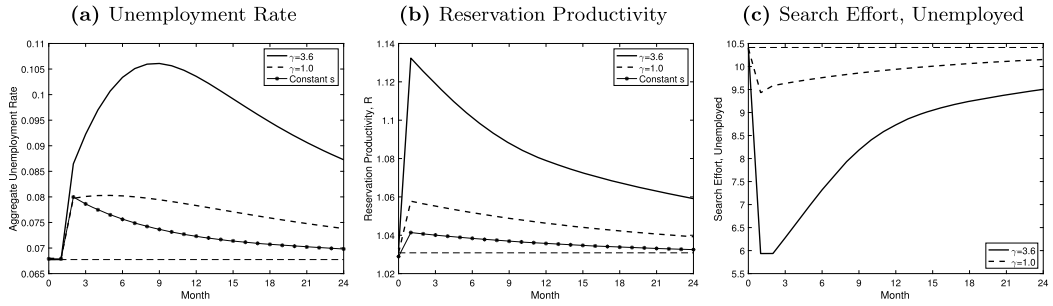


FIGURE D1.—Labor market responses to aggregate productivity shock—additional variables. *Note:* The figures show the response of the economy to an unexpected 4% decline in aggregate labor productivity with a monthly auto-correlation of 0.95 and with the economy starting out in steady state in month 0.

*Additional results.* Figure D1 shows the dynamic response to a productivity shock for additional variables not shown in the main paper. The economy with  $\gamma = 3.6$  features larger responses for all of these variables including vacancies and the unemployment rate. Interestingly, the model also features a spike in separations at the time of the negative productivity shock, consistent with the observed dynamics of separations during recessions. The reason for the spike is a sharp increase in the reservation productivity, leading to a large wave of endogenous separations of all matches with productivity below the new reservation threshold. Figure D2 shows the Beveridge curve responses to the aggregate productivity shock in  $(u, \theta)$  space (left panel) and  $(u, v/u)$  space (right panel).

*Robustness.* Table DI provides a robustness analysis for alternative model specifications. Note that unless otherwise noted, in Table DI, we do not recalibrate the parameters  $\gamma$ ,  $\tau_u$ , and  $\sigma_x$  and thus these calibrations do not necessarily match the search-wage elasticity, the wage offer differential, and the standard deviation of log wages in the data. All other parameters are recalibrated to match the targeted data moments. We emphasize the following four sets of results:

*Number of  $x$  types:* We show that the results for the model with two  $x$ -types instead of ten are nearly identical in column (1) of Table DI. This suggests that there are no issues with restricting the model to two types for the dynamic simulations shown in the main paper. Figure D3 also shows that the dynamic labor market responses to an aggregate productivity shock are very similar when we simulate the responses for an economy *without* ex ante worker heterogeneity, showing that amplification is not driven by compositional shifts in  $x$  in the pool of job seekers.

*Heterogeneous  $\gamma$  by labor force status:* Our results are robust to allowing  $\gamma$  to depend on employment status ( $\gamma_u = 1$  and  $\gamma_e = 3.6$ ): the results in column (3) show that this model is nearly identical in terms of its parameters (except for those relating to the search cost function) and Figure D4 shows that this model still features substantial amplification on vacancy posting and search effort relative to an economy where  $\gamma_u = \gamma_e = 1$ .

*Calibration of  $\gamma$ :* The search-wage gradient is strongly increasing in the parameter  $\gamma$ , as shown by comparing columns (2) and (4) in the table. This shows that the search-wage gradient is a highly informative moment to identify the parameter  $\gamma$ .

*Roles of censoring, bargaining, and endogenous search:* Columns (5), (6), (7), and (8) demonstrate how the model behaves if we gradually turn off key features of our model such as censoring, bargaining, and endogenous search effort. More precisely, in column (5), we do not allow for censoring both in the model and in the targeted moments. This implies that the total offer rate (formal + censored offers) is substantially lower for the

TABLE DI  
ALTERNATIVE CALIBRATIONS OF MODEL.

