Journal of Monetary Economics 59 (2012) 352–369

Contents lists available at SciVerse ScienceDirect

Journal of Monetary Economics

journal homepage: www.elsevier.com/locate/jme

Joint-search theory: New opportunities and new frictions

Bulent Guler [a,*], Fatih Guvenen [b], Giovanni L. Violante [c]

[a] Department of Economics, Indiana University, 105 Wylie Hall, Bloomington, IN 47405, United States
[b] University of Minnesota, Federal Reserve Bank of Minneapolis, and NBER, United States
[c] New York University, CEPR and NBER, United States

ARTICLE INFO

Article history:
Received 8 June 2010
Received in revised form
16 April 2012
Accepted 3 May 2012
Available online 11 May 2012

ABSTRACT

The job-search problem of couples differs in significant ways from that of singles. We characterize the reservation wage strategies of a couple that perfectly pools income to understand the ramifications of joint search for individual labor market outcomes. Two cases are analyzed. First, when couples are risk averse and pool income, joint search yields new opportunities relative to single-agent search. Second, when spouses receive job offers from multiple locations and incur a cost when living apart, joint search features new frictions and can lead to worse outcomes than single-agent search.

1. Introduction

Macroeconomics is rapidly shifting away from the stylized "bachelor model" of the household to models that explicitly recognize the relevance of within-household decisions for aggregate economic outcomes.[1] Surprisingly, instead, search theory has almost entirely focused on the single-agent search problem, since its inception in the early 1970. The recent comprehensive survey by Rogerson et al. (2005), for example, does not contain any discussion on optimal job search strategies of two-person households acting as the decision units. This state of affairs is rather surprising given that Burdett and Mortensen (1977), in their seminal piece entitled "Labor Supply Under Uncertainty," sketch a characterization of a two-person search problem, explicitly encouraging further work on the topic. Their pioneering effort, which remained virtually unfollowed, represents the starting point of our theoretical analysis.

This paper studies the job search problem of a couple who faces exactly the same economic environment as in the standard single-agent search problem of McCall (1970) and Mortensen (1970) without on-the-job search, and of Burdett (1978) with on-the-job search. A couple is an economic unit composed of two ex ante identical individuals linked by the assumption of perfect income pooling. The simple unitary model of a household adopted here is a convenient and logical starting point. It helps us to examine transparently the role of labor market frictions and insurance opportunities introduced by joint-search, and it makes the comparison with the canonical single-agent search model especially stark.

From a theoretical perspective, couples may make joint decisions (leading to choices different from those of a single agent) for several reasons. Our analysis starts from the two most natural and relevant ones. First, the couple has concave utility over pooled income. Second, the couple can receive job offers from multiple locations, but faces a cost of living apart. In the latter case, deviations from the single-agent search problem occur even for linear preferences. As summarized

* Corresponding author. Tel.: +1 812 855 7791.
E-mail address: bguler@indiana.edu (B. Guler).

[1] For example, see Aiyagari et al. (2000) on intergenerational mobility and investment in children, Cubeddu and Rios-Rull (2003) on precautionary saving, Blundell et al. (2007) on labor supply, Heathcote et al. (2010) and Lise and Seitz (2011) on economic inequality, and Guner et al. (2010) on taxation.

0304-3932/$ - see front matter
http://dx.doi.org/10.1016/j.jmoneco.2012.05.001

by the title of our paper, in the first environment joint search introduces new opportunities, whereas in the second it introduces new frictions relative to single-agent search. The set of propositions proven below characterizes optimal behavior in terms of comparison between the reservation wage functions of the couple and the reservation wage value of the single agent. One appealing feature of our theoretical analysis is that it yields two-dimensional diagrams in the space of the two spouses' wages (w_1,w_2), where the reservation wage policies can be easily analyzed and interpreted.

In the first environment, couples are risk-averse and the economy has one location only. A dual-searcher couple (both members unemployed) will quickly accept a job offer—in fact, faster than a single unemployed agent. The dual-searcher couple can use income pooling and joint search to its advantage: it initially accepts a lower wage offer (to smooth consumption across states) while, at the same time, not giving up completely the search option (to increase lifetime income) which remains available to the other spouse. Once a worker–searcher couple (one spouse employed and the other unemployed), the pair will be more choosy in accepting subsequent job offers. The shape of the reservation wage of the worker–searcher couple (a function of the employed spouse's wage) depends on how absolute risk aversion changes with the level of consumption.

A key feature of the solution to the joint-search problem is that the searching spouse accepting a job offer may trigger a quit by the employed spouse motivated by the search for a better job. The outcome of this behavior is a switch between the breadwinner and the searcher within the household. As is well known, endogenous quits never happen in the corresponding single-agent version of the search model. We call this process – of work-quit-search-work that allows a couple to climb the wage ladder even in the absence of on-the-job search – the "breadwinner cycle." Therefore, one can view joint search as a "costly" version of on-the-job search, even in its formal absence. The cost comes from the fact that, in order to keep the search option active, the pair must remain a worker–searcher couple, and cannot enjoy the full wage earnings of a dual-worker couple as it would be capable of doing in the presence of on-the-job search.

Overall, relative to singles, couples spend more time searching for better jobs, which results in longer unemployment durations, but eventually leads to higher lifetime wages and welfare (whence, the "new opportunities" in the title of the paper). Quantitatively, deviations of joint-search behavior from its single-agent counterpart can be substantial. For example, a plausible calibration of the model implies that each spouse in a couple earns a lifetime income that is 1–2 higher than a comparable single agent. Using micro-data from the Survey of Income and Program Participation (SIPP), which tracks weekly employment histories of all household members, this paper shows that some key empirical stylized facts about joint search (e.g., frequency of breadwinner cycles, and mean unemployment durations of different household types) are quantitatively in line with simulations of the model with CRRA utility and risk aversion coefficient around two.

Our second environment features multiple locations and a flow cost of living apart for each of the spouses in the couple. The couple has to choose reservation wages with respect to "inside offers" (jobs in the current location) and "outside offers" (jobs in other locations). Even with risk-neutral preferences, the search behavior of couples differs from that of single agents in important ways. First, the dual-searcher couple is less choosy than the individual agent because it is effectively facing a worse job offer distribution, since some wage offer configurations are attainable only in different locations—hence, by paying the cost of living apart. Second, there is a region in which the breadwinner cycle is optimal for the couple. For example, a couple who gets a very generous job offer from the outside location could be better off if the currently employed spouse quits and follows the spouse with the job offer to the new location. It should be noted that these two results – couples being less picky than singles and the breadwinner cycle – also hold in our previous environment, but for completely different reasons.

The model allows us to formalize what Mincer (1978) called tied-stayers – i.e., workers who turn down a job offer from a different location that they would accept if single – and tied-movers – i.e., workers who accept a job offer in the location of the partner that they would turn down if single. Overall, the disutility of living separately shrinks the set of job offers that are viable for couples, compared to that of singles (whence, the "new frictions" in the title).

The relevance of a multiple-location joint-search model of the labor market is supported, for example, by Costa and Kahn (2000) who document that highly educated dual-career couples have increasingly relocated to large metropolitan areas in the United States since the 1960s (more so than comparable singles); cities offer a greater and more diverse set of job opportunities, thereby mitigating the frictions associated with joint search.

Also for the multiple-location model, deviations of joint-search behavior from its single-agent counterpart can be quantitatively substantial. For example, when the (flow) disutility cost of living separately is equal to 15% of a couple's earnings, half of all households moving across locations composed of a partner who is a tied-mover, and the lifetime income of each spouse in a couple is 6.6% lower than comparable singles.

This introduction concludes by briefly reviewing the related literature. Only very recently, a handful of papers have started to follow the lead offered by Burdett and Mortensen (1977) into the investigation of household interactions in frictional labor market models. Garcia-Perez and Rendon (2004) numerically simulate a model of family-based job-search decisions to tease out the importance of the added worker effect for consumption smoothing. Dey and Flinn (2008) study quantitatively the effects of health insurance coverage on employment dynamics in a search model where the economic unit is the household. Gemici (2011) estimates a rich structural model of migration and labor market decisions of couples to assess the implications of joint location constraints on labor outcomes and the marital stability of couples. Flabbi and Mabli (2011) focus on the bias in estimates of structural search parameters when the model is misspecified because it ignores the joint-search component. Relative to these contributions, our paper is less ambitious in its quantitative analysis, but provides a more focused and systematic study of joint-search theory.

From a theoretical perspective, our analysis of the one-location model has useful points of contact with existing results in search theory applied to at least two separate contexts. First, starting from the static analysis of Danforth (1979), a number of papers have studied the role of risk-free wealth in shaping dynamic job-search decisions (e.g., Andolfatto and Gomme, 1996; Gomes et al., 2001; Pissarides, 2004; Lentz and Tranaes, 2005; Browning et al., 2007). The income of the spouse differs crucially from risk-free wealth because it is risky (in the presence of exogenous separations) and because it can be optimally controlled by the job-search decision itself. Second, Albrecht et al. (2010) study a different type of joint-search decision, that of a committee voting on an option which gives some value to each member. The authors are interested in drawing a comparison between single-agent search and committee search, in the same spirit as our exercise.[2]

The rest of the paper is organized as follows. Section 2 lays out the single-agent problem which provides the benchmark of comparison throughout the paper. Section 3 analyzes the baseline joint-search problem as well as some extensions. Section 4 shows that simulations from a calibrated model yield implications broadly in line with stylized facts about joint-search documented from SIPP data. Section 5 studies the joint-search problem with multiple locations. Section 6 concludes.

2. The single-agent search problem

First, consider the sequential job-search problem of a single agent—the well-known McCall–Mortensen model (McCall, 1970; Mortensen, 1970). This model provides a useful benchmark against which the joint-search model that we introduce in the next section will be compared. For clarity, this section begins with a very stylized version and considers several extensions later.

Economic environment: Consider an economy populated by single individuals who all participate in the labor force: they are either employed or unemployed. Time is continuous and there is no aggregate uncertainty. Workers maximize the expected lifetime utility from consumption, $E_0 \int_0^\infty e^{-rt} u(c(t))\, dt$, where r is the subjective rate of time preference, $c(t)$ is the consumption flow, and $u(\cdot)$ is the instantaneous utility function, which is strictly increasing, concave, and smooth.

