Discussion Paper Series

IZA DP No. 19011

October 2026

The Labour Market Dynamics of Households: Eyes Down for a Full House

Paul Gregg
CEP, London School of Economics

Jonathan Wadsworth
Royal Holloway University of London,
CEP(LSE), CReAM/RF Berlin and IZA@LISER

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IZA@LISER NETWORK
ISSN: 2365-9793

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The Labour Market Dynamics of Households: Eyes Down for a Full House*

Abstract

Little is known about the dynamic factors that shape movements in household labour market stocks. Expanding on the literature used to analyse individual labour market flows, we apply and extend dynamic techniques to the study of changes in household labour market states. The methodology allows us to assess the contribution of different household sub-groups to household dynamics and facilitates an assessment of the role of changing household populations and the roles of sorting and dependence. We apply this framework to compare individual and household labour market transition flows in the UK. The relative contributions of these inflows and outflows in explaining labour market stocks differ across cycles, across household types and across individual and household levels of aggregation.

JEL classification

J6

Keywords

employment, households, labour market dynamics

Corresponding author

Jonathan Wadsworth
j.wadsworth@rhul.ac.uk

* *Acknowledgements:* Thanks to Mike Elsby, Dan Hamermesh and seminar participants at seminars at LSE, Royal Holloway, Southampton and The Royal Economic Society for helpful comments.

1. Introduction

For more than fifty years, economists have used dynamic modelling to help understand the labour market experience of individuals, (Perry (1970, 1972), Marston (1972). Knowing how frequently individuals move into and out of any given labour market state contributes greatly to understanding both the level of and persistence in that state. The matching literature, (Pissarides 2000), is predicted on modelling individual flows between workers and firms. Knowing how these different flows change over time or over the economic cycle is also central to any analysis of labour market performance and targeted policy interventions, (See the discussions in, for example, Elsby, Michaels and Solon, (2009), Shimer(2012), Elsby, Smith and Wadsworth (2024)).

Economists interested in the study of poverty have long applied dynamic analysis at the level of the household, rather than at the level of the individual, in order to understand better both the incidence and persistence of poverty, (for example Bane and Ellwood (1986), Stevens (1999), Jenkins (2011)). Gregg and Wadsworth (1996, 2001, 2008) have argued that a household level of aggregation can also be applied to study employment. When this is done, they demonstrate that individual and household based estimates of jobless rates can offer conflicting signals about labour market performance - essentially because jobs are not evenly distributed across households. In this paper we argue that to understand any differences in the levels of labour market stocks or changes in these stocks across different aggregations, it can be useful to compare the labour market dynamics across aggregations. As yet, the study of household labour market dynamics has not been formalised.

If all adults lived in single adult households, modelling labour market dynamics at either level of aggregation would be identical. However, a majority of working age adults live in households with other adults and their respective labour market decisions or circumstances can

interact. The labour supply literature has long acknowledged the existence of added worker or discouraged worker effects in modelling household labour supply, (see for example Chiappori (1988)). The labour demand literature has also demonstrated that many firms find new workers using friends and family of existing workers, (Oyer and Schaefer 2011). Household transitions will be the net result of interaction of these supply, demand and individual effects but with firms and connected individuals interacting.

Little attention has so far been given to explicit modelling of aggregate household labour market dynamics. Lundberg (1985) raises the issue of a 2-person household labour market transition decision when estimating individual transition rates conditional on the labour force status of the partner in an analysis of the added worker effect without establishing a general framework. Blundell, Pistaferri and Saporta-Eksten (2016) also recognise the role that changes in household (family) labour supply can have in smoothing incomes and by extension household consumption. They integrate this into a life-cycle model of consumption and labour supply.

Our paper provides an analytical framework for comparing the dynamics of the labor market at both the individual and household level. As we show below, a household level approach can give additional insights into the workings of the labour market that will not be revealed by a focus on individual labour market dynamics. A household's labour market state will depend on the movements in and out of work of the individuals who comprise them. Sometimes, these within-household employment dynamics will be complementary, sometimes not. As a result, the household labour market dynamics need not move at the same rate or in the same direction as the individual dynamics.

To show this, we adapt a Markovian decomposition accounting framework used by Elsby, Smith and Wadsworth (2024) who estimate the roles of population flows alongside labour market flows in shaping individual labour market stocks. We extend their dynamic modelling

methodology to study household labour market dynamics. This reveals, for the first time, new insights into the reasons for changes in household labour market states and also insights into differences in the job inflow and outflow rates of individuals compared to households.

Section 2 tracks the divergence in individual and household-levels of jobless stocks, using UK as an exemplar, in order to help motivate the flow analysis that follows. Section 3 establishes some basic metrics regarding the expected behaviour of household transition rates compared to individual transition rates and the likely roles of sorting and dependence in shaping these differences. Section 4 then sets out the theoretical framework and mechanics of the decomposition. The role of individual population dynamics in shaping individual labour market stocks, highlighted by Elsby et al. (2024), is replaced by the role of household formation and dissolution (effectively household creation and destruction) in shaping household labour market stocks.

Section 5 discusses the type of data needed to apply such a decomposition. The UK has experienced a sharp divergence in labour market performance at the individual and household level over time and has suitable data with which to apply the analytical framework outlined here. Section 6 presents some results. The results suggest that the relative contributions of inflows and outflows differs across individual and household levels of aggregation and at different points in time. Section 7 concludes.

2. Empirical Motivation

The existence of multiple adult households opens up the possibility that work can be unevenly distributed across households. Gregg and Wadsworth (1996) first showed that the path of non-employment in the UK measured at the household level was not aligned with the non-employment rate measured at the individual level.[1] Aside from any putative effects this may

[1] This pattern also appears to hold for several other OECD economies, Gregg, Scutella and Wadsworth (2010).

have on labour market performance, an unequal distribution of work also has implications for government spending and revenues. Figure 1 uses UK Labour Force Survey (LFS) data to show that the individual non-employment rate in 1977 was similar to that observed in 2013, but the household non-employment rate was twice as high in the latter period. This finding appears to have changed little, in the UK, in recent years. Over the pandemic and its aftermath, the household non-employment rate was again rising faster than the individual non-employment rate.

An unequal distribution of work across households means that there have, at times, been simultaneous rises in the number of households where no occupant works and the number of households where all occupants work, (along with an associated a fall in the number of households with a mixture of individuals both in work and not in work). Figure 2 shows that most of the fall in the workless household share between 2013 and 2020 seems to have been absorbed by a rise in the stock of all-work households rather than households containing a mixture of working and non-working adults (Figure 2). The rise in the workless household rate after 2020 has been accompanied by a stalling of the all-working household share alongside a continued fall in the mix working household share.

Suggestive evidence that the workless household rate is likely higher than expected given the aggregate labour market performance is shown in Figure 3. The Figure tracks the workless household rate over time alongside a measure of the "excess" workless household rate used by Gregg and Wadsworth (2008).[2] The graph shows that the workless household rate is still around 5 percentage points higher than might be expected given the level of labour market performance measured at the individual level.

In essence, work, in the UK, is still unequally distributed across households and the signals

[2] The authors construct a counterfactual household non-employment rate as a function of the aggregate individual rate and the number of household occupants. The addition of controls for age gender education and region makes little difference to the expected counterfactual levels.

stemming from individual and household measures of joblessness are often not aligned. The rest of the paper examines how measuring labour market flows at household level can help understanding of this issue.

2.1 Household Labour Market Stocks

Individual and household labour market stocks are linked and this matters for the modelling of household labour market transitions in the next section. Many of the issues involved in the concept and measurement of household labour market stocks have been discussed in Gregg and Wadsworth, (2001,2008). Here we briefly review them in order to frame the subsequent discussion.

Let there be 2 individual states of the world, Employed, E=1, and Non-Employed, (or workless), E=0. Consider a simple world of 2 households each containing 2 adults and a non-employment rate in the individual population of 50%. The state in which one adult is out of work in each household, $\mathscr{A} = [\{1,0\},\{1,0\}]$ is different from the state of the world in which both adults work in one household and no one works in the other, $\mathscr{B} = [\{1,1\},\{0,0\}]$.
The aggregate, individual-based, non-employment rate is the same in both cases, but the workless household rate is 0% in $\mathscr{A}$ and 50% in $\mathscr{B}$. The individual-based non-employment statistic is uninformative regarding the distribution of work across households.

Households do not always have two adult occupants. Rather, individuals, i, are distributed across households with n_h occupants, such that the individual population $P = \Sigma_{n_h=1}^{N} n_h H_{n_h}$, where H_{n_h} is the number of households of size n_h. It is easy to show that as household size rises, the expected probability that a household is workless falls (and the chance of a household being employed rises), since

$$Pr[WorklessHousehold] = \prod_{i=1}^{n_h} w_i = w_i^{n_h} \tag{1}$$

- the product of each occupant's individual probability of being workless, w_i. The more people in the household, the greater the chance that at least one person will have a job, assuming independence of the workless probabilities.[3] Figure A1 in the appendix confirms that household job finding rates rise with the number of occupants in the UK over time.

The existence of households containing a mixture of adults in work and out of work suggests that a simple binary two-state framework (work/no work) could miss important elements of the determinants of household labour market stocks and the underlying dynamics. To account for this, let there now be three household states dependent on the labour market status of the individuals therein: Workless (W_h) , but now split working households into: Mixed, $M_h = \{1,0\}$, those containing a mix of working and non-working adults,and All Working in which all occupants are in work, $A_h = \{1,1\}$.

Some jobless individuals live with other jobless individuals. Other jobless individuals live with individuals in work. Others are not partnered. Gregg and Wadsworth (2008) show that the stock of workless individuals is distributed across households according to the identity

$$\sum_i W_i = \sum_{n_h} n_h * W_{n_h} + \sum_{n_h \geq 2} \sum_{j=1}^{n_h - 1} j * M_{n_h}^j \tag{2}$$

where W_{n_h} is the number of workless households with n_h occupants, $M_{n_h}^j$ is the number of jobless individuals in household size n_h living in a mixed-work household.[4]

The realisation that employment can be distributed across different household types gives rise to the possible divergence between individual and household non-employment rates. However, equations (1) and (2) show that a rising share of single adult households is positively correlated with an increase in the workless household rate for a given individual jobless rate.