Calibrated parameter values	Baseline Model	Alternative Models:								
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
		$n_x = 2$	$\gamma = 1$	$\gamma_u < \gamma$	$\gamma = 10$	$\chi_i = 0$	$\chi_i = 0$ $\tau_i = 0.5$	$\chi_i = 0$ $\tau_i = 1$	$\beta_i = 0$ $\chi_i = 1$	
$\gamma$	3.6	3.6	1	3.6	10	3.6	3.6	3.6	3.6	
$\gamma_u$	3.6	3.6	1	1	10	3.6	3.6	3.6	3.6	
$\tau_u$	0.4	0.4	0.4	0.4	0.4	0.4	0.5	1	1	
$\tau_e$	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	
$n_x$	10	2	10	10	10	10	10	10	10	
$\sigma_x$	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	
$\sigma_y$	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	0.273	
$\kappa_u$	0.014	0.014	0.003	0.003	0.019	0.018	0.023	0.038	0	
$\kappa_e$	0.062	0.062	0.058	0.062	0.066	0.039	0.039	0.069	0	
$\alpha_u$	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.331	
$\alpha_e$	0.026	0.026	0.027	0.026	0.026	0.027	0.027	0.027	0.058	
$\beta_u$	0.032	0.032	0.032	0.032	0.032	0.029	0.029	0.029	0	
$\beta_e$	0.115	0.115	0.108	0.115	0.116	0.046	0.046	0.046	0	
$\chi_u$	0.139	0.139	0.139	0.139	0.139	0	0	0	0	
$\chi_e$	0.458	0.457	0.465	0.458	0.465	0	0	0	0	
$z$	0.662	0.662	0.583	0.667	0.654	0.552	0.482	0.293	0.149	
$\delta_0$	0.010	0.010	0.016	0.010	0.009	0.021	0.021	0.022	0.026	
$\delta$	0.007	0.007	0.004	0.007	0.008	0.002	0.001	0.001	0.000	
$\delta_x$	0.002	0.002	0.003	0.002	0.003	0.002	0.002	0.005	0.000	
$c$	0.937	0.933	1.052	0.935	0.889	1.492	1.342	—	—	
<i>Targeted moments</i>	<i>Data</i>									
Search-wage elasticity	-0.36	-0.36	-0.36	-0.21	-0.36	-0.45	-0.29	-0.31	-0.40	—
Wage offer differential (E-U)	0.194	0.193	0.193	0.164	0.193	0.224	0.092	0.084	0.075	0.000
St. dev. log wage offers	0.679	0.678	0.680	0.677	0.679	0.674	0.673	0.675	0.689	0.689
Search effort U	10.39	10.39	10.39	10.39	10.40	10.39	10.39	10.39	10.39	0
Search effort E	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0.769	0
Unsol. offer rate U	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0
Unsol. offer rate E	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0.026	0
Censored offer rate U	0.028	0.028	0.028	0.028	0.028	0.028	0	0	0	0
Censored offer rate E	0.041	0.041	0.041	0.041	0.041	0.041	0	0	0	0
Formal offer rate U	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.342	0.331
Formal offer rate E	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.082	0.083
Acceptance rate U	0.493	0.493	0.493	0.493	0.493	0.494	0.494	0.494	0.494	0.523
Acceptance rate E	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.309	0.299
Unemployment rate	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.068	0.067
Prior wage diff. (E-U)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.000	-0.038

(Continues)

TABLE DI  
Continued.

		Alternative Models:							
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Calibrated parameter values	Baseline								$\beta_i = 0$
	Model	$n_x = 2$	$\gamma = 1$	$\gamma_u < \gamma$	$\gamma = 10$	$\chi_i = 0$	$\chi_i = 0$ $\tau_i = 0.5$	$\chi_i = 0$ $\tau_i = 1$	$\chi_i = 0$ $\tau_i = 1$
<i>Additional moments</i>									
Wage offer differential	0.193	0.193	0.164	0.193	0.221	0.092	0.084	0.075	0
... due to composition	0.118	0.118	0.082	0.117	0.135	0.063	0.065	0.074	0
... due to censoring	0.036	0.036	0.035	0.036	0.037	0	0	0	0
... due to bargaining	0.039	0.040	0.048	0.039	0.048	0.029	0.019	0	0
Unempl. rate of low- $x$ types	0.083	0.086	0.077	0.079	0.097	0.076	0.076	0.077	0.067
Unempl. rate of high- $x$ types	0.053	0.050	0.059	0.057	0.039	0.060	0.060	0.059	0.067
Mean-min ratio	1.556	1.557	1.500	1.556	1.573	1.418	1.418	1.414	1.350

*Note:* All moments referring to wages are based on residualized wage data as described in the paper. Note that unless otherwise noted, for the alternative models, we do not recalibrate the parameters  $\gamma$ ,  $\tau_u$ , and  $\sigma_x$  and thus these calibrations do not necessarily match the search-wage elasticity, the wage offer differential, and the standard deviation of log wages in the data. The other parameters are recalibrated to match the targeted moments in the data. Column (1) shows the results for the model with 2  $x$ -types instead of 10; column (2) shows results for the model where we set  $\gamma = 1$ ; column (3) shows results for the model where we allow for  $\gamma_u < \gamma$ ; column (4) shows results for the model where we set  $\gamma = 10$ ; column (5) shows results for the model without censoring ( $\chi_u = \chi_e = 0$ ); column (6) shows results for the model without censoring and where  $\tau_u = \tau_e = 0.5$ ; column (7) shows results for the model without censoring and with  $\tau_u = \tau_e = 1$ ; column (8) shows results for the model without censoring, with  $\tau_u = \tau_e = 1$ , and without endogenous search effort, which amounts to setting  $\beta_u = \beta_e = 0$ . Note that in columns (7) and (8), the general equilibrium is not well defined for  $c > 0$  as firms have no incentive to post vacancies, but the results can be viewed as identical to a partial equilibrium model where the wage is equal to productivity and where  $\theta$  is set to 1.