An unemployed worker receives wage offers w at rate α from the exogenous distribution $F(w)$ with bounded support $[0,\overline{w}]$, and is entitled to a benefit flow $b \in (0,\overline{w})$. There is no recall of past wage offers. The worker observes the offer, w, and decides whether or not to accept it. If she rejects the offer, she continues to search. If she accepts the offer, she becomes employed at wage w forever, i.e., there are no exogenous separations and no new offers on the job. Individuals do not save or borrow.[3]

Value functions: Denote by V and W the value functions of an unemployed and employed agent, respectively. Then, using the continuous time Bellman equations, the search problem can be written in the following flow value representation[4]:

$$rV = u(b) + \alpha \int \max\{W(w) - V, 0\}\, dF(w) \tag{1}$$

$$rW(w) = u(w). \tag{2}$$

This well-known problem yields a unique reservation wage, w^*, such that for any wage offer above w^* the unemployed agent accepts the offer, and below w^*, she rejects the offer. This reservation wage is the solution to the equation

$$u(w^*) = u(b) + \frac{\alpha}{r} \int_{w^*} [u(w) - u(w^*)]\, dF(w). \tag{3}$$

The flow utility of accepting a job offer paying w^* (the left-hand side, LHS) is equated to the option value of continuing to search in the hope of obtaining a better offer (the right-hand side, RHS). Since the LHS is increasing in w^* whereas the RHS is decreasing in w^*, and they are both continuous functions, Eq. (3) uniquely determines the reservation wage, w^*.

3. The joint-search problem

This section studies the search problem of a couple facing the same environment described above. A couple is a pair of ex ante identical individuals who pool income to purchase a market good that is “public” within the household.[5]

A couple can be in one of the three labor market states. A “dual-searcher couple” is one where both spouses are unemployed and searching. A “dual-worker couple” is one where both spouses are employed (an absorbing state). A

[2] The similarities, though, more or less stop here. For example, Albrecht et al. (2010) also find that committees are less picky than single agents. In our one-location model, this result is due to a consumption-smoothing argument. In their environment, it is due to the negative externality that committee members impose on each other.

[3] Without exogenous separation risk, saving does not need to be ruled out: individuals face a wage earnings profile that is nondecreasing over the life cycle. As a result, since borrowing *is* ruled out, they would optimally set consumption equal to their wage earnings every period even though they were allowed to save. However, this is no longer true with exogenous separation, as Section 3.4 explains.

[4] When the limits of integration are not specified, they are understood to be the lower and upper bound of the support of $F(w)$.

[5] Clearly, some consumption goods have marked features of public goods (e.g., housing services), others of private goods (e.g., food). Section 3.5 analyzes the robustness of our results with respect to this assumption.

"worker–searcher couple" is one where one spouse is employed and the other is unemployed. As can perhaps be anticipated, the most interesting state is the last one.

Value functions: Let U denote the value function of a dual-searcher couple, $\Omega(w_1)$ the value function of a worker–searcher couple when the working spouse wage is w_1, and $T(w_1,w_2)$ the value function of a dual-worker couple earning wages w_1 and w_2. The value functions satisfy

$$rT(w_1,w_2) = u(w_1+w_2), \tag{4}$$

$$rU = u(2b)+2\alpha \int \max\{\Omega(w)-U,0\}\, dF(w), \tag{5}$$

$$r\Omega(w_1) = u(w_1+b)+\alpha \int \max\{T(w_1,w_2)-\Omega(w_1),\Omega(w_2)-\Omega(w_1),0\}\, dF(w_2). \tag{6}$$

The equations determining value functions (4) and (5) are straightforward analogs of their single-agent counterparts. When both spouses are employed, their flow value is simply determined by the total wage earnings of the household. When they are both unemployed, their flow value is equal to the instantaneous utility of consumption (which equals the total unemployment benefit) *plus* the expected gain in case a wage offer is received. Because both agents receive new offers independently at rate α, the total offer arrival rate of a dual-searcher couple is 2α.[6]

The value function (6) of a worker–searcher couple is more involved. Upon receiving a wage offer the couple faces three choices. First, if the offer is rejected, there is no change in value. Second, if the offer is accepted and both spouses remain employed, the value increases by $T(w_1,w_2)-\Omega(w_1)$. Third, if the unemployed spouse accepts the wage offer w_2 *and* the employed spouse quits to search for a better one, the gain to the couple is $\Omega(w_2)-\Omega(w_1)$.

This last scenario is the crucial difference between the joint-search problem and the single-agent search problem. In the single-agent problem, once a job offer is accepted, the worker will never choose to quit. In contrast, in the joint-search problem, the reservation wage of each spouse depends on the income of the partner. When this income grows – for example, because of a transition from unemployment to employment – the reservation wage of the previously employed spouse may also increase, which could lead to exercising the quit option. The next section returns to this "endogenous nonstationarity" implicit in the joint-search problem.

3.1. Characterizing the couple's decisions

We are now ready to characterize the couple's search behavior, beginning with the following useful lemma. All proofs are contained in the Appendix.[7]

Lemma 1. *$\Omega(w)$ is a continuous and strictly increasing function of w.*

3.1.1. Dual-searcher couple

For a dual-searcher couple, the reservation wage – which is the same for both spouses by symmetry – is denoted by w^{**} and is determined by the equation

$$\Omega(w^{**}) = U. \tag{7}$$

By virtue of Lemma 1, w^{**} is a singleton.

3.1.2. Worker–searcher couple

As noted earlier, a worker–searcher couple's decision, upon receiving a wage offer w_2, involves choosing the highest among three values

$$\max\{T(w_1,w_2),\Omega(w_2),\Omega(w_1)\},$$

which is a different way of writing the choices embedded in Eq. (6).

It is instructive to think of this problem in two stages. First, consider: when does the couple *accept* a new wage offer? This happens if and only if w_2 is such that

$$\Omega(w_1) < T(w_1,w_2) \quad \text{or} \quad \Omega(w_1) < \Omega(w_2). \tag{8}$$

When this condition fails to hold, i.e., $\Omega(w_1) \geq \max\{T(w_1,w_2),\Omega(w_2)\}$, the couple will reject the offer. Second, *if* the offer is accepted – condition (8) *is* satisfied – the next question is, when does spouse 1 (currently employed) quit? A quit will happen if and only if

$$T(w_1,w_2) < \Omega(w_2). \tag{9}$$

For a given worker–searcher couple with current wage w_1, our goal is to find the threshold values that divide the range of w_2 into (potentially) three intervals: (i) one in which the offer is rejected ((8) fails to hold), (ii) another interval in which

[6] In continuous time, the probability of both spouses receiving offers simultaneously is negligible.

[7] This supplemental appendix (which contains all the proofs and additional results) is available on the JME website through Science Direct.

the offer is accepted and the employed spouse quits ((8) and (9) hold), and (iii) a third interval in which the offer is accepted but no quit takes place ((8) holds and (9) fails). The reservation wage functions that determine these thresholds are characterized below.

First, consider the accept/reject decision described by condition (8). For every w_1, define $\phi^+(w_1)$ as the *lowest* wage offer that makes the couple weakly prefer $T(w_1,w_2)$ over $\Omega(w_1)$. Formally, this function solves

$$T(w_1,\phi^+(w_1)) = \Omega(w_1). \tag{10}$$

Similarly, define $\phi^-(w_1)$ to be the *lowest* wage offer that makes the couple weakly prefer $\Omega(w_2)$ over $\Omega(w_1)$. Then, $\phi^-(w_1)$ solves

$$\Omega(\phi^-(w_1)) = \Omega(w_1) \Rightarrow \phi^-(w_1) = w_1, \tag{11}$$

since Ω is invertible by Lemma 1. Thus, a wage offer w_2 that exceeds either one of the thresholds defined by (10) or (11) will be accepted. More formally, the reservation wage function for the accept/reject decision, $\phi(w_1)$, is defined as

$$\phi(w_1) \equiv \min\{\phi^-(w_1),\phi^+(w_1)\}. \tag{12}$$

Now, consider the stay/quit decision described by condition (9). A quit will never take place if the wage offer w_2 is rejected, as the couple would be worse off. Thus, consider a worker–searcher couple who has just received and accepted a wage offer w_2. Because the couple's income has changed with this decision, it will re-evaluate the wage of the employed spouse, w_1. As before, for every w_2, define the "quitting wage," $q(w_2)$, as the *highest* value of w_1 that makes the couple weakly prefer $\Omega(w_2)$ over $T(w_1,w_2)$. Formally, the associated indifference condition is

$$T(q(w_2),w_2) = \Omega(w_2). \tag{13}$$

Any value of $w_1 < q(w_2)$ satisfies condition (9) and triggers a quit. A comparison of (13) with (10) and the symmetry of the function T imply that $q(\cdot) \equiv \phi^+(\cdot)$—that is, the stay/quit decision is characterized by the same functional form as the accept/reject decision, except, of course, that the argument is w_1 in one case and w_2 in the other. This finding provides an important simplification in our analysis: by symmetry, the properties of q will follow from the properties of ϕ^+.

The following lemma is useful for the characterization of the reservation wage function ϕ.

Lemma 2. *There exists*: (i) *a wage* $\hat{w} \geq w^{**}$ *such that* $\phi^+(w_1)$ *and* $\phi^-(w_1)$ *intersect at* $w_1 = \hat{w}$ *and, for all* $w_1 < \hat{w}$, $\phi^+(w_1) > \phi^-(w_1)$, *and* (ii) *a wage* $\tilde{w} \in [\hat{w},\overline{w})$ *such that, for all* $w_1 > \tilde{w}$, $\phi^+(w_1) < \phi^-(w_1)$ *and there are no quits.*

In light of (12), the main implication of this lemma is that, for $w_1 \leq \hat{w}$, the relevant reservation wage function is $\phi^-(w_1) = w_1$ (i.e., the 45°-line in the (w_1,w_2) space), and for $w_1 > \tilde{w}$ the relevant reservation wage function is $\phi^+(w_1)$ and the quit option is never exercised—a useful result which simplifies many of our proofs below.[8]

3.1.3. Taking stock

It is helpful to visualize the various functions defined so far in the (w_1,w_2) space. Fig. 1 shows a generic diagram of reservation wage functions for a worker–searcher couple. Throughout the paper, we will think of spouse 1 as the employed spouse and display his current wage w_1 on the horizontal axis, and think of spouse 2 as the unemployed spouse and display her offer, w_2, on the vertical axis.