[3] Conditional dependence in the work probabilities within households could overturn this result. We address this issue when modelling dynamics in the next section.

[4] For example, in a world of one and two-adult households, the number of jobless individuals is, $W = W_1 + 2W_2 + Mix_2^1$ ie the count of single adult workless households, W_1, plus the total number of two-adult workless households, W_2, multiplied by two added to the total of two-adult mixed-work households, ${M_2}^1$. A similar equation applies to the distribution of working individuals across households.

The more single households, the closer the stocks at the two levels of aggregation. Figure A2 in the appendix shows that single adult households now account for nearly 80% of all workless households, (panel B), almost twice their share in the (working age) household population, (panel A). This will also raise both the workless and the all-working household rates, other things equal.

There are also changing propensities to experience a given labour market state within household types. Figure A1 indicates that this has been a feature across UK households over time. Jobless rates for all household size types display both secular and cyclical movement over time. Absolute volatility is largest for single adult households.

The next section introduces household labour market dynamic modelling that accounts for both within and between-household size changes.

3. Modelling Household Labour Market Transitions

As with comparisons of labour market stocks across aggregations, it follows that if everyone lived in 1-person households, the individual and household labour market transition probabilities would be identical.[5] If there is a distribution of household sizes, the individual and household job finding and job separation rates can diverge.

Consider again a simple two state economy where individuals can either be employed, (E) or workless, (W). To simply further, we initially classify a household with anyone in work as employed, so combining all-work and mixed-work households. A non-employed household has no-one in work. We abstract away from the myriad reasons why an individual and by extension a household, may be employed or non-employed. With J labour market sub-states, (eg. full-time employee, self-employed, unemployed, want work but not seeking, etc) there

[5] The majority of workless households in the 1980s were couple households with children. Since then, the workless household stock in the UK is increasingly dominated by single households without children. The share of lone parents in the stock has also fallen over time.

are J^n possible realisations of those sub-states in a household with n occupants. There are then J^{2n} possible different transitions across those sub-states. Rather than look at each of these possible transitions separately we offer an overarching, generalisable framework for modelling household labour market dynamics that also facilitates a sub-state analysis.

3.1 Household Employment Separation Rates

We first outline some theoretical results regarding household transition rates. Appendix B derives these results in more detail.

Individuals are distributed across households of varying sizes $n_h = 1, 2...N$.

There are h = 1, 2...H households in the household population.

Each individual i = 1... P has a job separation probability at time t, $s_{it} \in (0,1)$ and $s_{it} \sim (\mu_{sit}, \sigma^2_{si})$

Individual separations are assumed, initially, to be heterogeneous but independent, so the probability that the household becomes workless equals the probability that all n_h individuals in the household separate in a given period which is then the product of these individual probabilities:

$$s_{hnt} = \prod_{i=1}^{n_h} s_{it} = s_{it}^{n_h} \sim \left(\mu_{sht}, \sigma^2_{sh}\right) \tag{3}$$

Given independence, the expected level of s_{hnt} falls as n_h increases. Larger households have lower separation probabilities. The expected household separation probability into worklessness falls exponentially with the number of occupants and is always less than the minimum individual job separation probability within a household, if there is more than one adult. Intuitively, the more individuals in the household, the smaller the chance that everyone leaves a job. It follows that the mean aggregate household separation probability is by construction always less than the aggregate mean of the individual separation probabilities.

The household-individual job separation gap also depends non-monotonically on the level

of the separation rate s_i. As $s_i \to 0.5$ from either 1 or 0, the gap between s_h and s_i gets larger. Other things equal, the individual and household separation rates will tend to diverge more in a recession, when both s_i and its dispersion typically rises. Figure 4 shows a wider gap between separation rates at the end of the 1990s recession, but the gap appears to narrow during the 2008 recession. This suggests additional influences on the separation rates.

Differences in separation rate paths across individual and household aggregations may also stem from sorting of high and low separation individuals into different households; interdependence of individual probabilities within households, such as might derive from added or discouraged worker effects in multiple-adult households; or any state dependence effects of being in a household of a given size. Appendix B shows that sorting, co-dependence or positive state dependence in themselves do not overturn the basic result that the household separation probability will be lower than the observed mean individual separation rate. However, the aggregate household separation rate and hence the gap between the two separation rates will vary with these factors. Positive co-dependence and positive (associative) sorting within households or negative state dependence (lower separation rates in larger households) will all raise the aggregate household separation rate and so narrow the gap. Since the mean separation rate for each aggregation is:

$$\mu_{IS} = \frac{1}{P}\sum_{i} s_{it} = \frac{1}{P}\sum_{h=1}^{H}\sum_{i\in h} s_{it} = \frac{1}{P}\sum_{h=1}^{H} n_h * m_{shn_h t} \quad \mu_{HS} = \frac{1}{H}\sum_{h=1}^{H} s_{ht} = \frac{1}{H}\sum_{h=1}^{H}(\prod_{i=1}^{n} s_{it}) \quad (4)$$

where $m_{shn_h t}$ is the mean separation rate for household size n_h.

Intuitively, the product sum in the household aggregate is generally lower than the individual aggregate mean due to the geometric-arithmetic mean inequality.

Sorting or shocks that put high separation probability individuals into high separation households raise the household sum of products relative to the individual aggregate mean and the gap between the two aggregate measures narrows. If individuals in larger households have

lower separation rates the extra gap added by the product is smaller and the gap also narrows. However, if the extent of sorting or co-dependence also varies by household size, Appendix B shows this can be sufficient to reverse the separation gap or ensure aggregate household and individual mean separation rates move in different directions over time. Appendix B also shows also that the individual aggregate separation rate gives larger weights to households with more occupants. The household aggregate mean gives the same weight to all households regardless of size. So factors that cause separation rates to vary with household size also influence the aggregate individual mean separation probability. Appendix B also confirms that the gap between the two aggregates

$$\mu_{IS} - \mu_{Hs} \approx \mu_{IS}(1 - \alpha_1) \tag{5}$$

where α_1 is the share of single adult households in the household population. The gap is approximately equal to the individual separation rate multiplied by the share of multi-person households. The product nature of household separation implies that employment separation is more likely for smaller households, other things equal. A shift toward smaller households will therefore raise the mean household separation rate for any given individual mean and narrow the gap between the individual and household means.

The important feature for understanding household dynamics is that variation in individual flows across different household sizes along with changes in their relative shares will help drive changes in the household transition rates over time.[6]

3.1.1 Mixed-Work Households and Separations

If we relax the assumption of wholly employed or wholly non-employed households, any divergence between household and individual separation rates will be dampened by households

[6]Household size, of course, is not the only possible disaggregation. Presence of children in the household, skill or ethnicity are other possible sub-group decompositions which could follow this framework.

that contain a mixture of working and non-working adults. By construction, the influence of assortative matching, positive co-dependence and state dependence must all be lower in the presence of mixed-work households. The number of employed adults, rather than total household size, determines the product relevant for household separation probability.

For all households of size n_h, the separation probability is

$$\bar{s}_{hn_h} = \delta_A \bar{s}_A + \delta_M \bar{s}_M + \delta_W * 0 \tag{6}$$

For an all-work household, $\bar{s}_A$ is the product of the n employed individuals' separation probabilities. For a mixed household containing $m < n$ employed adults, it is the product of only the m separation probabilities. Thus, as the share of mixed households increases, a greater proportion of households have fewer than n separation probabilities entering the product. This reduces the divergence between the household and individual measures. So $\uparrow \delta_M \implies \bar{s_h} \rightarrow \bar{s_i}$ without any change in sorting or dependence. It also follows that an increase in the share of single adult households will also lower the household product and narrow the gap between the two aggregate separation measures.

3.2 Household Job Finding Rates

As with separations, there are several reasons to think that household job finding rates can differ from individual job finding rates in both level and direction over time. Assume, initially, that the individual outflow probability, f_{it} are independent but heterogeneous with $f_{it} \sim (\mu_{If}, \sigma^2_{si})$. It only requires one individual from a workless household to find a job, whatever the household size, to generate a household outflow from the workless state. Intuitively, the more adults who live in the household the greater the chance that any of them find work.

Given these assumptions, the expected household job finding rate out of the workless state is one minus the probability of staying workless. For a household with n_h working age occu-

pants this is

$$f_{ht} = 1 - Pr[W_{h,t+1}, W_{h,t}] = 1 - \binom{n_h}{0} f_{it}^0 (1 - f_{it})^{n_h - 0} = 1 - (1 - f_{it})^{n_h} \geq f_{it} \tag{7}$$

Equation (7) shows that, under these assumptions, the expected job finding rate of households is always greater than or equal to the job finding rate of individuals. The expected difference between individual and household job finding rates is strictly increasing in n, the number of residents. More occupants means a greater chance that any one of them will find a job.

Appendix B shows that the aggregate mean household job finding probability can be written as a weighted average of the mean job finding flows for each household size

$$\mu_{Hf} = \sum_{n \geq 1} \gamma_{n_h} [1 - (1 - \mu_{If})^{n_h}] \approx \sum_{n_h \geq 1} \gamma_{n_h} \left[n_h \mu_{If} - \frac{n_h(n_h - 1)}{2} \mu_{If}^2 \right] \approx \bar{n}_h \mu_{If} - \frac{\mu_{fi}^2}{2} \Omega \tag{8}$$

where γ_{n_h} is the share of household size n_h in the non-employed household population, $\bar{n}_h$ is mean household size in the household stock and $\Omega = \sum_n \gamma_n n(n-1)$

The household-individual aggregate job finding gap is then

$$\Delta_f = \mu_{If} - \mu_{Hf} \approx \mu_{If} - \left[\bar{n}_h \mu_{If} - \frac{\mu_{If}^2}{2} \Omega \right] = \mu_{If}(1 - \bar{n}_h) + \frac{\mu_{If}^2}{2} \Omega \tag{9}$$

The first term in (9) is non-positive, since $n_h \geq 1$ and so the (average) level of the individual job finding rate f_{it} matters for the expected gap between the individual and household job finding rates. The second term in (9) is positive. This suggests that there are diminishing marginal returns to household size in job finding that may eventually offset the first term. Figure A1 shows that the UK household job finding rate is dominated by 1-Adult households. Appendix B confirms that the household mean job finding probability is proportional to household size and that gap, Δ_f will be smaller as the share of single adult households rises. However, for small f, typical of the mean job finding rates observed in the data, the second term will be smaller than the first term. Hence, other things equal, the mean aggregate household job finding rate is

greater than the mean individual job finding rate.