employed, reducing their relative search efficiency. The relative search efficiency also declines because the reallocation parameter  $\delta_0$  is estimated to be higher, leaving less room for offers arising due to endogenous search effort. In column (6), we also set  $\tau_e = \tau_u = 0.5$ , allowing for equal bargaining power of the employed. In column (7), we set  $\tau_e = \tau_u = 1$ , effectively eliminating the role of bargaining in the model and setting the wage equal to the marginal product. Note that with  $\tau_e = \tau_u = 1$ , the general equilibrium is not well defined for  $c > 0$  as firms have no incentive to post vacancies, but the results can be viewed as identical to a partial equilibrium model where the wage is equal to productivity and where  $\theta$  is set to 1. In column (8), we also set  $\beta_e = \beta_u = 0$ , which effectively shuts down endogenous search effort in the model. In this model, we calibrate  $\alpha_i$  to match the offer rate by employment status, though the model cannot match the targeted moments exactly.<sup>10</sup> The model's implied flow value of unemployment gradually decreases from columns (5) to (8), with a values of  $z$  of 0.55, 0.48, 0.29, and 0.15 compared to 0.66 in our baseline model. These results show that the resolution of the wage dispersion puzzle in our baseline model is due to all of these model ingredients.

<sup>10</sup>The model requires a high value of  $\delta_0$  to match the acceptance rate of the employed, but since  $\delta_0$  also leads to more separations, this implies that, for high values of  $\delta_0$ , the estimated value of  $\delta(x_{\text{med}}) = 0$ . Thus, we are no longer able to match both the separation rate and the employed's acceptance rate. In any event, the model moments are still close to the targeted moments.

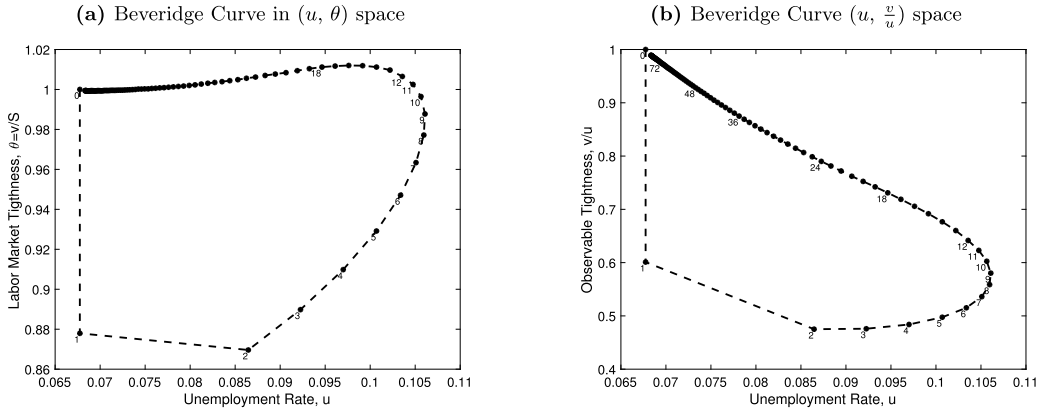


FIGURE D2.—Labor market responses to aggregate productivity shock—Beveridge curve. *Note:* The figures show the response of the economy to an unexpected 4% decline in aggregate labor productivity with a monthly auto-correlation of 0.95 and with the economy starting out in steady state in month 0. In panel (b), tightness is normalized to 1 in period 0. The labels in the figure correspond to the months since the shock.