The lowest possible wage at which one can observe a worker–searcher couple is w^{**}. Recall that the accept/reject reservation function ϕ traces the minimum of ϕ^- and ϕ^+. For a given w_1, if a wage offer w_2 falls below this curve, it is rejected by the couple. Second, the quitting wage q is the mirror image of ϕ^+ with respect to the 45°-line.[9] If the current spouse's wage w_1 is to the left of q, then the employed spouse quits as the unemployed partner accepts a job. Because a quit is conditional on accepting a job, wage combinations that lie below the 45°-line are not relevant. Notice that the quitting region is the mirror image of the reject region—indeed, one can interpret a quit as a "rejection" of the current wage w_1. Finally, pairs (w_1,w_2) in the region between ϕ^+ and q imply a transition into dual-worker status.

The two functions ϕ and q intersect on the 45°-line at $(\hat{w},\hat{w})$. Thus, at $\hat{w}$, the unemployed spouse of a worker–searcher couple is indifferent between accepting and rejecting an offer and, at the same time, her spouse is indifferent between keeping and quitting his job. To emphasize this feature, $\hat{w}$ is referred to as the (smallest) "double indifference point."[10]

Based on this discussion, it should be clear that characterizing the optimal joint-search strategy involves the following steps: (i) studying the conditions under which $w^{**} < \hat{w}$, a necessary inequality to activate the reservation rule $\phi(w_1) = w_1$; (ii) analyzing the shape of ϕ beyond $\tilde{w}$; and (iii) ranking $\tilde{w}$ and $\hat{w}$ relative to w^*, which is useful for comparing joint-search to single-agent search strategies. Proposition 2 tackles (i). Proposition 3 tackles (ii) and (iii) when utility is in the HARA class.

[8] By definition, $\hat{w}$ is the first intersection point between ϕ^- and ϕ^+. Although other crossings between $\hat{w}$ and $\tilde{w}$ cannot be ruled out, in a broad range of simulations multiple intersections were never observed. In what follows, all reservation wage figures are drawn under the assumption of a single intersection, and so $\phi^+ > \phi^-$ for $w_1 < \hat{w}$ and $\phi^+ < \phi^-$ for $w_1 > \hat{w}$. None of the theoretical results relies on the uniqueness of intersections.

[9] The portions of these two functions that are not relevant for a couple's actions are plotted as dashed lines vis-a-vis solid lines for the relevant portions.

[10] Since $\hat{w}$ satisfies both (10) and (11), it follows that $T(\hat{w},\phi^+(\hat{w})) = \Omega(\hat{w}) = \Omega(\phi^-(\hat{w}))$. Further, $rT(\hat{w},\hat{w}) = u(2\hat{w})$, so $\hat{w}$ can be solved from $u(2\hat{w}) = r\Omega(\hat{w})$.

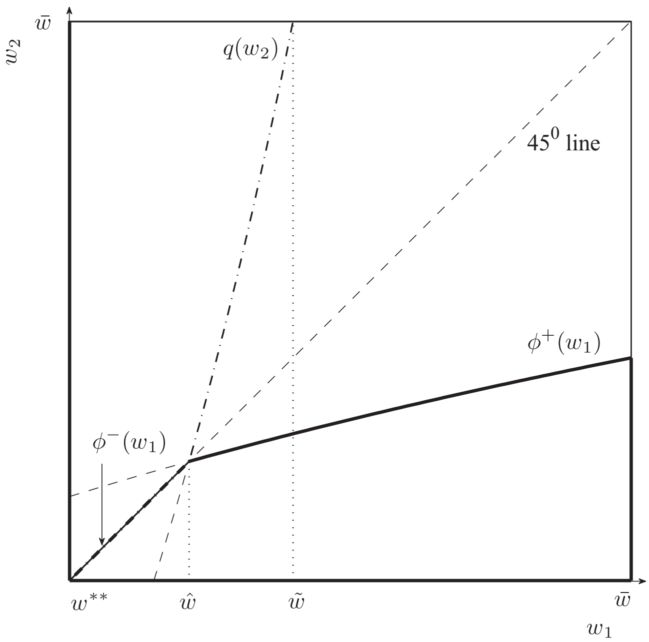

Fig. 1. A generic diagram of reservation wage functions for worker–searcher couples. *Note*: This figure shows the reservation wage functions for a worker–searcher couple. ϕ^+ is the (accept/reject) reservation wage function of the unemployed spouse conditional on the employed spouse not quitting the job. ϕ^- is the (accept/reject) reservation wage function of the unemployed spouse conditional on the employed spouse quitting the job. q is the (quit/stay) reservation wage function of the employed spouse conditional on the unemployed spouse accepting the offer. w^{**} denotes the reservation wage of the dual-searcher couple, $\hat{w}$ is the intersection point of ϕ^+ and ϕ^-, and $\tilde{w}$ is the point beyond which the employed spouse never quits.

3.2. Risk neutrality

This section begins by presenting the risk-neutral case, then turns to the results with risk-aversion.

Proposition 1 (*Risk Neutrality*). *With risk-neutrality, i.e.,* $u''=0$, *the joint-search problem reduces to independent single-agent search problems for the two spouses, with value functions* $U=2V$, $\Omega(w_1)=V+W(w_1)$, *and* $T(w_1,w_2)=W(w_1)+W(w_2)$. *Further,* $\phi(w_1)=w^{**}=\hat{w}=\tilde{w}=w^*$.

Fig. 2 shows the relevant reservation wage functions in the (w_1,w_2) space. As stated in the proposition, $\phi(w_1)$ is simply the horizontal line at w^{**}. Similarly, the quitting function $q(w_2)$ is the mirror image of $\phi(w_1)$ and is shown by the vertical line at $w_1=w^{**}$. The intersection of these two lines generates four regions, and the couple displays distinct behaviors in each.

3.3. Risk aversion

To observe deviations between single-agent search and joint-search in this one-location model, risk aversion must be brought to the fore. First, a key implication of risk aversion is summarized by the following proposition.

Proposition 2 (*Breadwinner Cycle*). *If u is strictly concave, the reservation wage value of a dual-searcher couple is strictly smaller than the smallest double-indifference point*: $w^{**}<\hat{w}$.

The reservation wage of a dual-searcher couple being strictly smaller than the double-indifference point activates a region where $\phi(w_1)=w_1$, which, in turn, gives rise to endogenous quits and to dynamics that we label the "breadwinner cycle" for worker–searcher couples. To understand how this happens, consider Fig. 1 for a worker–searcher couple. Suppose that $w_1 \in (w^{**},\hat{w})$ and the unemployed spouse receives a wage offer $w_2 \in (w_1,\hat{w})$. Because $w_2>w_1=\phi(w_1)$, the unemployed spouse accepts the offer, which in turn implies that $w_1<q(w_2)$. Since the first spouse's current wage is now below her reservation wage (which just increased), she will quit. As a result, spouses simultaneously switch roles and transit from one worker–searcher couple into another one with a higher wage level. This process might repeat itself over and over again – and the breadwinner alternates – until the employed spouse strictly prefers retaining her job and the pair becomes a dual-worker couple.

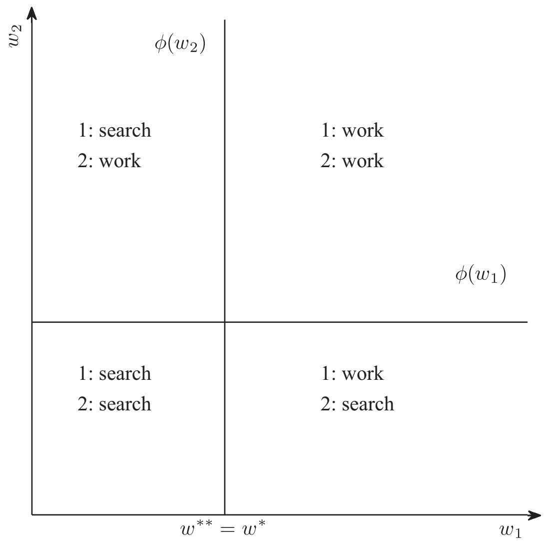

Fig. 2. Reservation wage functions with risk neutrality. *Note*: This figure shows the reservation wage functions for a couple when the individuals are risk neutral. ϕ is the global reservation wage function for the unemployed spouse. It is defined as the minimum of ϕ^+ and ϕ^-. w^* corresponds to the reservation wage of a risk neutral single individual.

3.3.1. *HARA utility*

To obtain a sharper characterization of the shape of $\phi(w_1)$ beyond $\hat{w}$, this section imposes more structure on preferences by restricting attention to the HARA (hyperbolic absolute risk aversion) class. Formally, the HARA class is defined as the family of utility functions with linear risk tolerance: $-u'(c)/u''(c)=\rho+\tau c$, where ρ and τ are parameters.[11] This class can be further divided into three subclasses depending on the sign of τ. When $\tau=0$, absolute risk aversion is independent of consumption level. This is the constant absolute risk aversion (CARA) case, also known as exponential utility: $u(c)=-\rho e^{-c/\rho}$. When $\tau>0$, absolute risk *tolerance* is increasing with consumption, which is the decreasing absolute risk aversion (DARA) case. A well-known special case of this class is the constant relative risk aversion (CRRA) utility: $u(c)=c^{1-\sigma}/(1-\sigma)$, which obtains when $\rho=0$ and $\tau=1/\sigma>0$. When $\tau<0$, risk aversion increases with consumption, which is the increasing absolute risk aversion (IARA) case. A special case of this class (for $\tau=-1$) is quadratic utility: $u(c)=-(\rho-c)^2$.