These results are, however, inconsistent with the patterns outlined in Figure 4 which show that the observed mean household job finding rate is typically *lower* than the individual rate. To account for this, it is likely that the transition rates of adults in multi-adult households are either correlated with and/or dependent on the transition rates of others in the household.

Appendix B2 shows that if there is systematic sorting of low outflow probability individuals into some households and high outflow probability individuals into others, the household transition probability will decline. Sorting reduces diversification within households, and so increases the chances that no-one in some households will find work. Similarly, positive dependence, (common positively correlated job finding shocks within households), implies that if one individual finds work, so would others in the household. Conversely, negative dependence, (negatively correlated shocks), would smooth the likelihood of household job finding and so raise the household job finding rate.

Appendix B also shows that the presence of household-size state dependence, where the job finding rate is conditional on being in a household of size n, creates similar patterns to conditional dependence of individuals or associative sorting in a household. In short, a combination of sorting, co-dependence and state dependence could describe the patterns observed in Figure 4. Changes in some or all of these elements could alter the size of the gap and even the direction of change in the household job finding probabilities relative to the individual mean over time.

3.2.1 Mixed-Work Households and Job Finding

As with job separations, relaxing the assumption of wholly non-employed households, divergence between household and individual separation rates will be dampened by households that contain a mixture of working and non-working adults. Again, the influence of assortative

matching, positive co-dependence and state dependence on job finding must all be attenuated in the presence of mixed-work households. The number of non-employed adults in the household, rather than total household size, determines the product relevant for household job finding probability. For a mixed household containing $m < n$ employed adults, the job finding probability is the product of the subset of m job finding probabilities. Thus, as the share of mixed households increases, a greater proportion of households have fewer than n job finding probabilities entering the product. This reduces the divergence between the household and individual measures.

Figure A3 in the appendix plots quarterly job finding and job separation rates of individuals conditional on household size. The Figure shows that job finding rates of individuals rise with the number of adult occupants. Job loss rates of individuals living in 2 adult households are lower. Table A2 shows that job finding rates rise monotonically with household size across a set of given characteristics; age, education and gender.

In contrast, Table A2 shows that job separation rates are typically *higher* for given characteristics in *smaller* households. Figure A5 outlines the within-household correlations of the individual job finding and job separation rates for households with more than one adult. These correlations combine elements of sorting and dependence. The correlations, while positive, are not large and do not show much systematic change over time. They are, however, larger for job finding rates, indicating that sorting or dependence may play a larger role in household job finding rates.[7]

However, the majority of individual job finding flows stem from jobless individuals who find work while living in a household with others already employed.[8] The exposition above

[7] Distinguishing between state dependence, sorting and co-dependence is left to future research with data that could help untangle these effects.

[8] The mean percentage share of all individual job finding flows accounted for by individuals living in mixed work households in our data is around 66%. The mean percentage share of job separations accounted for by individuals living in mixed work households is around 25%.

subsumes these movements into the continuously employed household state. We augment the flows accounting framework to account for this mixed-work realisation in the next section.

4. Decomposing Changes in Household Labour Market States

We now set out our framework that facilitates understanding of the relative contributions of job finding and job separation flows on changes in labour market stocks at either the individual or household level of aggregation.

4.1 Log-Decomposition of Changes in Household Stocks

One way to assess the roles of job inflows and outflows in determining changes in labour market stocks across the two levels of aggregation is to adapt the steady state decomposition of changes in the individual unemployment rate outlined in Elsby, Michaels and Solon (2009) to examine changes in both individual and household non-employment rates.

Write the steady state non-employment (workless) rate at either individual or household level of aggregation as

$$\bar{W}_{jt} = \frac{s_j}{(s_{jt} + f_{jt})} \qquad j = i, h \tag{10}$$

Log differentiation of this gives

$$dlog\ \bar{W}_{jt} \approx (1 - \bar{w}_{jt})[dlog\ s_{jt} - dlog\ f_{jt}] \tag{11}$$

So changes in the (log) non-employment rate are approximately equal to changes in the (log) job finding or job separation rates at either the individual or the household level of aggregation. This is only a broad approximation, since a) in the first term on the right hand side of (11), unlike the unemployment rate typically used in such decompositions, the workless rate is not close to zero. b) Neither is our observed sum of s+f close to 0.5, more typical in the United

States individual unemployment transition data, which would mean that the half-life deviation of the stock from its steady state would be close to one time period. Both these features imply that the actual non-employment rate, of whatever aggregation, will often be a long way from the steady state. We argue therefore that it is preferable to model dynamic changes in the *actual* household labour market stocks.

We also advocate modelling all stocks as a system with which to evaluate the contributions of the various transition rates that drive changes in these household stocks. The next section outlines how this can be done using a Markovian accounting decomposition.

4.2 Household Labour Market System Dynamics

In a 2-state world, the number of non-employed individuals at time t, W_{it}, is given by the difference between the number of people flowing into and out of non-employment, or, equivalently, the number of non-employed stayers plus the number of new entrants from employment.

$$W_{it} = (1 - we_{it})W_{it-1} + (ew_{it})E_{it-1} \tag{12}$$

where *we* is the flow probability from W to E and *ew* is the flow probability from E to W. The household equivalent to this 2-state law of motion for individuals just replaces individual based stocks and flows with household equivalents. So the workless household stock at time t

$$W_{ht} = (1 - we_{ht})W_{ht-1} + (ew_{ht})E_{ht-1} \tag{13}$$

where the discrete-time transition probabilities, $p_{kj_t} = \frac{kj_t}{k_{t-1}}$ equal the number of individuals moving between state k and j divided by the previous period stock of individuals in state k. Equation (13) says that this period's workless household stock equals last period's workless household stock multiplied by the fraction still there, plus those moving from working households to workless households. A similar law of motion applies to employed households.

Elsby, Hobijn and Sahin (2015) put these laws of motion into a system discrete-time Markov chain model to analyse changes in individual-based labour market stocks. If we instead use the same approach for households and for two equivalent household labour market states then the household labour market system is

$$\begin{bmatrix} E_{ht} \\ W_{ht} \end{bmatrix} = \begin{bmatrix} ee_{ht} & we_{ht} \\ ew_{ht} & ww_{ht} \end{bmatrix} \begin{bmatrix} E_{ht-1} \\ W_{ht-1} \end{bmatrix} \tag{14}$$

To separate the role played by mix-work households suggested by the previous section, there is a 3-state analogous system which adds the flows between the mix-work state

$$\begin{bmatrix} A_{ht} \\ M_{ht} \\ W_{ht} \end{bmatrix} = \begin{bmatrix} aa_{ht} & ma_{ht} & wa_{ht} \\ am_{ht} & mm_{ht} & wm_{ht} \\ aw_{ht} & mw_{ht} & ww_{ht} \end{bmatrix} \begin{bmatrix} A_{ht-1} \\ M_{ht-1} \\ W_{ht-1} \end{bmatrix} \tag{15}$$

Normalizing [9] the household labour market stocks by the (working-age) household population, H_t, so that $w_t = W_t/H_t, \quad m_t = M_t/H_t, \quad a_t = A_t/H_t$

we obtain a system that governs the rates of each household labour market state

$$\begin{bmatrix} a_{ht} \\ m_{ht} \\ w_{ht} \end{bmatrix} = \begin{bmatrix} aa_{ht} & ma_{ht} & wa_{ht} \\ am_{ht} & mm_{ht} & wm_{ht} \\ aw_{ht} & mw_{ht} & ww_{ht} \end{bmatrix} \begin{bmatrix} a_{ht-1} \\ m_{ht-1} \\ w_{ht-1} \end{bmatrix} \tag{16}$$

The rates in each column add to one, so the system can be written in a more compact form [10]

$$\underbrace{\begin{bmatrix} a_{ht} \\ w_{ht} \end{bmatrix}}_{\text{St}} = \underbrace{\begin{bmatrix} 1 - aw_{ht} - am_{ht} - ma_{ht} & wa_{ht} - ma_{ht} \\ aw_{ht} - mw_{ht} & 1 - wa_{ht} - wm_{ht} - mw_{ht} \end{bmatrix}}_{\text{Pt}} \underbrace{\begin{bmatrix} a_{h,t-1} \\ w_{h,t-1} \end{bmatrix}}_{\text{St-1}} + \underbrace{\begin{bmatrix} ma \\ mw \end{bmatrix}}_{\text{qt}} \tag{17}$$

4.2.1 Steady State Household Rates

The equilibrium household labour states are given by the steady state equivalent of (17)

$$\bar{s}_t = P_t \bar{s}_t + q_t = (I - P_t)^{-1} q_t \tag{18}$$

[9] Assuming the household population is constant between t-1 and t

[10] Use the fact that $w_{ht} = (1 - wa_{ht} - wm_{ht})w_{h,t-1} + (mw_{ht})(1 - w_{h,t-1} - a_{h,t-1}) + (aw)a_{h,t-1}$
$= (1 - wa - wm - mw)w_{h,t-1} + mw + (aw - mw)a_{h,t-1}$
and
$a_{ht} = (1 - aw_{ht} - am_{ht})a_{h,t-1} + (ma_{ht})(1 - w_{h,t-1} - a_{h,t-1}) + (wa)w_{h,t-1}$
$= (1 - aw - am - ma)a_{h,t-1} + ma + (wa - ma)w_{h,t-1}$

Elsby et al. (2015) show that given a dynamic system as in (18), convergence to the flow steady states can be expressed in the form of a partial adjustment mechanism.

$$\Delta s_t = A_t \Delta \bar{s}_t + B_t \Delta s_{t-1} \tag{19}$$

where $A_t = (I - P_t)$ and $B_t = (I - P_t)P_{t-1}(I - P_{t-1})^{-1}$

Applied to households, the first term in (19) then gives the effect from contemporaneous changes in the household transition probabilities on the steady states. The second term summarises the impact of past changes in household transition probabilities on the current household labour market states.