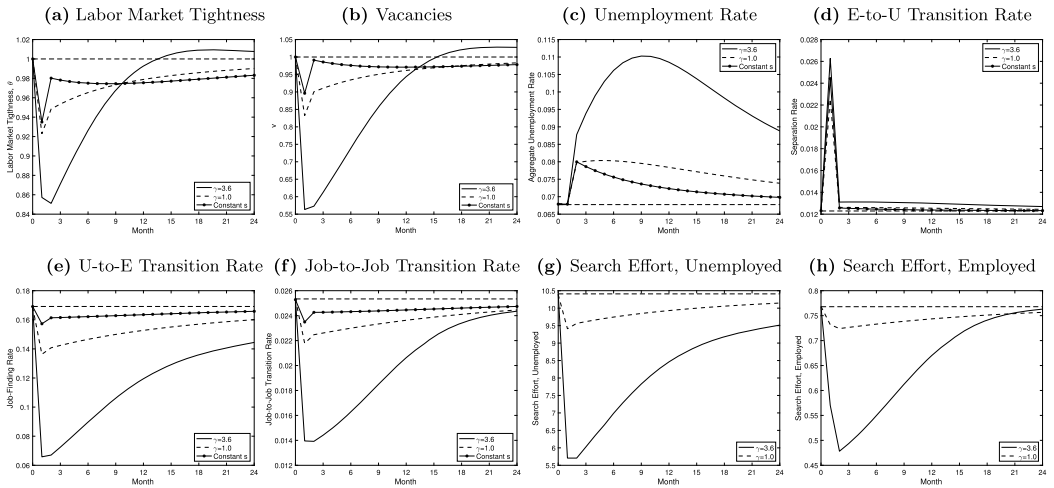


FIGURE D3.—Labor Market Responses to Aggregate Productivity Shock—Economy Without Ex-Ante Worker Heterogeneity ( $x$ ). *Notes:* Responses of the economy to an unexpected 4% decline in aggregate labor productivity with a monthly auto-correlation of 0.95 and with the economy starting out in steady state. Vacancies are normalized to 1 in month 0.

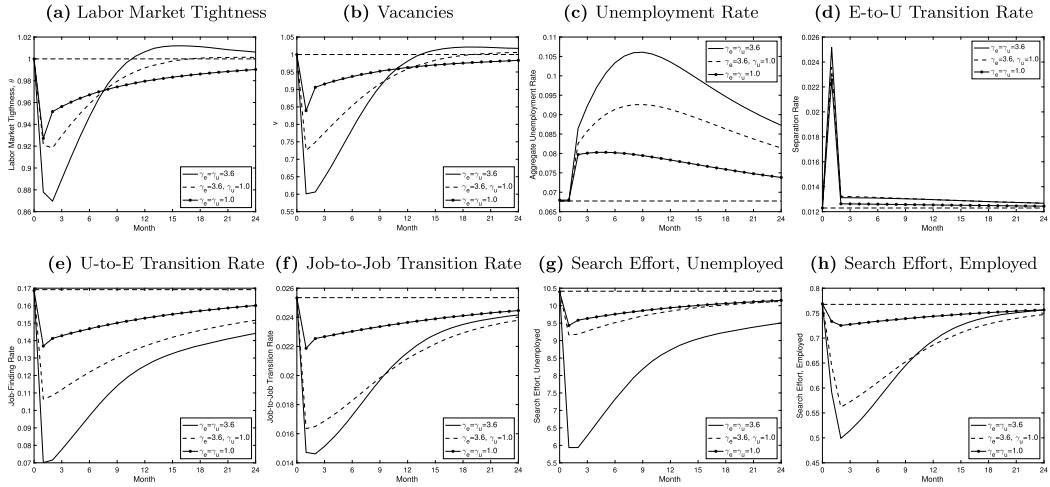


FIGURE D4.—Labor Market Responses to Aggregate Productivity Shock—Comparing Responses of Economies where  $\gamma_e = \gamma_u = \gamma_e$  to Responses of an Economy where  $\gamma_e = 3.6$  and  $\gamma_u = 1.0$ . *Notes:* Responses of the economy to an unexpected 4% decline in aggregate labor productivity with a monthly auto-correlation of 0.95 and with the economy starting out in steady state. Vacancies are normalized to 1 in month 0.

## REFERENCES

- ABRAHAM, KATHARINE G., JOHN C. HALTIWANGER, AND LEA E. RENDELL (2020): “How Tight Is the U.S. Labor Market?” *Brookings Papers on Economic Activity*, Spring, 2020. [13]
- ARMANTIER, OLIVIER, GIORGIO TOPA, WILBERT VAN DER KLAUW, AND BASIT ZAFAR (2017): “An Overview of the Survey of Consumer Expectations,” *Economic Policy Review*, 23 (2), 51–72. [1]
- BRAUN, CHRISTINE (2021): “Revisiting Unemployment With an Intensive Margin,” Report, University of Warwick. [12]
- CAHUC, PIERRE, FABIEN POSTEL-VINAY, AND JEAN-MARC ROBIN (2006): “Wage Bargaining With On-the-Job Search: Theory and Evidence,” *Econometrica*, 74 (2), 323–364. [5]
- ECKHOUT, JAN, AND ILSE LINDENLAUB (2019): “Unemployment Cycles,” *American Economic Journal: Macroeconomics*, 11 (4), 175–234. [13]
- FLORO, MARIA SAGRARIO, AND MARJORIE MILES (2003): “Time Use, Work and Overlapping Activities: Evidence From Australia,” *Cambridge Journal of Economics*, 27 (6), 881–904. [13]

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