Proposition 3 (*HARA Utility*). *With HARA preferences, for $w_1>\tilde{w}$, the reservation wage function $\phi(w_1)$ and $\tilde{w}$ satisfy*

$$\phi'(w_1):\begin{cases} >0 \text{ and } \phi(w_1)\le w_1 & \text{if } u \text{ is DARA} \\ =0 & \text{if } u \text{ is CARA} \\ <0 & \text{if } u \text{ is IARA,} \end{cases} \quad \text{and} \quad \tilde{w}:\begin{cases} >\hat{w}>w^* & \text{if } u \text{ is DARA} \\ =\hat{w}=w^* & \text{if } u \text{ is CARA} \\ =\hat{w}<w^* & \text{if } u \text{ is IARA.} \end{cases}$$

Appendix A contains a formal proof of this proposition.[12] It is instructive to sketch the argument behind the proof here. Lemma 2 shows that beyond $\tilde{w}$ it is never optimal to exercise the quit option and $\phi=\phi^+$. Therefore, in this wage range, Eq. (6) simplifies to

$$r\Omega(w_1)=u(w_1+b)+\alpha\int_{\phi(w_1)}[T(w_1,w_2)-\Omega(w_1)]\,dF(w_2).$$

Substituting out T and Ω by using Eqs. (4) and (10) yields

$$u(w_1+\phi(w_1))-u(w_1+b)=\frac{\alpha}{r}\int_{\phi(w_1)}[u(w_1+w_2)-u(w_1+\phi(w_1))]\,dF(w_2). \tag{14}$$

[11] Risk tolerance is defined as the reciprocal of Pratt's measure of "absolute risk aversion." Thus, if risk tolerance is linear, risk aversion is hyperbolic. See Pratt (1964).

[12] Individuals draw wage offers from the same probability distribution regardless of the current earnings of the couple. As a result, the uncertainty they face (determined by the dispersion of this distribution) is fixed, making the attitudes of a couple toward a fixed amount of risk – and therefore, absolute (rather than relative) risk aversion – the relevant concept.

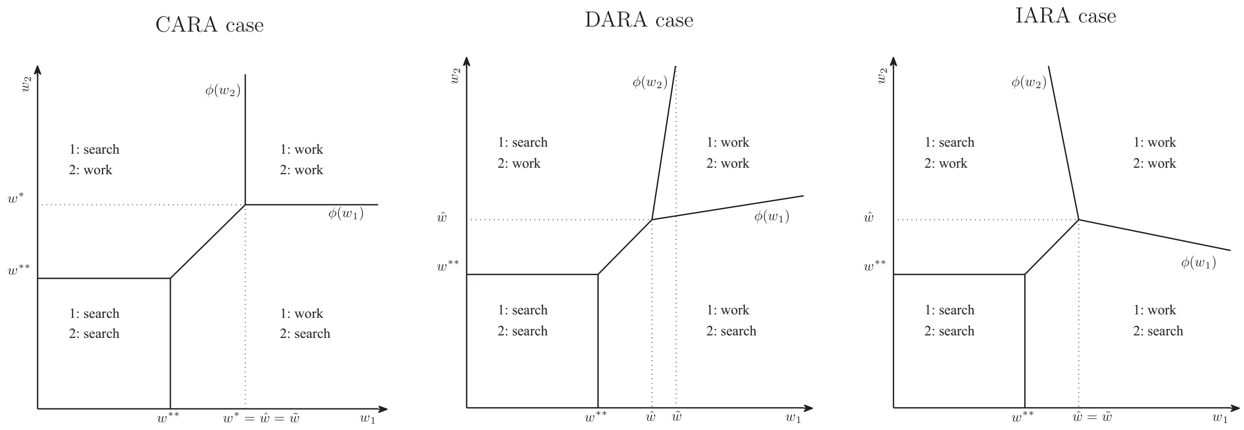

Fig. 3. Reservation wage functions for HARA—class preferences. *Note*: This figure shows the reservation wage functions of a couple for three different utility classes. The left panel is for the constant absolute risk aversion (CARA) case, the middle panel is for the decreasing absolute risk aversion (DARA) case, and the right panel is for the increasing absolute risk aversion (IARA) case.

Dividing both sides by the left-hand side yields

$$1 = \frac{\alpha}{r}\int_{\phi(w_1)}\left[\frac{u(w_1+w_2)-u(w_1+\phi(w_1))}{u(w_1+\phi(w_1))-u(w_1+b)}\right]dF(w_2). \tag{15}$$

Next, applying a well-known property of HARA preferences established by Pratt (1964, Theorem 1), it can be shown that the RHS of (15) is strictly increasing (decreasing) in w_1 in the DARA (IARA) case, and independent of w_1 in the CARA case. Also, note that the RHS is strictly decreasing in $\phi(w_1)$. Hence, for the equality to hold in Eq. (15), in the wage range beyond $\tilde{w}$, $\phi(w_1)$ must be strictly increasing (decreasing) with DARA (IARA) preferences, and constant with CARA preferences.

3.3.2. CARA case

The left panel of Fig. 3 provides a visual summary of the contents of this proposition for the CARA case. The reason ϕ is constant and equal to w^* beyond $\hat{w}$ is that, with CARA utility, attitudes toward risk do not depend on the consumption (and hence wage) level. As the wage of the employed spouse increases, the couple's absolute risk aversion remains unaffected, implying a constant reservation wage for the unemployed partner.

Combining the results of Propositions 2 and 3, we conclude that, with CARA preferences, the dual-searcher couple is less choosy than the single agent ($w^{**} < w^*$). With risk aversion, the optimal search strategy involves a trade-off between lifetime income maximization and the desire for consumption smoothing. Income maximization pushes up the reservation wage, whereas consumption insurance pulls it down since risk-averse agents particularly dislike the low income state (unemployment). The dual-searcher couple can use income pooling to its advantage: it initially accepts a lower wage offer (to smooth consumption across states) while, at the same time, not giving up completely the search option (to increase lifetime income) which remains available to the unemployed spouse. In contrast, when the single agent accepts his job he gives up the search option for good, which induces him to be more picky at the start. Notice that joint search plays a role similar to on-the-job search in its absence, precisely through the breadwinner cycle. Section 3.5 returns to this analogy.

3.3.3. DARA and IARA cases

Under DARA (IARA) preferences, ϕ is increasing (decreasing) with w_1 beyond $\tilde{w}$ (Fig. 3, center and right panels).[13] With DARA, a couple becomes less concerned about smoothing consumption as household resources increase and, consequently, becomes more picky in its job search (and vice versa in the IARA case).

An important feature of DARA – one that complicates the proof of Proposition 3 – is that breadwinner cycles emerge over a wider range of wages of the employed spouse compared to the CARA and IARA cases. As seen in the center panel of Fig. 3, ϕ is strictly increasing in w_1. As a result, there is a wage range where, even when $w_1 > \hat{w}$, a high wage offer may trigger a breadwinner cycle.

Finally, in the DARA case, it does not seem possible to rank w^{**} and w^* unless further restrictive assumptions are made.[14] Simulations showed that with CRRA utility there are parameter configurations where $w^{**} > w^*$.

[13] A full characterization of the slope of $\phi(w_1)$ is not provided in the region between $\hat{w}$ and $\tilde{w}$ for the DARA case. However, in a very broad range of simulations, $\phi(w_1)$ was always found to be strictly increasing in that wage range.

[14] To see why, consider the one-period gain when deciding whether to accept or reject an offer w. The couple compares $u(b+w)$ to $u(2b)$, whereas the single agent compares $u(w)$ to $u(b)$. The couple makes this comparison at a higher level of consumption and, because of DARA, the couple is less risk averse. This force tends to push w^{**} above w^* and does not allow a general ranking.

3.4. Exogenous separations

Now, suppose exogenous separations occur at rate δ. The modifications to the value functions are straightforward, and so are omitted here (see Appendix A). Under risk neutrality, once again, joint-search collapses to single-agent search. The following proposition characterizes reservation wage strategies in the CARA and DARA case.[15]

Proposition 4 (*CARA or DARA Preferences with Exogenous Separations*). *With CARA or DARA preferences, and exogenous job separation, the search behavior of a couple can be characterized as follows*:

(i) *There exists a wage $\tilde{w} \in (\hat{w},\overline{w})$ such that, for any $w_1 > \tilde{w}$, there are no quits.*
(ii) *For $w_1 \le \hat{w}$, $\phi(w_1) = w_1$, and for $w_1 > \tilde{w}$, $\phi(w_1)$ is strictly increasing with $\phi(w_1) < w_1$.*
(iii) *$w^{**} < \hat{w} < \tilde{w}$, which implies that the breadwinner cycle exists.*

For DARA preferences, the existence of exogenous separations has *qualitatively* no effect on joint-search behavior, as can be seen by comparing Propositions 3 and 4. However, for CARA preferences $\phi(w_1)$ is no longer constant beyond $\hat{w}$: it increases with w_1. In the context of joint-search, the separation risk has two effects. Consider the problem of the worker–searcher couple with wage w_1 contemplating an offer w_2. First, there is the risk associated with the duration of the new job offered to the searching spouse. Second, there is the risk of job loss for the currently employed spouse.

The first effect of exogenous separations is also present in the single-agent search model: if the expected duration of a job is lower (high δ), the unemployed agent reduces her reservation wage for all values of w_1. The higher is w_1, the smaller is this effect, since the marginal utility from the additional income decreases in w_1. Since, under CARA/DARA utility, $\phi(w_1)$ is weakly increasing when $\delta = 0$, with $\delta > 0$ the function $\phi(w_1)$ becomes strictly increasing.

The second effect is related to the event that the currently employed spouse might lose his job. If the couple turns down the offer at hand and the job loss indeed occurs, its income will fall from $w_1 + b$ to $2b$ for a net change of $b - w_1 < 0$. Clearly, this income loss (and, therefore, the fall in consumption) increases with w_1. If instead the couple accepts the job offer and spouse 1 loses his job, income will change from $w_1 + b$ to $b + w_2$, for a net change of $w_2 - w_1$. On the one hand, setting the reservation wage to $\phi(w_1) = w_1$ would completely insure the downside risk of spouse 1 losing his job (because then $w_2 - w_1 \ge 0$). At the same time, letting the reservation wage rise this quickly with w_1 reduces the probability of an acceptable offer and increases the probability that the searcher will still be unemployed when spouse 1 loses his job. The optimal search strategy balances these two forces by letting $\phi(w_1)$ rise with w_1, but less than one for one.[16]

From this discussion, it should be clear that one cannot prove a general result on the slope of ϕ beyond $\hat{w}$ in the IARA case with exogenous separations. On the one hand, the economic forces associated with job destruction risk make ϕ an increasing function of w_1. On the other hand, IARA pushes the reservation wage down as w_1 increases.

3.5. Additional results

Some additional results on joint search are now discussed.