4.2.2 Flow Contributions to Actual Household Rates

To understand how to estimate the contribution of changes in the transition probabilities on the actual household labour market states, (rather than on the steady state), iterate backwards by repeated substitution for Δs_{t-1} in (19) to give

$$\Delta s_t = \sum_{k=0}^{t-1} C_{k,t} \Delta \bar{s}_{t-k} + D_t \Delta s_0 = \sum_{k=0}^{t-1} C_{k,t} \Delta \bar{s}_{t-k} + D_t A_0 \Delta \bar{s}_0 \tag{20}$$

where $C_{k,t} = (\prod_{n=0}^{k-1} B_{t-n}) A_{t-k}$ and $D_t = \prod_{n=0}^{t-1} (B_{t-n})$

Hence, the change in any household labour market stock can be written as the (weighted) history of steady state changes plus the initial starting period change in the household stock. The steady states in this distributed lag adjust immediately to any change in the transition probabilities p_{ijt}. The C_{lt} coefficients capture the cumulative effect of the historical values of the transition probabilities.

Again following Elsby et al. (2105), the influence of each transition probability on the stocks can be approximated by taking a first-order Taylor expansion to the change in the steady state

$$\Delta \bar{s} = \bar{s}_t - \bar{s}_{t-1} \approx \sum_{i \neq j} \frac{\delta \bar{s}}{\delta p_{ij}} \Delta p_{ij} \tag{21}$$

Substituting (21) into (20) indicates that the effect of each transition probability on the change in the stock at any point in time is the cumulative (weighted) sum of derivative of the steady state with respect to the transition probability in each interval. The derivatives $\frac{\delta \bar{s}}{\delta p_{ij}}$ can be calculated analytically or by using standard rules for matrix derivatives.

Inserting this approximation for $\Delta \bar{s}$ into (20) allows the changes in labor market stocks to be written as a function of the changes in the transition probabilities.[11]

$$\Delta s_t \approx \sum_{k=0}^{t-1} C_{k,t} \frac{\delta \bar{s}_{t-k}}{\delta p_{ij,t-k}} \Delta p_{ij,-t-k} + D_t A_0 \sum_{i \neq j} \frac{\delta \bar{s}_0}{\delta p_{ij}} \Delta p_{ij} \tag{22}$$

This linear representation in equation (22) can then be used to decompose the variance in each of the aggregate household labour market states over time into the fractions accounted for by each household labour market transition probability.[12] For example, the fraction of the variance in the change in the aggregate workless household rate accounted for by the job loss flow into the workless household state, (ew), is given by

$$\beta_{ew} = \frac{Cov(\Delta w_t, \delta w / \delta p_{ew})}{Var(\Delta w_t)} \tag{23}$$

4.3 Household Sub-Group Decomposition

As discussed in Section 3, the aggregate household-level transition rates are weighted averages of the different household types that comprise the total. Often researchers are interested in the relative contributions of sub-groups to aggregate change. To enable this, Elsby, Smith and Wadsworth (2024) develop a sub-group matrix decomposition of aggregate individual-based labour market state changes.[13]

It seems pertinent to apply a similar approach to household analysis. Since we show above that the number of occupants in a household affects observed household transition rates, one

[11] The derivation with respect to households is given in Appendix C.
[12] Fujita and Ramey (2009) show how to do this in their analysis of changes in the individual unemployment rate.
[13] The authors use migrants and UK-born workers as their sub-groups.

obvious sub-group household decomposition is an assessment of the different contributions of household size types. These contributions will reflect both the relative share of household types in each transition and the differing importance of each transition path across the groups.

The aggregate household transition from state k to j can be rewritten as the weighted sum of the transition probabilities for each sub-group n_h.

$$p_{kj} = \Sigma_{n_h} \phi_{n_h} p_{kj}^{n_h} \tag{24}$$

where $\phi_{n_h} = k_{n_h t-1}/k_{t-1}$ is the share of household type n_h that makes up the total stock of households in labour market state k at time t-1.

Given (24), it follows that the law of motion for the workless household labour market state, W, at time t now becomes

$$W_t = [\Sigma_{n_h} \varepsilon_{n_h,t} ww_{n_h,t}] * W_{t-1} + [\Sigma_{n_h} \upsilon_{n_h,t} mw_{n_h,t}] * M_{t-1} + [\Sigma_{n_h} \eta_{n_h,t} mw_{n_h,t}] * A_{t-1} \tag{25}$$

where $\varepsilon_{n_h,t} = W_{n_h,t-1}/W_{t-1}$, $\upsilon_t = M_{n_h,t-1}/M_{t-1}$ and $\eta_t = A_{n_h,t-1}/A_{t-1}$

are the shares of household type n_h in the workless, mixed and all-work household stocks.[14]

This also allows the total differential of the steady state stocks $\bar{s}$ with respect to a given transition probability p_{kj} in (21) to be disaggregated as

$$\frac{\delta \bar{s}}{\delta p_{kj}} = \Sigma_{k \neq j} \left(\frac{\delta \bar{s}}{\delta p_{kj}} \Delta p_{kj} \right) = \Sigma_h \Sigma_{k \neq j} \left(\frac{\delta \bar{s}}{\delta p_{kj,h}} \Delta p_{kj,h} \right) \tag{26}$$

so that the transition rate contributions of the household sub-groups add to the total contribution of each transition rate. Analytical expressions for subgroup derivatives based on (26) can be obtained, and the contribution to overall household labour market dynamics for each subgroup can be calculated .

[14] The laws of motion for the other household stocks follow accordingly from (25)

4.4 Accounting for Changing Household Structure

The decomposition above implicitly assumes that the household population is constant over time, (or at least does not change composition over time in a way that affects transition rates). Elsby, Smith and Wadsworth (2024) show that existing flow decompositions based on individuals miss out on population dynamics. they show that for any country with fluctuating populations caused by immigration or baby booms, this can be an important omission.

The analogous reasoning applied to households is to recognise that household formations change over time. The employment status of households can also change because of changes in demographic composition. Individuals partner, couples separate, children leave or return to the family home. These factors may change household labour market status even without any change in the underlying individual transition probabilities for the individuals.[15]

To address this issue, we adapt the model of Elsby et al. (2024), applying it to household populations. Between surveys, some households will leave (a combination of emigration, non-response and household dissolution) and some households will join (a combination of new household formation and immigration).

Let the working age household population change as a result of these net inflows, N:

$$HPOP_t = HPOP_{t-1} + N_t \tag{27}$$

where N_t is the total net household population inflow at time t, which comprises net inflows to workless, mixed and all-work households $N_t = N_t^w + N_t^m + N_t^a$. The net household population inflow *rate*, in discrete time, is then $n_t = \frac{N_t}{HPOP_t}$

Hence, net new inflows to each of the 3 household labour market states can be described in

[15] For example a working single individual and a single non-working individual gives a household state of the world $\mathscr{A} = [\{1\},\{0\}]$ If they partner, the state of the world is $\mathscr{B} = [\{1,0\}]$. This reduces both the workless and all work household count by one and raises the mixed work household count by one, leaving the individual non-employment rate unchanged. It is, of course, possible that such an event, partnering or divorce, for example, could also directly affect the labour market transition probabilities.

terms of inflow rates and existing population $n_t^j = \frac{N_t^j}{HPOP_t} \iff N_t^j = n_t^j HPOP_t$

Net population inflows change the dynamics of workless, mixed and all-work household states. Each state is boosted by direct net inflows. In matrix form, these dynamics are now

$$\underbrace{\begin{bmatrix} W_t \\ M_t \\ A_t \end{bmatrix}}_{\mathsf{S_t}} = \underbrace{\begin{bmatrix} 1-wa-wm & mw & aw \\ wm & 1-ma-mw & am \\ wa & ma & 1-aw-am \end{bmatrix}}_{\mathsf{P_t}} \underbrace{\begin{bmatrix} W_{t-1} \\ M_{t-1} \\ A_{t-1} \end{bmatrix}}_{\mathsf{S_{t-1}}} + \underbrace{\begin{bmatrix} n^w \\ n^m \\ n^a \end{bmatrix} HPOP_{t-1}}_{\mathsf{q_t}} \quad (28)$$

Dividing through by current household working age population, $HPOP_t$ and using

$HPOP_{t-1}/HPOP_t = 1/(1+n_t)$, the augmented dynamic system expressed in rates becomes

$$\underbrace{\begin{bmatrix} w_t \\ m_t \\ a_t \end{bmatrix}}_{\mathsf{s_t}} = \underbrace{\frac{1}{1+n_t} \begin{bmatrix} 1-wa-wm & mw & aw \\ wm & 1-ma-mw & am \\ wa & ma & 1-aw-am \end{bmatrix}}_{\mathsf{Pt}} \underbrace{\begin{bmatrix} w_{t-1} \\ m_{t-1} \\ a_{t-1} \end{bmatrix}}_{\mathsf{s_{t-1}}} + \underbrace{\frac{1}{1+n_t} \begin{bmatrix} n^w \\ n^m \\ n^a \end{bmatrix}}_{\mathsf{q_t}} \quad (29)$$

The scalar $1/(1+n_t)$ dampens the effect of total household population growth on household labour market dynamics. For example, any new inflows to M or A increase the household population without raising the workless household numbers, W. This will therefore tend to reduce the workless household rate.