Consumption as a private good within the couple: In the baseline model, consumption within the household was assumed to be a public good. Now suppose that consumption is a private good for the couple. In keeping with the symmetry assumption adopted throughout the paper, assume that the two spouses have the same weight in household utility, and hence per-capita intra-period household utility is $u((y_1 + y_2)/2)$. One can easily adapt all the proofs and show that all the results stated so far are still true, the only exceptions being that in the CARA case $w^* < \hat{w}$, and in the DARA and IARA cases this ranking becomes ambiguous. See Appendix B for details. Thus, our findings are largely independent of the degree to which consumption is private within the household.

Equivalence with single agent search: Besides risk neutrality, there are two other important cases where joint-search strategies are equivalent to those of a single agent, as formally proved in Appendix B.

The first case is when couples with CARA utility are free to save and borrow, and debt constraints do not bind. Borrowing effectively substitutes for the consumption smoothing provided within the household through interdependent job search strategies, making the latter redundant.

The second case is when couples can search with the same effectiveness on and off the job. Through the breadwinner cycle, joint search offers the couple a way to climb the wage ladder: one can view joint search as a costly version of on-the-job search. The cost comes from the fact that, absent on the job search, in order to keep the search option active, the pair must remain a worker–searcher couple and forgo the full wage earnings of a dual-worker couple. When on-the-job search

[15] With separation risk, assets can be used to smooth consumption when agents lose their jobs. This consideration introduces a precautionary saving motive. Thus, as explained earlier, the results in this section do hinge on the no-saving assumption, whereas previous propositions did not require this assumption.

[16] This mechanism is closely related to Lise (2010), in which individuals climb the wage ladder but fall to the same unemployment benefit level upon layoff. As a result, in his model, the savings rate increases with the current wage, whereas this precautionary demand manifests itself as delayed offer acceptance in our model.

is explicitly introduced and the offer arrival rate is equal across employment states, it completely neutralizes the benefits of joint search.

An isomorphism: search with multiple job holdings: The joint-search framework analyzed so far is isomorphic to a search model with a single agent who can hold multiple jobs at the same time. To see this, suppose that the time endowment of a worker can be divided into two subperiods (e.g., day shift and night shift). The single agent can be (i) unemployed and searching for his first job while enjoying $2b$ units of home production; (ii) working one job at wage w_1 while searching for a second one; or (iii) holding two jobs with wages w_1 and w_2. It is easy to see that the problem faced by this individual is exactly given by the equations (4)–(6) and therefore it has the same solution as the joint-search problem.[17] Consequently, for example, when the agent works in one job and gets a second job offer with a sufficiently high wage, he will accept the offer and simultaneously quit the first job to search for a better one. Here, it is not the breadwinners who alternate, but the jobs that the individual holds.

4. Quantitative analysis

The goal of this section is twofold. First, the model is calibrated to match basic facts about the US labor market and present some illustrative simulations to gain some sense about the quantitative differences in labor market outcomes between single- and joint-search economies. For example, a priori it is not obvious whether the joint-search economy would have a higher or lower unemployment rate: for dual-searcher couples, w^{**} is below w^*, but for worker–searcher couples $\phi(w_1)$ may be above w^* for a wide range of values of w_1. Second, we turn to US micro-data from the Survey of Income and Program Participation (SIPP) and show that some key implications of the simulated model are quantitatively in line with the corresponding stylized facts about job search behavior of couples.

4.1. Model simulations

The model used in this section features CRRA utility and exogenous job terminations. First, labor market histories for a large number of "singles" are simulated. Then these "singles" are paired together to form couples that conduct joint search in the same economy (i.e., under the same set of parameters). The same sequence of wage offers and separation shocks are used for each individual in both economies, and compare some key labor markets statistics (e.g., mean wage, unemployment rate, unemployment duration, separation rate, etc.) across economies.

4.1.1. Calibration

The economy populated with singles is calibrated so as to replicate some salient features of the US economy. The time period in the model is set to 1 week. The economy is characterized by the following set of parameters: $\{\rho, r, F, \delta, \alpha, b\}$. The coefficient of relative risk aversion, ρ, varies from zero (risk neutrality) to eight in simulations. The weekly net interest rate, r, is set equal to 0.001, corresponding to an annual interest rate of 5.3%. The wage offer distribution F is a truncated log-normal with standard deviation $\sigma = 0.1$, mean $\mu = -\sigma^2/2$ (so that the average wage offer is normalized to one), and truncation point at three standard deviations above the average. Setting $\delta = 0.0054$ reproduces a monthly exogenous separation rate of 2%. For each risk aversion value, the offer arrival rate, α, is recalibrated to generate an unemployment rate of 5.5%.[18] Finally, the value of leisure, b, is set to 40% of the mean of the wage offer distribution.

4.1.2. Results

Table 1 reports some key statistics of the two economies. The first two columns confirm Proposition 1: under risk neutrality ($\rho = 0$) the joint-search economy coincides with the single-agent search economy. Next, consider the case $\rho = 2$. The reservation wage of the dual-searcher couple is 23% lower than in the single-agent search economy, which is reflected in the shorter unemployment durations for these couples. At the same time, though, the reservation wage of worker–searcher couples is higher than w^* for a wide range of the employed spouse's wage.[19] For example, for every wage above the mean of the wage offer distribution (equal to one), the reservation function ϕ is above w^*, implying a longer unemployment duration than for singles. Overall, this second effect dominates and the joint-search economy displays higher average unemployment duration – 14.5 weeks instead of 10.8 – and higher unemployment rate, 7.7% instead of 5.5%.[20]

---

[17] There is a further implicit assumption here: the arrival rate of job offers is proportional to the nonworking time of the agent (that is, 2α when unemployed and α when working one job).

[18] As ρ goes up, w^{**} falls and unemployment duration decreases. So, to continue matching an unemployment rate of 5.5%, a lower value of α is needed. For example, for $\rho = 0$, $\alpha = 0.25$ and for $\rho = 8$, $\alpha = 0.097$.

[19] Two further findings that hold true for all the parameterizations reported in Table 1 are that (i) $\tilde{w}$ is only slightly higher than $\hat{w}$, and (ii) between these two points ϕ satisfies: $0 < \phi'(w_1) < 1$.

[20] An unemployment spell of an X–Y couple is defined to start the first week both X and Y are true, and to end the first week either X or Y are false. For example, an unemployment spell of a dual-searcher couple starts the first week both spouses are unemployed, and ends the week when one of the unemployed spouses accepts a job offer (a transition into worker–searcher couple).

Table 1
Single versus joint search: CRRA preferences and exogenous separations.

Variable name	$\rho=0$		$\rho=2$		$\rho=4$		$\rho=8$	
	Single	Joint	Single	Joint	Single	Joint	Single	Joint
Reservation wage (w^* or w^{**})	1.01	1.01	0.96	0.74	0.80	0.58	0.59	0.48
Reservation wage $\phi(1)$	–	*n/a*	–	1.00	–	0.93	–	0.88
Double indifference point $\hat{w}$	–	1.01	–	1.00	–	0.93	–	0.80
Mean wage among employed	1.05	1.05	1.05	1.09	1.00	1.05	1.00	1.01
Mean–min wage ratio	1.04	1.04	1.09	1.47	1.25	1.81	1.70	2.10
Unemployment rate (%)	5.5	5.5	5.5	7.7	5.5	7.5	5.5	5.7
Unemployment duration	10.8	10.8	10.8	14.5	10.8	14.4	10.8	11.2
Dual-searcher	–	5.8	–	3.9	–	5.7	–	5.9
Worker–searcher	–	10.3	–	14.0	–	13.7	–	10.6
Quits/separations (%)	–	0	–	5.9	–	3.3	–	0.5
Breadw. cycles/UE transitions (%)	–	0	–	7.4	–	4.3	–	1.0
Welfare gain (consumption) (%)	–	0	–	4.7	–	14.7	–	25.5
Welfare gain (income) (%)	–	0	–	1.2	–	2.6	–	0.5

Note: This table compares the simulated labor market outcomes of single-agent search and joint-search models with one location. ρ is the risk-aversion parameter. To make the comparison meaningful, the same history of exogenous separations and wage offers is used in each economy.

Comparing mean wages tells a similar story. The job-search choosiness of worker–searcher couples dominates the insurance motive of dual-searcher couples, so the average wage for individuals in couples is higher than for singles.

The endogenous quit rate (a reflection of the breadwinner cycle in action) is sizable: 5.9% of all separations are quits, and 7.4% of all workers making unemployment to employment (UE) transition have partners making the opposite transition in the same week.[21]

The next four columns in Table 1 display how these statistics change as the risk aversion is increased. As ρ increases, both w^* and w^{**} fall because of the stronger demand for consumption smoothing that makes agents accept job offers more quickly. Notice, however, that the gap between the two first widens and then shrinks. This is intuitive: as $\rho\to\infty$, it must be true that $w^*=w^{**}=b$, so the two economies converge again. As for $\phi(1)$, it falls as risk aversion increases, implying that worker–searcher couples accept job offers more quickly, thus reducing their unemployment duration and the frequency of breadwinner cycles.

Table 1 also reports a measure of frictional wage dispersion, the mean–min ratio (*Mm*), defined as the ratio between the mean wage and the lowest wage, i.e., the reservation wage. Hornstein et al. (2011) demonstrate that the single-agent search model with homogeneous workers, when plausibly calibrated, generates very little frictional wage dispersion.[22] What is novel here is that the joint-search model can generate more frictional dispersion: the reservation wage for the dual-searcher couple is lower (which translates into a lower minimum wage) and the couple can climb the wage ladder faster (which translates into a higher mean wage).

Finally, consider two separate measures of the welfare gains of joint search. Recall that couples have two advantages over singles: first, they can smooth consumption better; second, they can attain a higher lifetime earnings. The first measure of welfare gain is the standard consumption-equivalent variation and captures both benefits of joint-search.[23] Not surprisingly, given the absence of saving, the welfare gain by this measure is very large and increases with risk aversion (ranging from 4.7% to 25.5% of lifetime consumption). The second measure is the increase in lifetime income that is due to joint-search and isolates the effect of the breadwinner cycle. This effect can also be quite large: for example, the gain in lifetime income is roughly 2.6% when $\rho=4$.

4.2. Stylized facts on joint search: a first look

This section investigates whether some of the key predictions of the simulated joint-search model are borne out by the micro data.

Data: Our empirical analysis is based on micro-data from the Survey of Income and Program Participation (SIPP). We use the 1996 panel, which contains 12 waves (48 months of data) starting in December 1995—an ideal period for our analysis because of the stationary aggregate labor market conditions.