Since the matrix setup retains the structure $s_t = P_{t-1}s_{t-1} + q_t$, the variance decomposition of the household stocks follows in the same way as outlined in section 4.2.2. Comparing equations (17) and (29) there are now three additional flow determinants of the household stocks, namely the net population flows into each household state. There are now three additional derivatives contributing to the change in the steady state in (21) and by extension the three additional determinants of the changes in the actual stocks in (22).

Having set down the household flow decomposition we now apply the methodology to household data from the UK.

5. Data

In order to calibrate household dynamics we need longitudinal data on household composition and the labour market states of the individuals who live in them.[16] Most labour force surveys operating throughout the OECD contain both individual and household identifiers and a longitudinal element to the sample. The UK Labour Force Survey (LFS) was a good exemplar of this, until recently, since it had both individual and household identifiers and followed households over a period of fifteen months at three month intervals.[17] We define working age individuals as all men and women aged between 16 and statutory retirement age at the time of the sample. We exclude any households with a head above state pension age to abstract from dynamics caused by retirement. [18]

We can then count the numbers of adults employed, according to the ILO/OECD definition, and the numbers out of work in each of the, approximately, 30,000 working age households and 70,000 adults sampled in every quarter. From this we can estimate the household labour market states: Workless, Mixed or All-Work by cumulating individual work status, (work/not working), within a household.

The longitudinal element of the LFS, introduced in 1992, means that addresses (rather than the same households) and their occupants are surveyed for 5 consecutive quarters in a rotating 5 wave structure. One fifth of the sample is replaced each quarter, giving an 80% sample overlap between consecutive quarters. It is this 2-quarter panel that is used to construct the quarterly flows covering the period 1992q2 to 2015q4.

Any selectivity in the sample could influence results if residential mobility is associated

[16] The UK definition of a household according to the UK Office of National Statistics is "one person living alone, or a group of people (not necessarily related) living at the same address who share cooking facilities and share a living room, sitting room or dining area."

[17] These identifiers were suppressed in 2016 and access restricted after this date. The COVID pandemic also reduced response rates significantly after 2019 which generates additional problems with the longitudinal samples.

[18] Men aged 65 and Women aged 60, for the majority of the sample period. There is no statutory retirement age in the UK.

with changes in labour market status. Equally there may be selectivity stemming from household non-response between quarters. Figure A3 in the appendix plots the time series of household employment rates using the panel sample and the full LFS sample. The series are closely aligned. The broad trends and cycles in all three states are common to both samples, though the levels diverge a little at the end of the period. The panel under-estimates the share of all work households and over-estimates the share of mixed work households by around 1 percentage point by the end of the estimation period. We proceed with the panel sample at our disposal, though the results should be interpreted accordingly.

For households that remain at the same address, we observe individual and household labour market status in quarter t and again at quarter t+1 . Both individual and household gross flow transition probabilities can then be estimated. The job separation and job finding probabilities, s and f, are given by the counts of individuals/households moving between employment and non-employment deflated by the relevant denominators. These flows can be disaggregated by the number of adult occupants of the household. We split the household sample into single adults, 2 adults and 3+ adults.[19]

The UK LFS, or any other data set that we are aware of, does not track the previous labour market status of new households that are sampled in the survey nor follows households that leave the UK. This means we are unable to estimate the role of net household inflows on household dynamics, which is therefore left for future work. We can, however, identify households affected by demographic change between quarters, (”movers”), and see whether the labour market dynamics of these households are different to households that retain the same individuals across quarters, (”stayers”), using the sub-group decomposition outlined above.

To identify mover households, we count the number of households where the number of occupants is not the same across the two quarters or, for a given number of occupants, the

[19] The typical 3+ adult household is a couple with non-dependent (ie age 18+) children living at the parental home.

person identifiers in the household are not the same in each quarter. This may be because the number of occupants is higher than in the last quarter, the result of marriage or a child reaching working age for example. Conversely, the number of occupants may be lower than last quarter because of partial household dissolution.[20]

6. Results

6.1 Individual and Household Transition Rates Compared

Table 1 outlines summary non-employment related statistics at individual and household level from the working panel sample. The sample period begins at the end of one recession in 1992, continues through the subsequent recovery until the next recession in 2007-2011 and the next recovery thereafter. Around 70% of non-employed individuals live in multi-adult households. Single households make up 70% of all non-employed households, (column 2). This share has risen over time. Around half of non-employed individuals live in households that have no working adult, (column 3).

Table 1 confirms that individual and household transition rates, as well as labour market stocks, are not always aligned. Between 1992 and 1996, the individual non-employment rate falls by 1.1 percentage points, while the household non-employment rate rises by 0.9 points. The individual job separation rate falls, while the household rate is broadly static over this time, (column 4). In contrast, the job finding rates for individuals are broadly static while the household job finding rate rises, (column 5). Thereafter, while the non-employment levels and transition rates move in the same direction over time, the magnitude of the changes in the transition rates at the two levels of aggregation are not always similar.

[20] We make no distinction as to reasons for change in composition, though this is one possible extension for future work.

Table 1. Non-Employment Inflow and Outflow Rates: Individual and Household

	Non-Employment rate (%) (n)	% in Single h'hold	% in Workless h'hold	Job Separation s	Job Finding f
	(1)	(2)	(3)	(4)	(5)
Individual					
1992	26.1	22.4	49.8	0.037	0.098
1996	25.0	28.2	54.2	0.025	0.102
2007	23.1	28.5	53.7	0.021	0.086
2011	24.5	31.4	54.6	0.021	0.068
2015	21.0	28.6	50.3	0.020	0.086
Household					
1992	17.2	62.1		0.021	0.079
1996	18.1	65.8		0.019	0.087
2007	16.4	66.3		0.016	0.072
2011	17.9	70.5		0.018	0.067
2015	14.4	71.4		0.013	0.074

Source LFS and authors' calculations. The numbers are base period q4 of each year.

Job separation rates for individuals are, consistent with section 3, higher than those measured at household level across all time periods. Around 1-2% of employed households become workless each quarter. Some 2-4% of individuals make the same transition. The amplitude of changes over time is also larger for the individual job finding measure. The gap between the individual and household rates is higher in the earlier half of the sample period when the individual job separation rate was higher, consistent with the prediction in section 3.1.

In contrast, job finding rates for workless households are lower than the individual rates, averaging around 7% and 9% a quarter respectively. This suggests that the assumption of homogeneity of the individual finding probabilities for workless households compared to the wider population may not hold. The gap between individual and household job finding rates does however fall, as expected, as the individual job finding rate falls.

Table A1 in Appendix A gives details on the characteristics of individuals in different household types. The Table confirms the over-representation of older individuals and women

among the non-employed and the over-representation of younger workers among non-employed job finders and job separations. There are also noticeable differences across household size groups for given characteristics. Table A2 documents the mean transition rates for the demographic groups by household size. Again it is apparent that household size matters for a given demographic.

Figure 5 tracks job separation and job finding rates by household size over time. Household job separation rates are higher, as section 3 suggested, for single adult households. Separation rates for 2 and 3-adult households often overlap, suggestive of sorting heterogeneity or some form of dependence by household type. Household job finding rates rise with the number of occupants, though again there are points in time, notably during the two recessions covered by the sample period, where the job finding rates for two and three adult households overlap. Figure 5 also confirms the suggestion in Appendix B that volatility over time in job finding rates is larger in households with more occupants.

As outlined in section 4, changes in aggregate household transition rates can stem from changes in the share of group types, for example more mixed or single adult households in the population or from changes within household types. Tables A3 and A4 in the appendix give shift-share decompositions of the change in the job finding and separation rates over the sample period.[21] Over most short-run intervals, within-group variation in the transition rates dominates the decomposition for both individuals and household job levels of aggregation. Reallocation across household types does not drive change in observed transition rates in the short run.

[21] Use

$$\Delta f = \sum_g (\gamma_{0,g} \Delta_{f_g}) + \sum_g (\Delta\gamma_g f_{0,g}) + \sum_g \Delta f_g \Delta\gamma_g$$

6.1.1 Steady State Comparisons

Table 2 uses the steady state approximation in equation (11) to evaluate the relative contributions of the log inflow and outflow rates to changes in steady state non-employment at both levels of aggregation. The Table gives the log point change in job separation and job finding rates for the start and end periods of the sample.

While the steady state approximation is far from exact, it is clear that the contribution of flows in explaining variation in the steady state stocks can differ when measured at different levels of aggregation. For 1992-1996, the fall in the steady state individual non-employment rate was driven by a large fall in the job separation rate (row 1, column 3). In contrast, the household separation and job finding rates explain a similar amount of the in the steady state household non-employment rate over the same period. Over the recovery period 2011-2015, changes in the job finding rate explain most of the improvement in individual steady state non-employment, but changes in the job separation rate drive changes in the fall in household steady-state non-employment. Table 1 also shows that steady state changes in non-employment rates are a poor approximation to the actual changes in non-employment rates. Sometimes the steady state changes take the opposite sign to the actual change. The next section outlines the results of the flow decomposition applicable to actual, rather than steady state, changes in household labour market states.

Table 2. Steady State Decomposition of Log Non-Employment (Workless) Rate

	dlog w	dlog $\bar{w}$	Job Separations: dlog s	Job Finding: dlog f
1992-1996				
Individual	-0.044	-0.314	-0.365	0.045
Household	0.048	-0.162	-0.096	0.105
2011-2015				
Individual	-0.154	-0.254	-0.082	0.241
Household	-0.215	-0.367	-0.343	0.103

Source LFS and authors' calculations. Note. Equation (11) implies that column 2 is approximately equal to the sum of the entries in columns 3 and 4 multiplied by one minus the steady state rate non-employment rate.

6.2 Accounting for Variation in Actual Household & Individual Labour Market Stocks

We first calibrate the decomposition of the 2-state system (employed/non-employed) in equation (26) at both individual and household level. Table 3 gives details. The decomposition is done for the full sample period, 1993 to 2016 and then separately for periods covering the run-up to the Great Recession, the recession itself and subsequent recovery.

Over the full sample period, variation in the individual job finding rate explains around 69 % of the variation in the individual non-employment rate. The share of job finding in the variation of household non-employment is somewhat lower at around 61%. The contribution shares differ across sub-periods and the level of aggregation in any given period. During the Great Recession, the contribution of job loss and job finding is more evenly balanced for individuals, but job finding variation dominates for households. In contrast, over the last sub period, job separation explains the majority of variation in the household non-employment rate, but only around 30% of variation in the individual non-employment rate.

These results suggest that to understand the rise and subsequent fall in the individual non-employment rate for this sample, understanding why the job finding rate varies is key.[22] Job finding is also the dominant explainer of changes in household non-employment rates over most of the period. The exception is the 2012-2016 recovery period, when variation in the job separation rate matters more for households, but not individuals.

[22] Elsby et al. (2024), using a different UK data set, show that job separations explain more of the variation in the individual unemployment rate, but that job finding explains more of the variation in economic inactivity rates. Since inactivity is larger than unemployment in the non-employment stocks, their results are broadly in line with the results shown here.

Table 3. Contributions of Job Separation and Job Finding to Non-Employment Rate Variation: Individual and Household Based Decompositions

	1993-2016	1993-1997	1998-2006	2007-2011	2012-2016
Individual					
EW (Job Separation s)	30.9	35.3	32.8	42.0	30.1
WE (Job Finding f)	69.1	64.7	67.2	58.0	69.9
Household					
EW (Job Separation s)	39.1	26.8	39.1	29.7	55.7
WE (Job Finding f)	60.9	73.2	60.9	70.3	44.3
1 Adult Households					
EW (Job Separation s)	45.4	41.7	50.5	44.3	60.9
WE (Job Finding f)	54.6	58.3	49.5	55.7	39.1
2 Adult Households					
EW (Job Separation s)	41.2	24.4	39.9	39.9	49.5
WE (Job Finding f)	58.8	75.6	60.1	60.1	50.5
3+ Adult Households					
EW (Job Separation s)	25.3	27.8	22.3	37.7	58.4
WE (Job Finding f)	74.7	72.2	77.7	62.3	41.6

Source LFS and authors' calculations. Note. Row entries show percentage contribution to total non-employment variation over the relevant period

The subsequent rows of Table 3 report the accounting decomposition separately for each household size group. The formal decomposition of these patterns shows that the contribution of job separation in explaining variation in household non-employment rates falls with the number of occupants. Among single adult households, job separation explains almost as much variation in the non-employment rate over time as job finding. Job separation is also more important in understanding individual non-employment variation of single adults than for all individuals, (compare panels a and c). In contrast, variation in the job finding rate is more important for households with more adults - with the exception of the later sub-period 2012-2016.

6.2.1 Contributions of Different Household Types

Table 4 uses the sub-group decomposition outlined in equation (26) to estimate the contribution of each household size groups to changes in the aggregate household non-employment rate.

Table 4. Percentage Contributions of Household Size Group to Aggregate Variation in Workless Household Rate

	1993-2016 (1)	1993-1997 (2)	1998-2006 (3)	2007-2011 (4)	2012-2016 (5)
EW (Job Separation s)	39.1	26.8	39.1	29.7	55.7
% of which					
1 Adult Households	*25.1*	*24.2*	*49.9*	*27.2*	*42.2*
2 Adult Households	*62.2*	*68.5*	*48.9*	*77.5*	*43.2*
3 Adult Households	*13.6*	*12.4*	*2.1*	*-4.1*	*12.7*
WE (Job Finding f)	60.9	73.2	60.9	70.3	44.3
% of which					
1 Adult Households	*44.6*	*32.8*	*47.8*	*41.7*	*34.8*
2 Adult Households	*47.4*	*61.8*	*47.5*	*48.9*	*61.6*
3 Adult Households	*8.2*	*2.6*	*4.3*	*11.7*	*1.8*

Source LFS and authors' calculations. The mean sample shares of the 1, 2 and 3 adult households in the workless household stock are .67, .30 and .03. The corresponding mean group shares in working households are .24, .62 and .14. respectively.

The share of variation in the job separation rate, (EW), is broadly in line with the share of each household type in the employed household population over the full sample period. So 2-adult households account for around two-thirds of the total variation in the household job finding rate. In contrast, the household group contributions to the variation in aggregate job finding rate over time are not aligned with their group shares.[23] Variation in job finding over the full sample period is driven by more variation in job finding rates among 3-adult, and particularly 2-adult workless households, than their shares in the workless household population. This again

[23] See Figure A1 for a graph of household size shares over time.

suggests that job finding mechanisms vary by household size.

The long time series decomposition in column 1 however, obscures large differences in the contributions of each household type to aggregate job loss and job separation over time. Column 3, for example, shows that between 1998 and 2006, variation in the job separation rate among single adult households explained more than 40% of the total variation in separation rates over this period. During the Great Recession, (column 4), the contribution of single adult households to total household job separation variation more than halved. Similarly, the contribution of different household types to variation in job finding is, at times, dominated by variation in job finding rates among 2-adult households, while at other times, (columns 3 and 4), single adults make an equal contribution to total variation. This indicates that the patterns of job loss also vary across different household types and the economic cycle.

Together, Tables 3 and 4 suggest that the rising workless household rate in the late 1990s was driven by a fall in job finding rates among 2 adult households. The fall in workless household rates after the Great Recession was influenced strongly by a fall in job separation rates among single adult households.

6.2.2 Accounting for Household Population Dynamics

Changes in household composition could explain some of the variation observed above. While the data do not allow us to measure net household population inflows we can apply the subgroup decomposition of (25) to allow for household dissolution and formation as in equation (29). In this way we can begin to get an insight into the role of population change in household dynamics.

Figure 6 contrasts the difference in transition probabilities between stayer and mover households. The Figure shows clearly that households with unstable populations exhibit more unstable household labour market states. The separation and job finding rates in Figure 6 are much

larger for ”mover” than ”stayer” households. So some of the observed changes in household labour market states will be due to these population movements and not directly to changes in labour market status of the individuals who comprise households. How much is estimated in Table 5 below.

Table 5. Contributions of Stayer and Mover Households to Workless Household Rate Variation

	1993-2016 (1)	1993-1997 (2)	1998-2006 (3)	2007-2011 (4)	2012-2016 (5)
EW (Job Separation s)	39.1	26.8	39.1	29.7	55.7
% of which					
Stayer Households	*87.5*	*75.3*	*60.7*	*102.2*	*78.3*
Mover Households	*12.5*	*24.6*	*39.3*	*-2.2*	*21.7*
Job Finding f	60.9	73.2	60.9	70.3	44.3
% of which					
Stayer Households	*76.3*	*87.1*	*64.1*	*71.8*	*61.0*
Mover Households	*23.7*	*12.9*	*35.9*	*28.1*	*39.0*

Source LFS and authors’ calculations.

Households with composition changes between quarters comprise average 5% of both employed and non-employed households over the sample period. Other things equal, their expected contribution to each flow should be around 5%. Table 5 (rows 3 and 6) shows that variation in the household transition rates among mover households over time generally accounts for more of the variation in overall transition rates than their share in the household population. Up to 40% of the variation in each transition rate can be attributed to changes in household labour market status stemming from movement of individuals in and out of households.

6.3 Decomposition of 3-Household State Variation

Since the 2-state decomposition ignores the existence of the mixed-work household state, we next apply the flow accounting methodology to changes in three household labour market states, all-work, mixed and workless. The time series of each of these household rates are outlined in Figure 2. Over the sample period the workless household rate rises and falls across two different cycles. Over time, the mixed work household falls, stabilises and the falls again, while the share of all-in-work households rises, pauses, falls in the Great Recession and then rises rapidly in the subsequent recovery.

Figure 7 gives the household transition rate matrix that measures flows into and out of these three household labour market states. The main diagonal panels in Figure 7 show the share of households that remain in the same state between two consecutive quarters. The columns of the matrix show inflow rates and the rows give outflow rates. Outflow rates for each household type have fallen over the sample period, indicating increased persistence in each household labour market state. Falling outflow rates indicate that the average duration of stay in each state is rising. The mixed household is the least stable household state over the sample period, consistent with the evidence in Figure 2.

Figure 7 also suggests that inflow rates to each state also fell over time. The flow rates between all-work and mixed households are typically larger than those into and out of workless households. Around 15% of mixed households, on average, become workless or all work households between quarters, though this outflow rate falls noticeably over the latter part of the sample window.

The effect of these transition rates changes is formalised in the decomposition results in Table 6. The decomposition is applied to both changes in the stock of workless and all-work households. Job loss manifests itself at the household level in the constituent flows aw, mw or

am. Job finding at household level is distributed among the constituent flows wa, ma and wm. Some of these constituent flows are directly out of the relevant stock, others are indirect flows.

Table 6. Percentage Contributions of Transition Rates to Household Labour Market State Variation: 3 State Decomposition

	1993-2016 (1)	1993-1997 (2)	1998-2006 (3)	2007-2011 (4)	2012-2016 (5)
Workless Household					
Job Separation s	39.1	26.8	39.1	29.7	55.7
% of which					
All to Workless (aw)	*36.5*	*26.2*	*55.2*	*83.4*	*54.4*
Mixed to Workless (mw)	*56.3*	*45.4*	*39.1*	*17.8*	*35.8*
All to Mixed, (am)	*3.5*	*17.5*	*5.7*	*-1.1*	*9.8*
Job Finding f	60.9	73.2	60.9	70.3	44.3
% of which					
Workless to All (wa)	*54.1*	*39.7*	*45.4*	*57.5*	*35.5*
Workless to Mixed (wm)	*49.1*	*56.8*	*52.7*	*53.0*	*57.6*
Mixed to All, (ma)	*-3.2*	*3.5*	*1.9*	*-10.5*	*6.8*
All Work Household					
Job Separation s	45.5	35.6	47.9	51.9	51.0
% of which					
All to Workless (aw)	*3.0*	*-3.4*	*7.9*	*11.8*	*-2.8*
Mixed to Workless (mw)	*2.1*	*0.1*	*-0.1*	*7.4*	*2.9*
All to Mixed, (am)	*94.9*	*103.3*	*92.5*	*80.8*	*99.9*
Job Finding f	54.5	64.4	52.1	48.1	49.0
% of which					
Workless to All (wa)	*14.5*	*18.6*	*17.2*	*-2.3*	*14.4*
Mixed to All (ma)	*82.7*	*79.1*	*80.5*	*102.6*	*87.4*
Workless to Mixed, (wm)	*2.8*	*2.3*	*2.3*	*-0.4*	*-1.8*

Source LFS and authors' calculations.