The SIPP has several features that make it an ideal data set for our purposes. First, it is a longitudinal survey, essential to our investigation. Second, one aim of the SIPP is measuring worker turnover. Therefore, the problem of classification error

[21] These two fractions are different because, in the (discrete time) simulations, it is possible that during a week when an unemployed spouse in a worker–searcher couple finds a job, his employed partner's job is terminated. Such transitions would be indistinguishable from "true" breadwinner cycles in virtually any micro-data set, and therefore are included as "measured" breadwinner cycles in simulations.

[22] The fifth row of Table 1 confirms this result. It also confirms the finding in Hornstein et al. that the *Mm* ratio increases with risk aversion.

[23] To make the welfare comparison between singles and couples meaningful, here consumption is assumed to be a private good (as in Section 3.5), so each spouse consumes half of household income.

is presumably much less severe than in other data sets. In particular, it contains *weekly* labor-force status information which makes the measurement of transitions very precise.[24] Third, a full employment, earnings and benefits history is available for all household members.[25]

Sample selection: Our sample is constructed to include individuals with strong labor force attachment who are likely to engage in job search when out of work (e.g., exclude individuals if they are enrolled in school). Our analysis of Section 3.5 suggests an "equivalence" between single-agent and joint search for households with sizable savings and with occupations where on-the-job search is very effective. Therefore, deviations from single-agent search behavior in the data are more likely to be detectable among young and low-educated households.[26] In light of this, our sample only includes individuals aged 20–40. Results are reported both for workers of all education levels and for workers with at most a high-school diploma. Our final sample comprises 335 unemployment spells for singles and 645 for couples. Appendix C contains more details on sample selection and a table with descriptive statistics for our final sample.

4.2.1. *Findings*

We now document some stylized facts of joint-search behavior and investigate whether they are quantitatively consistent with the simulated model of Section 4.1.

First, consider how the employed spouse's wage affects the job offer acceptance decision of worker–searcher couples. Regressing log unemployment duration of worker–searcher couples on the log wage of the employed spouse yields an estimated elasticity of 0.33 (S.E. 0.07): doubling the wage of the employed spouse increases unemployment duration of the unemployed partner by a third. This finding is qualitatively consistent with the joint-search model with CRRA utility and exogenous separations, where the transition between worker–searcher status and dual-worker status is regulated by a reservation wage function that increases with the employed spouse wage. Running the same regression on simulated data from the model of Section 4.1 yields elasticities in the range 0.1–0.5 as ρ varies from one to eight. For ρ around two, the elasticity is around 0.3, as estimated in the micro data.

Next, mean unemployment duration is analyzed by household type. Table 2 reports the results. Worker–searcher couples have the longest spells (14 weeks), followed by singles (12 weeks) and, finally, by dual-searcher couples who have much shorter spells of job-search on average (7 weeks).[27] Differences across household types are always statistically significant. Excluding households with high education levels yields similar results—only durations for dual-searcher are somewhat shorter (5 weeks). These facts about unemployment durations line up closely with the predictions of the calibrated model in Table 1. In the range between $\rho = 2$ and $\rho = 8$, the average duration for worker–searcher couples varies between 11 and 14 weeks, for dual-searcher couples it varies between 4 and 6 weeks, and for singles it always equals 10.8 weeks by construction. Overall, the differences in job search durations across household types implied by the model are very close to those estimated in our SIPP sample.

The next step is to explore the presence of breadwinner cycles in the data. Define a breadwinner cycle as a worker–searcher to searcher–worker (or vice versa) transition with a possible intervening dual worker spell of at most 4 weeks.[28] We find that 7.6% of all the transitions from unemployment to employment (UE) for individuals in couples involve a breadwinner cycle. Recall that, in simulations, this fraction rises from 1% when $\rho = 8$ to 7.4% when $\rho = 2$, suggesting again that the data are closest to the model with risk aversion around two.

Finally, since the simulated sample is much larger and longer than the SIPP sample, one may be concerned that our results are affected by small sample bias and right-censoring bias in the data. We therefore recomputed all our statistics on an artificial sample with the same number of spells for singles and couples, and the same length (192 weeks) as our empirical sample. The results were largely unchanged.[29]

5. Joint search with multiple locations

The importance of the geographical dimension of job search is undeniable. For a single agent, accepting a job in a different location could require a moving cost high enough to induce her to turn down the offer. For a couple, this spatial dimension introduces an additional friction with important ramifications for joint job search. A couple is likely to suffer from the disutility of living apart if spouses work in different locations. This cost of living apart can easily rival the physical cost of relocation, since it is a flow cost as opposed to the latter, which is arguably better thought of as a one-time cost.

[24] At least since Gottschalk and Moffitt (1999), the SIPP has become a standard source to study labor market transitions. The greatest measurement challenge in the SIPP is the seam bias: a disproportionate number of labor-market transitions are reported as taking place between waves, not during waves. In our sample, there is a spike in the frequency of spells of 17 weeks. Our results are robust to the exclusion of those observations.

[25] For our investigation, this latter feature is a distinct advantage over the Panel Study of Income Dynamics (PSID), which follows in detail only heads of households. See also Dey and Flinn (2008) for a similar motivation.

[26] It is well known that wealth increases steeply with education level and with age until retirement. Table 4 in Nagypal (2008) shows that the importance of job-to-job transitions, as a fraction of total separations, increases with age and education.

[27] The definition of an unemployment spell for dual-searcher couples and worker–searcher couples is the same used in the simulations of Section 4.1.

[28] In the data, about half of these cycles occurs within 1 week.

[29] For $\rho = 2$, the average unemployment duration for worker–searcher couples is 14.4 weeks, for dual-searchers is 3.1 weeks, and for singles is 11.1 weeks. Other discrepancies were also minor. Simulation results show that such small discrepancies are mostly due to the small sample size as opposed to the right-censoring. Intuitively, the empirical sample is quite long relative to the mean length of jobless spells.

Table 2
Unemployment duration by household type.

Household type	All education	Less than H-S
Worker–searcher couple	13.59[a]	15.33[a]
	(0.46)	(0.76)
Dual–searcher couple	6.61[a]	4.56[a]
	(1.14)	(0.62)
Single	11.84[a]	11.85[a]
	(0.51)	(0.82)
N of obs.	980	412
	Hypothesis testing ($\Pr > \chi^2$)	
Worker–searcher=single	0.009	0.002
Worker–searcher=dual–searcher	0.000	0.000
Dual–searcher=single	0.000	0.000

Note: This table compares unemployment duration across different household types (worker–searcher couples, dual-searcher couples, and singles) calculated from SIPP data. Bootstrapped S.E. based on 500 replications.
[a] Denotes significance at the 1% level.

The introduction of location choice leads to important changes in the search behavior of couples compared to a single agent, *even* with risk neutrality. To make this comparison sharper, this section focuses precisely on the risk-neutral case. Furthermore, many of these changes are not favorable to couples. As a result, joint search can create new frictions as opposed to the new opportunities studied in the one-location model.[30]

To keep the analysis tractable, this section first considers agents searching for jobs in two symmetric locations and provides a theoretical characterization of the solution. Then, it examines the more general case with $L(>2)$ locations that is more suitable for a meaningful calibration, and provides some results based on numerical simulations.

5.1. Two locations

Environment: The economy has two locations and individuals are risk neutral. Couples incur a flow resource cost, denoted by κ, if the spouses live apart. Denote by i the "inside" location, i.e., the location where the couple resides, and by o the "outside" location. Unemployed individuals receive job offers at rates α_i and α_o, respectively, from the inside and outside locations. Both locations have the same wage offer distribution, F. There are no moving costs: the aim of the analysis is the comparison with the single-agent problem, and such costs would also be borne by the single agent.

A couple can be in one of the four labor market states. In addition to the dual-searcher and worker–searcher couples, now couples can have two different dual-worker statuses. If both spouses are employed in the same location they are a "dual-worker couple" with value function $T(w_1,w_2)$; if they are employed in different locations they are instead a "*separate* dual-worker couple" (another absorbing state) with value function $S(w_1,w_2)$.[31] The corresponding value functions are

$$rT(w_1,w_2) = w_1 + w_2, \tag{16}$$

$$rS(w_1,w_2) = w_1 + w_2 - \kappa, \tag{17}$$

$$rU = 2b + 2(\alpha_i + \alpha_o)\int \max\{\Omega(w) - U, 0\}\, dF(w), \tag{18}$$

$$r\Omega(w_1) = w_1 + b + \alpha_i \int \max\{T(w_1,w_2) - \Omega(w_1), \Omega(w_2) - \Omega(w_1), 0\}\, dF(w_2) + \alpha_o \int \max\{S(w_1,w_2) - \Omega(w_1), \Omega(w_2) - \Omega(w_1), 0\}\, dF(w_2). \tag{19}$$

The first three equations are easily understood, and the definition of $\Omega(w_1)$ now has to account separately for inside and outside offers. The decision of the dual-searcher couple is entirely characterized by the reservation wage w^{**}. For a worker–searcher couple, let $\phi_i(w_1)$ and $\phi_o(w_1)$ be the reservation functions corresponding to inside and outside offers. Once again, these functions are piecewise with one piece corresponding to the 45°-line. As in the one-location case, the same functions $\phi_i(w_2)$ and $\phi_o(w_2)$ characterize the quitting decision.

[30] This friction raises the issue of whether, in some states, the couple should split. Studying the interaction between labor market frictions and changes in marital status is beyond the scope of this paper. Here we assume that the couple has committed to stay together or, equivalently, that there is enough idiosyncratic non-monetary value in the marriage to justify continuing the relationship.

[31] Because of symmetry across locations, couples with a searching spouse have no advantage from living separately.

5.1.1. Optimal search strategies

It is easy to see that the single-agent search problem with two locations is the same as the one-location case (with the arrival rate, α, in Eq. (3) replaced by $\alpha_i+\alpha_o$). The single-agent reservation wage is still denoted w^*. The next proposition characterizes the optimal joint-search strategies in the two-location case, whenever there is a positive cost κ of living apart.

Proposition 5 (*Two Locations*). *With two locations, risk neutrality, and $\kappa>0$, the search behavior of a couple can be characterized as follows. There is a wage value*

$$\hat{w}_S=b+\kappa+\frac{\alpha_i}{r}\int_{\hat{w}_S-\kappa}[1-F(w)]\,dw+\frac{\alpha_o}{r}\int_{\hat{w}_S}[1-F(w)]\,dw,$$

and a corresponding value $\hat{w}_T=\hat{w}_S-\kappa$ such that:

(i) [*Outside offers*]: *for $w_1<\hat{w}_S$, $\phi_o(w_1)=w_1$, and for $w_1\geq\hat{w}_S$, $\phi_o(w_1)=\hat{w}_S$.*
(ii) [*Inside offers*]: *for $w_1\leq\hat{w}$, $\phi_i(w_1)=w_1$, for $w_1\in(\hat{w},\hat{w}_S)$, $\phi_i(w_1)$ is strictly decreasing, and for $w_1\geq\hat{w}_S$, $\phi_i(w_1)=\hat{w}_T$.*
(iii) *$w^{**}\in(\hat{w}_T,\hat{w})$, whereas $w^*\in(\hat{w},\hat{w}_S)$. Since $w^{**}<\hat{w}$, the breadwinner cycle exists.*

The first result is that a dual-searcher couple is less choosy than a single agent because it is effectively facing a worse offer distribution: some wage configurations are attainable only in separate locations, hence by paying the cost κ.

Fig. 4 shows the reservation functions for both outside and inside offers. Consider outside offers (left panel) to the unemployed spouse of a worker–searcher couple where the employed spouse earns $w_1<\hat{w}_S$. Any wage less than w_1 is rejected. For offers exceeding w_1, the employed worker quits his job and follows his spouse to the outside location: his earnings are not high enough to justify living apart and paying κ. In this region, the breadwinner cycle is active *across locations*. In contrast, when $w_1>\hat{w}_S$ and the couple receives a wage offer $w_2>\hat{w}_S$, it will bear the cost of living separately in order to keep both of those high wages.

Comparing the two panels of Fig. 4, it is immediate that inside offers are accepted by a worker–searcher couple over a broader range (of w_1 values), since no cost κ has to be paid. The function $\phi_i(w_1)$ has three distinct pieces. For w_1 small enough, $\phi_i(w_1)=w_1$, and the breadwinner cycle is active. For w_1 large enough, it is constant. A new intermediate range $(\hat{w},\hat{w}_S)$ arises where the function is decreasing. This is because ϕ_o is increasing in this range: as w_1 rises, the expected gains from search accruing through outside offers are lower (it takes a higher outside wage offer w_2 to induce the employed spouse to quit) and the reservation wage for inside offers falls.

The multiple-location model *with risk neutrality* shares two results with the one-location model *with risk aversion*: (i) the unemployed couple being less picky than the individual, and (ii) the breadwinner cycle. However, the economic mechanisms are different in the two models.

5.1.2. Tied-movers and tied-stayers

In a seminal paper, Mincer (1978) studied empirically the job-related migration decisions of couples in the United States. Following the terminology introduced by Mincer, we refer to a spouse who rejects an outside offer that she would

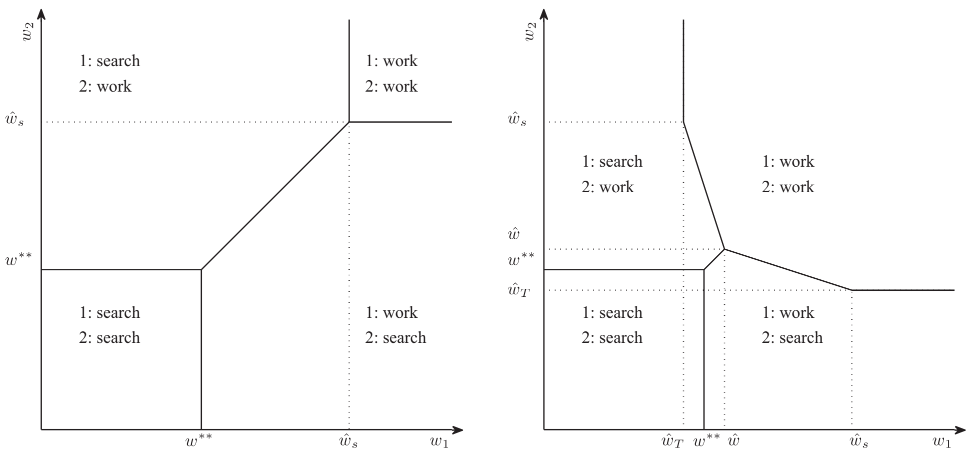

Fig. 4. Reservation wage functions for outside (left) and inside (right) offers. *Note*: This figure shows the reservation wage functions of a couple in an environment with multiple locations and risk-neutral individuals. The left panel depicts the reservation wage functions for the offers originating from outside locations, and the right panel depicts the reservation wage functions for offers originating from the inside location. $\hat{w}_S$ is the wage of the employed spouse beyond which she never quits, if the unemployed spouse accepts an outside offer. Similarly, $\hat{w}_T$ is the wage of the employed spouse beyond which the employed spouse never quits, if the unemployed spouse accepts an inside offer.

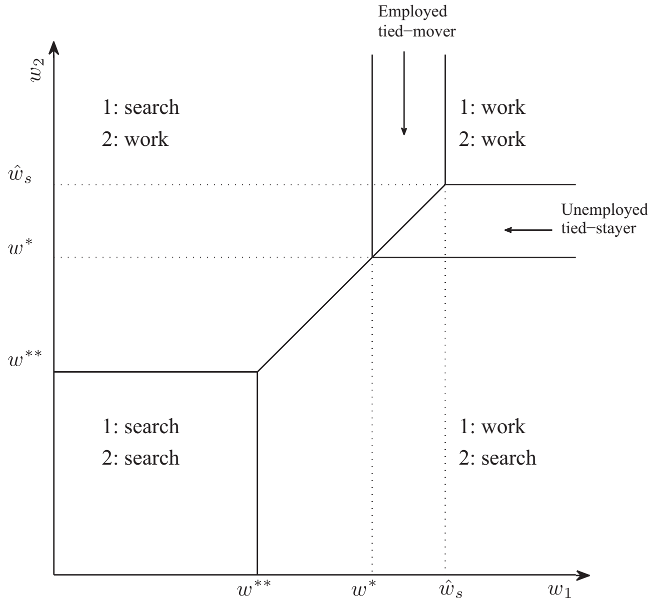

Fig. 5. Tied-stayers and tied-movers in the joint-search model. *Note*: This figure shows the regions in the (w_1,w_2) space where we observe tied-movers and tied-stayers in the multiple location model. A tied-mover is defined as an individual who follows her spouse to another location even though she would stay in her current location if she were single. Similarly, a tied-stayer is an individual who rejects an outside offer from a different location, and stays in the current location, even though she would accept the offer and move if she were a single.

accept when single as a "tied-stayer." Similarly, a spouse who follows her partner to the new destination even though her individual calculus (as single) would dictate otherwise is called a "tied-mover."[32]

Fig. 5 redraws $\phi_i(w_1)$ and indicates the regions giving rise to tied-stayers and tied-movers in our model. When $w_1 > w^*$, the unemployed spouse rejects all outside offers with $w_2 \le \phi_i(w_1)$ and stays in the current location. In contrast, a single agent would accept all offers w_2, which is less than $\phi_i(w_1)$ by Proposition 5. Therefore, an unemployed spouse who rejects an outside wage offer $w_2 \in (w^*,\phi_i(w_1))$ is formally a tied-stayer. Second, there is a region in which the currently *employed* spouse becomes a tied-mover. Suppose that $w_1 \in (w^*,\hat{w}_S)$. If the unemployed spouse receives an outside offer higher than w_1, she will accept it, the employed spouse will quit his job, and both will move to the other location. In contrast, if the employed spouse were single, she would not have moved to the outside location because she would not even be searching for a job. Thus, the employed spouse is a tied-mover.

Both sets of choices involve potentially large concessions by a spouse compared to the situation where he/she were single, but they are optimal from a joint-search perspective. This feature opens the possibility of welfare costs of joint search, an aspect of the model that the next section analyzes quantitatively, through simulation.

Finally, note that the isomorphism to the single-agent search model with multiple job holding extends to this set up as well. It is enough to think of κ as a commuting cost the agent would incur when holding two jobs in different locations.

5.2. *Illustrative simulations*

For this simulation exercise, the two-location model is extended to allow for multiple locations and exogenous separations. Specifically, consider an economy with L geographically separate symmetric labor markets. Firms in each location generate offers at flow rate ψ. A fraction θ of total offers are distributed equally to the $L-1$ outside locations and the remaining $(1-\theta)$ is made to the local market.[33]

L is set to nine, representing the number of US census divisions; θ is set to $1-1/L$, implying that firms make offers to all locations with equal probability. κ ranges between 0 and 0.3. Because this cost is shared between two spouses, $\kappa = 0.3$ corresponds to a flow cost of slightly less than 15% of the average *household* income of a dual worker couple. The remaining parameter values are exactly the same as those used in the simulations of the one-location model of Section 4.1 for the risk-neutral case ($\rho = 0$).

[32] Using data from the 1962 Bureau of Labor Statistics (BLS) survey of unemployed persons, Mincer (1978) defined an individual to be a tied-stayer (a tied-mover) if the individual cites his/her spouse's job as the main reason for turning down (accepting) a job in a different location.

[33] The assumption that there is a very large number of individuals in each location, combined with the fact that the environment is stationary (i.e., no location-specific shocks), implies that the number of workers in each location is effectively constant, despite the fact that workers move freely across locations.

Table 3
Single versus joint search: multiple locations.

Variable name	Cost of living separately per spous			
	$\kappa=0.0$		$\kappa=0.1$	$\kappa=0.3$
	Single	Joint	Joint	Joint
Reservation wage (w^* or w^{**})	1.01	1.01	0.96	0.90
$\hat{w}_T$	–	1.01	0.94	0.84
Double indiff. point ($\hat{w}$)	–	1.01	0.98	0.94
$\hat{w}_S$	–	1.01	1.03	1.10
Reservation wage $\phi_i(1)$	–	*n/a*	0.96	0.90
Mean wage	1.05	1.05	1.05	1.05
Mean–min wage ratio	1.04	1.04	1.12	1.25
Unemployment rate (%)	5.5	5.5	6.7	15.6
Unemployment duration	10.8	10.8	11.4	17.6
Dual-searcher	–	5.8	3.1	2.6
Worker–searcher	–	10.3	11.1	17.3
Movers (% of population)	0.5	0.5	0.6	1.1
Stayers (% of population)	0.6	0.6	0.9	2.6
Tied-movers/movers (%)	–	0	20.0	51.3
Tied-stayers/stayers (%)	–	0	14.6	33.1
Quits/separations (%)	–	0	14.1	44.5
Welfare gain (income) (%)	–	0	−0.5	−6.6

Note: This table compares the simulated labor market outcomes of single search and joint search models with multiple locations. κ is the per period cost of living separately for each spouse, and the table makes the comparison for different levels of this cost. To make the comparison meaningful, the same history of exogenous separations and wage offers is used in each economy.