Table 6 shows that the relative contributions of the constituent components of job separation and job finding differ across the household labour market stocks and also within these stocks over time. Each household employment cycle has different facets.

For workless households, Table 3 has shown that job finding variation is the more important flow. Table 6 shows that the direct transitions from workless to mixed households, (row 6) and from workless to all-work households, (row 7) are the more important constituent flows in job finding. So to understand how households find work, research is needed on both these types of transitions. The former is likely from single adult households, the latter is, by construction, from multiple adult households.

Variation in the workless household job separation is driven by variation in the direct transition between mixed work to workless households, (row 3), and though the direct flows from all- work to workless. Over the Great Recession, column 4, these aw flows account for more than 80% of variation in household job separations. Since these are likely single adult households, this suggests that single adult households were more likely to be affected by job loss during this time and indeed over the subsequent recovery. Before this, mixed households were more likely to lose work than all-working households.

The contributions to the variation in the all-work household rate are given the lower panel of Table 6. Unlike for the workless household variation, the contributions of job loss and job finding are much closer over the full sample and the different sub-periods, suggesting that variation in both job finding and job separation are both important factors in explaining variation in the stock of working households.

The direct transition rates from all- work to mixed and from mixed into all working households explains much of the fall and subsequent rise in the all-work household stock over this period. These movements come from within multi-adult households.

Table A5 in the appendix shows the results of the same decomposition for 2-adult households. The relative contributions of job separations and job finding for all households broadly also holds for 2-adult households. Job separation rates for 2-adult workless households become

increasingly important over time. Variation in job separation and job finding rates account for are broadly the same amounts in explaining variation in 2-adult all-work stocks. The role of transitions in and out of the mix-work state is, unsurprisingly, greater when the focus is on 2-adult households.

7. Conclusions

Measuring employment at both individual and household levels of aggregation, can give a more comprehensive insight into labour market performance, particularly when the measures are not aligned over the economic cycle. Just as it makes sense to decompose individual changes in stocks into their dynamic components it is insightful to do something similar to household based measures of labour market stocks.

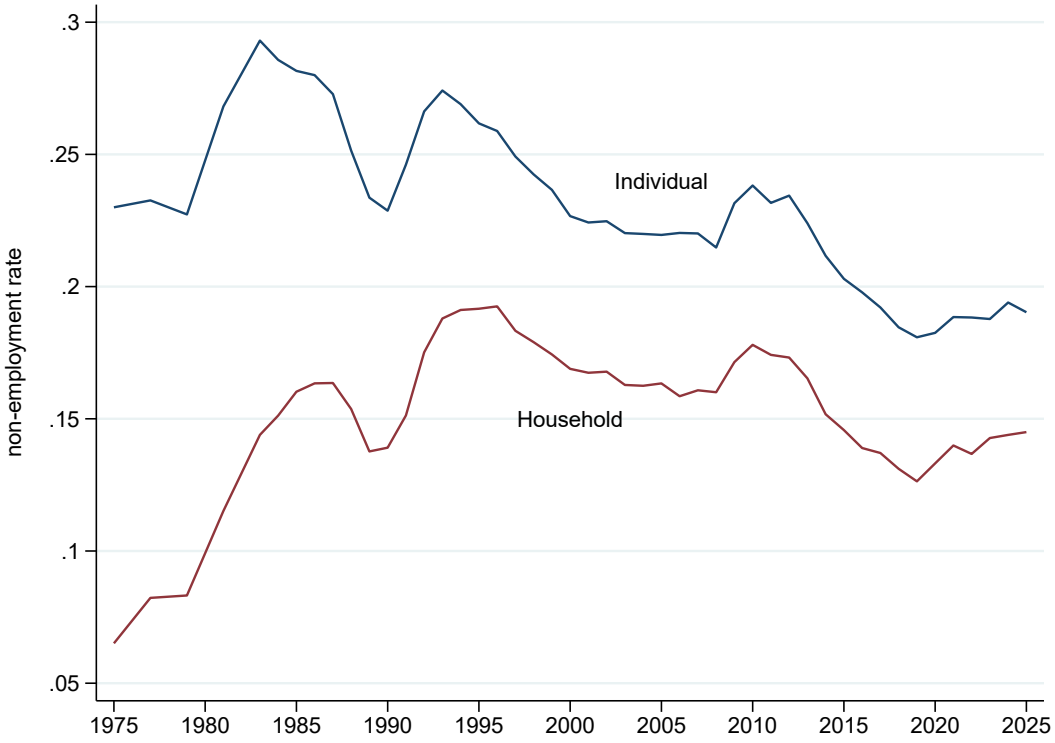
The methodology and decomposition we propose lends itself to a) comparison of the factors that drive individual and household labour market stock changes and b) the analysis of the contribution of different household sub-groups. Sub-group decompositions are also helpful, since we document that labour market dynamics differ by the number of adults present in the household. Our methodology facilitates an assessment of the different roles of changes in household composition and individual labour market status toward explaining any changes in household dynamics and understanding of why the labour market stocks at different levels often move differentially over time.

The results of the decomposition used here suggest that changes in household labour market states are, at different times, driven by changes in transition rates both in and out for workless-ness. Sometimes job finding drives changes. Sometimes job separations are equally important. Moreover, the contribution of these labour market inflows and outflows differs at individual and household levels of aggregation for a given observation period. Job separations may matter for individuals more than households at a given point in the cycle or vice versa.

Reallocation of individuals across household types does not drive change in observed household transition rates in the short run. However, some of the variation in each transition rate over time can be attributed to the change in household labour market status that stems from movement of people in and out of households rather than a change in the labour market state of an individual.

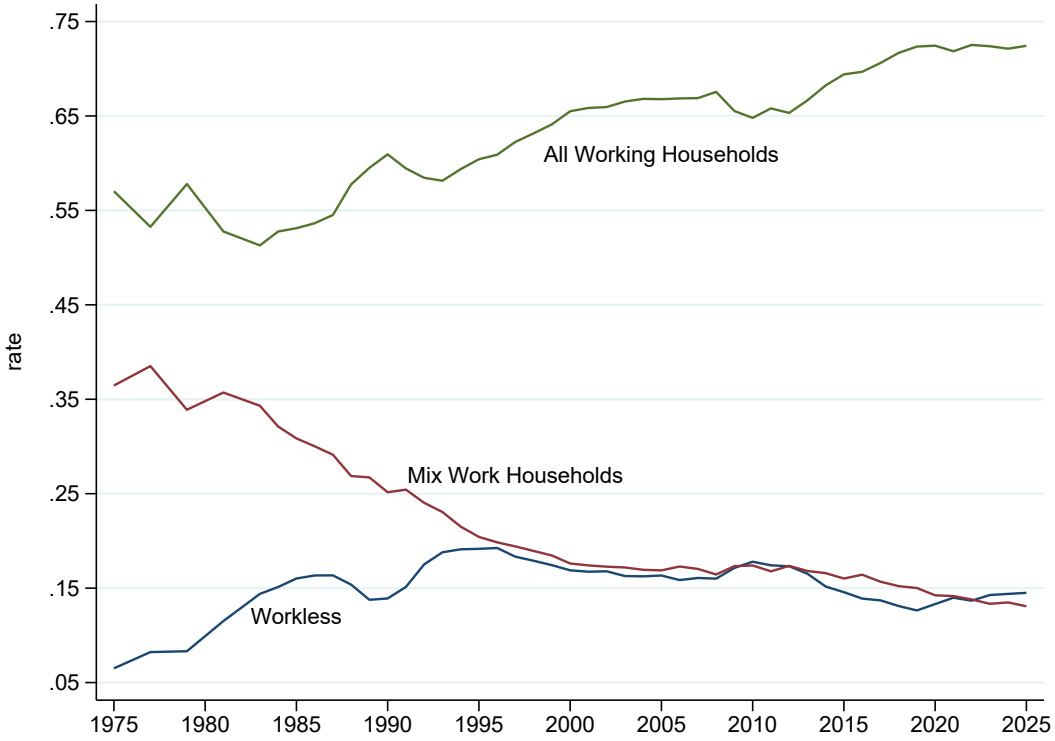
A more comprehensive knowledge of the labour market can therefore be gained if analysts were to study and understand both flows and their determinant components at both levels of aggregation. The methodology outlined here highlights where analysts can focus their efforts.