Table 3 presents the results. A comparison of the first two columns confirms that the single-agent and joint search problems are equivalent when $\kappa=0$. The third and fourth columns show the simulation results when $\kappa=0.1$ and $\kappa=0.3$. The reservation wages are in line with our theoretical results in Proposition 5: $\hat{w}_T<w^{**}<w^*<\hat{w}_S$. A positive cost κ makes outside offers less appealing, inducing couples to reject some offers that a single would accept. As a result, the unemployment rate is higher under joint search. For example, when $\kappa=0.3$ the unemployment rate is 15.6% compared to 5.5% in the single-agent model. Average unemployment duration increases from 10.8 weeks to 17.6 weeks as κ rises from 0 to 0.3. The duration for dual-searcher couples is shorter than for single agents (since $w^{**}<w^*$) and gets even shorter as κ increases (falls from 5.8 weeks to 2.6 weeks). However, because worker–searcher couples face a smaller number of feasible job offers from outside locations, they have longer unemployment spells: 11.1 weeks when $\kappa=0.1$ and 17.3 weeks when $\kappa=0.3$, compared to 10.8 weeks when $\kappa=0$. Overall, there are more jobless workers at any point in time, and some of these unemployed individuals – those in worker–searcher families – stay unemployed for much longer than they would have, had they been single.

Next consider the impact of joint search on the mobility decision of couples. In our context, "movers" are only those couples who move to another location because one of the spouses accepts an outside job offer.[34] Similarly, a couple is defined to be a "stayer" if either member of the couple turns down an outside job offer. Using this definition, the fraction of movers in the population is 0.5% *per week* when $\kappa=0$; it rises to 1.1% when $\kappa=0.3$.[35] Notice that while the fraction of movers appears high, this is not surprising given that physical costs of moving were assumed away. Perhaps more strikingly, 51.3% of all movers are tied-movers, using Mincer's definition, when $\kappa=0.3$. The fraction of tied-stayers is also sizable: 33.1% in the high κ case.[36] The fraction of job separations due to voluntary quits is as large as 44.5% in the high κ case.

Finally, a comparison of lifetime wage incomes shows that the friction introduced by the interaction of joint search and multiple locations can be substantial: lifetime income of a couple is reduced by about 0.5% (per person) compared to a single agent when $\kappa=0.10$ and by 6.6% when $\kappa=0.3$. Overall, these results show that with multiple locations, joint-search behavior can differ substantially from the standard single-agent search.

6. Conclusions

Search theory has almost exclusively focused on the single-agent problem, ignoring the ramifications of joint search for labor market dynamics. This paper characterizes theoretically the joint job-search behavior of couples in a variety of economic environments.

[34] If one of the spouses belonging to a separate dual-worker couple receives a separation shock and becomes unemployed, she will move to her spouse's location. In this case, the household is not considered a mover, since the move did not occur in order to accept a job.

[35] Part of the rise in the moving rate is mechanically related to the rise in the unemployment rate with κ: because there is no on-the-job search, individuals only get job offers when they are unemployed, which in turn increases the number of individuals who accept offers and move.

[36] In his empirical investigation, Mincer estimated that roughly two-thirds of the wives of moving families are tied-movers, and over one third of wives in families of stayers are tied-stayers.

As is often the case in theoretical analyses, we had to strike a balance between generality and tractability to make sharp statements about optimal joint-search behavior. Structural empirical analyses of the data may require richer models. However, knowing the properties of the reservation wage functions in special cases (like ours) provides guidance towards the numerical solution and the interpretation of simulation-based results in these more complex joint-search environments. From a theoretical viewpoint, there are additional forces that could influence joint-search decisions in the labor market beyond those studied in this paper. Some examples include complementarity/substitutability of leisure between spouses (Burdett and Mortensen, 1977), or consumption-sharing rules within the family that deviate from full income pooling, as in the collective model (Chiappori, 1992), or the option given to the couple to split and break up the marriage (Aiyagari et al., 2000), or fundamental asymmetries between men and women.

One key challenge in the advancement of this research program is the access to micro-data with household-level, high-frequency information on labor market histories of both members of the couple and on their geographical movements. Data in such format would allow a structural estimation of the model.[37] While a full structural estimation is beyond the scope of this paper, a first step is made here towards uncovering patterns of joint-search behavior in the micro data. As already argued, in light of our theoretical results it seems that deviations from single-agent search behavior are more likely to be detectable among young and poor households, who are closer to being hand-to-mouth consumers. In data from the SIPP, among such households the breadwinner cycle indeed appears to be active, and the unemployment durations of different types of households are broadly consistent with the predictions joint search.

Looking ahead, it will be interesting to enrich our environment with an equilibrium determination of the wage distribution and study the conditions under which joint search may offer another resolution to the Diamond paradox, which undermines the standard single-agent equilibrium search model.

Acknowledgments

The authors would like to thank seminar participants at various seminars and conferences. Chris Huckfeldt and Cloe Ortiz de Mendivil provided excellent research assistance. Guvenen acknowledges financial support from the NSF under grant number SES-0351001.

Appendix A. Supplementary data

Supplementary data associated with this article can be found in the online version at http://dx.doi.org.10.1016/j.jmoneco.2012.05.001.

References

Aiyagari, R., Greenwood, J., Guner, N., 2000. On the state of the union. Journal of Political Economy 108 (2), 213–244.
Albrecht, J., Anderson, A., Vroman, S., 2010. Search by committee. Journal of Economic Theory 145 (4), 1386–1407.
Andolfatto, D., Gomme, P., 1996. Unemployment insurance and labor-market activity in Canada. In: Carnegie-Rochester Conference Series on Public Policy, vol. 44, pp. 47–82.
Blundell, R., Chiappori, P., Magnac, T., Meghir, C., 2007. Collective labour supply: heterogeneity and non-participation. Review of Economic Studies 74 (2), 417–445.
Browning, M., Crossley, T., Smith, E., 2007. Asset accumulation and short term employment. Review of Economic Dynamics 10 (3), 400–423.
Burdett, K., 1978. A theory of employee job search and quit rates. American Economic Review 68 (1), 212–220.
Burdett, K., Mortensen, D., 1977. Labor supply under uncertainty. In: Ehrenberg, R.G. (Ed.), Research in Labor Economics, JAI Press, New York, pp. 109–158.
Chiappori, P.-A., 1992. Collective labor supply and welfare. Journal of Political Economy 100 (3), 437–467.
Costa, D., Kahn, M., 2000. Power couples: changes in the locational choice of the college educated, 1940–1990. Quarterly Journal of Economics 115 (4), 1287–1315.
Cubeddu, L., Rios-Rull, J.-V., 2003. Families as shocks. Journal of the European Economic Association 1 (2–3), 671–682.
Danforth, J., 1979. On the role of consumption and decreasing absolute risk aversion in the theory of job search. In: Lippman, B., McCall, J. (Eds.), Studies in the Economics of Search, North Holland, Amsterdam, pp. 109–131.
Dey, M., Flinn, C., 2008. Household search and health insurance coverage. Journal of Econometrics 145 (1–2), 43–63.
Flabbi, L., Mabli, J., 2011. Household search or individual search: does it matter? Evidence from lifetime inequality estimates, manuscript.
Garcia-Perez, J., Rendon, S., 2004. Family job search and consumption: The added worker effect revisited, manuscript.
Gemici, A., 2011. Family migration and labor market outcomes, manuscript.
Gomes, J., Greenwood, J., Rebelo, S., 2001. Equilibrium unemployment. Journal of Monetary Economics 48 (1), 109–152.
Gottschalk, P., Moffitt, R., 1999. Changes in job instability and insecurity using monthly survey data. Journal of Labor Economics 17 (S4), S91–S126.
Guner, N., Kaygusuz, R., Ventura, G., 2010. Taxation, aggregates and the household, manuscript.
Heathcote, J., Storesletten, K., Violante, G.L., 2010. The macroeconomic implications of rising wage inequality in the U.S. Journal of Political Economy 118 (4), 681–722.
Hornstein, A., Krusell, P., Violante, G.L., 2011. Frictional wage dispersion in search models: a quantitative assessment. American Economic Review 101 (7), 2873–2898..
Lise, J., 2010. On-the-job search and precautionary savings: theory and empirics of earnings and wealth inequality, manuscript.
Lise, J., Seitz, S., 2011. Consumption inequality and intra-household allocations. Review of Economic Studies 78 (1), 328–355.

[37] A more feasible task is the structural estimation of a search model to understand patterns of multiple job holding, an environment that was shown to be isomorphic to joint search, under some assumptions. The survey data needed for such a task are more readily available.

McCall, J., 1970. Economics of information and job search. Quarterly Journal of Economics 84 (1), 113–126.
Mincer, J., 1978. Family migration decisions. Journal of Political Economy 86 (5), 749–773.
Mortensen, D., 1970. A theory of wage and employment dynamics. In: Phelps, E. (Ed.), Microeconomic Foundations of Employment and Inflation Theory, W. Norton, New York.
Nagypal, E., 2008. Worker reallocation over the business cycle: the importance of employer-to-employer transitions, manuscript.
Pissarides, C., 2004. Consumption and Savings with Unemployment Risk: Implications for Optimal Employment Contracts. IZA Discussion Paper 1183.
Pratt, J., 1964. Risk aversion in the small and in the large. Econometrica 32 (1–2), 122–136.
Lentz, R., Tranaes, T., 2005. Job search and savings: wealth effects and duration dependence. Journal of Labor Economics 23 (3), 467–490.
Rogerson, R., Shimer, R., Wright, R., 2005. Search-theoretic models of the labor market: a survey. Journal of Economic Literature 43 (4), 959–988.