Figure 1. Individual and Household Non-Employment Rates in the UK: 1975-2025



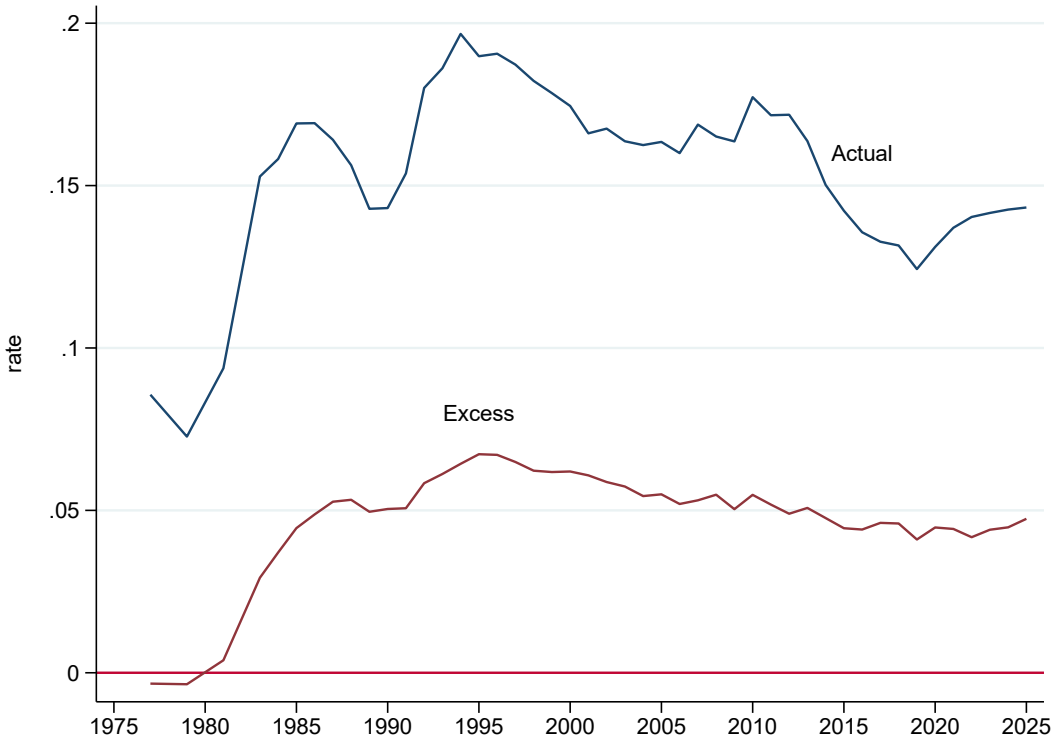
Notes: author calculations. Source: LFS

Figure 2. The Distribution of Work Across UK Households: 1975-2025



Notes: author calculations. Source: LFS

Figure 3. Actual and Excess Workless Household Rates: 1975-2025



Notes: author calculations. Source: LFS

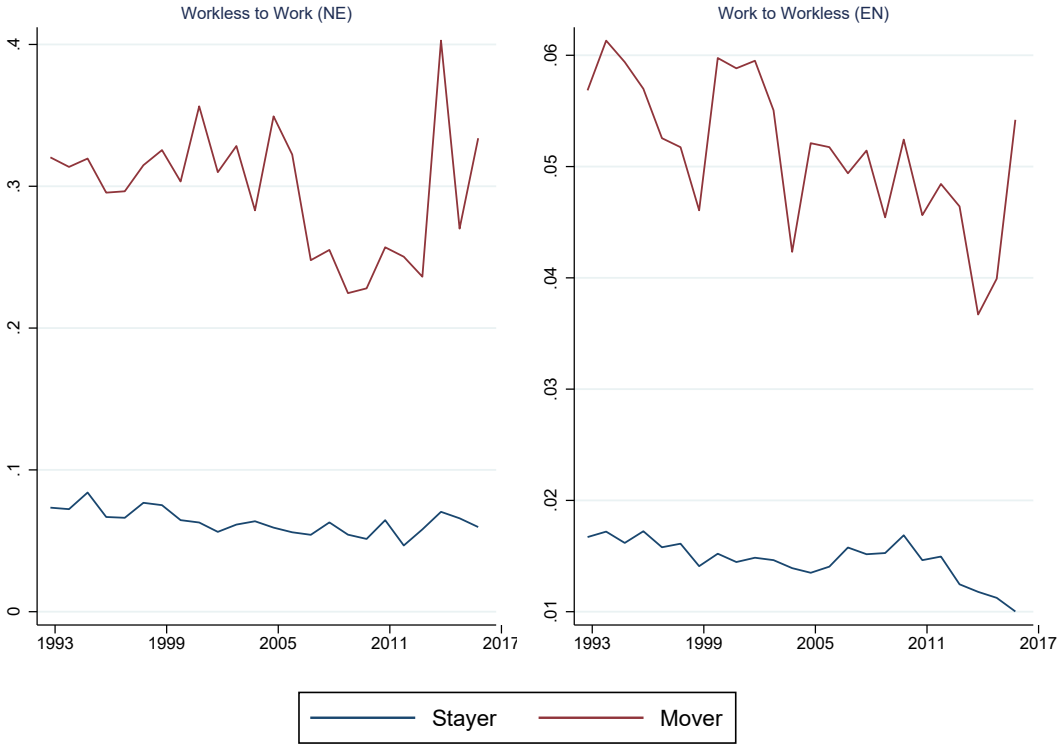
Figure 4. Job Separation and Job Finding Rates Across Individual and Households

Notes: author calculations. Source: LFS

Figure 5. Household Separation Rates and Job Finding Rates by Household Size

Notes: author calculations. Source: LFS

Figure 6. Household Transition Rates: Stayer & Mover Households



Notes: author calculations. Source: LFS

Figure 7. Household Transition Rates Between No Work, Mixed and All Work States

Notes: author calculations. Source: LFS

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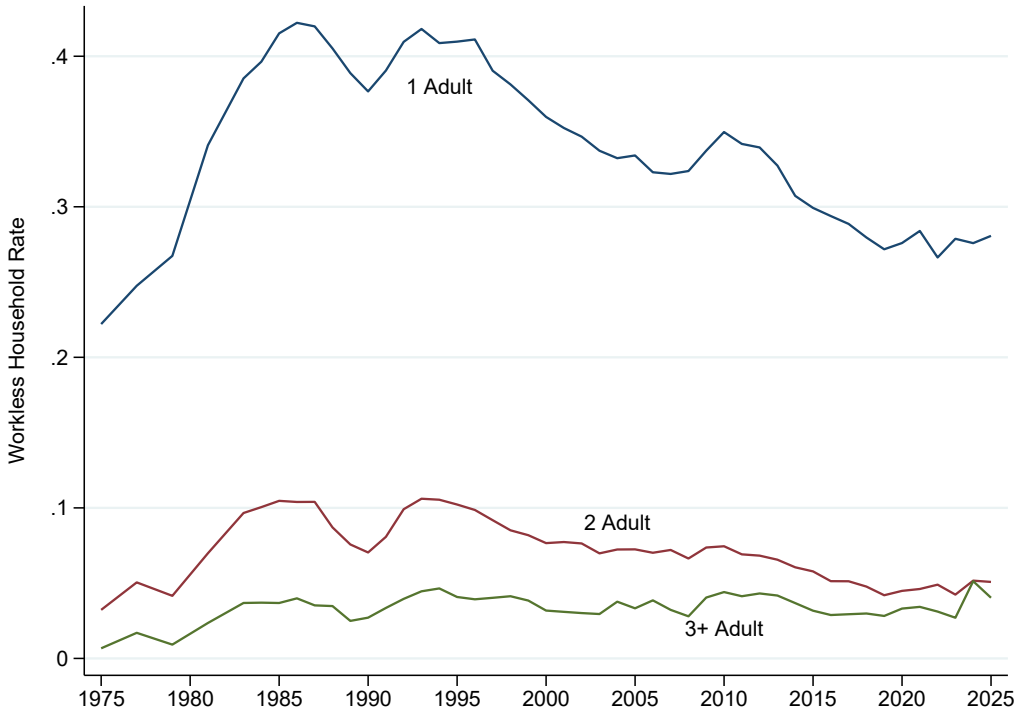
Appendix A:

Figure A1. Workless Household Rate by Number of Adults: 1975-2025



Source: LFS, author calculations.

Figure A2. Household Size Types in the Household Population: 1979-2025

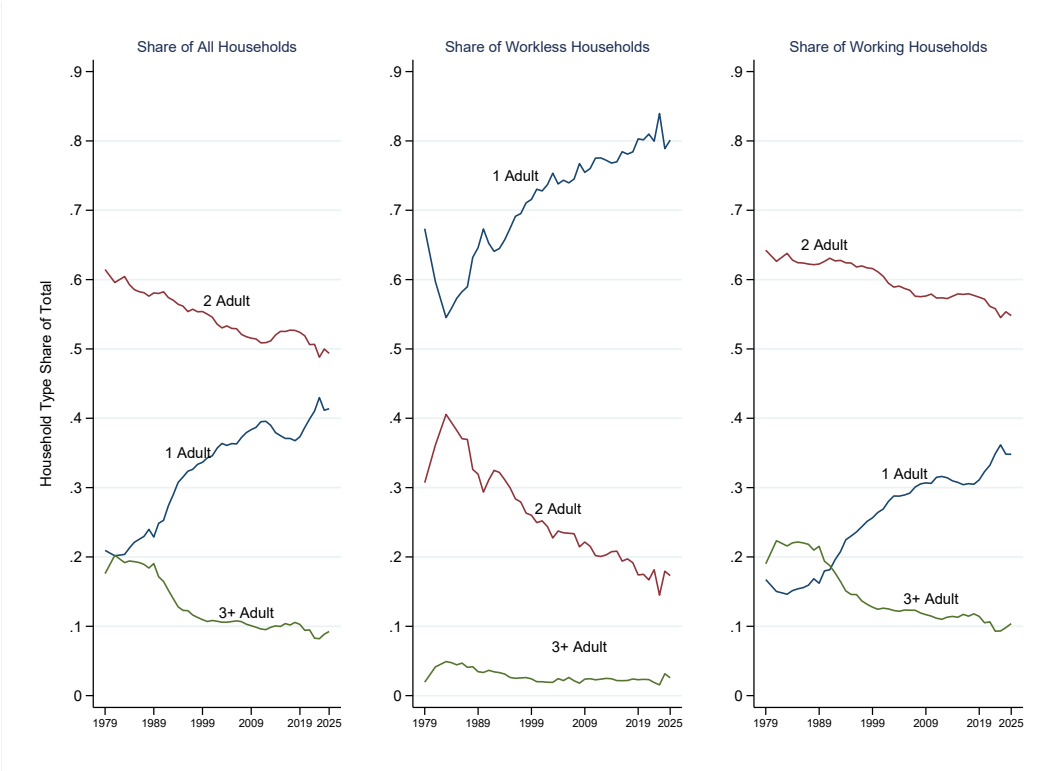
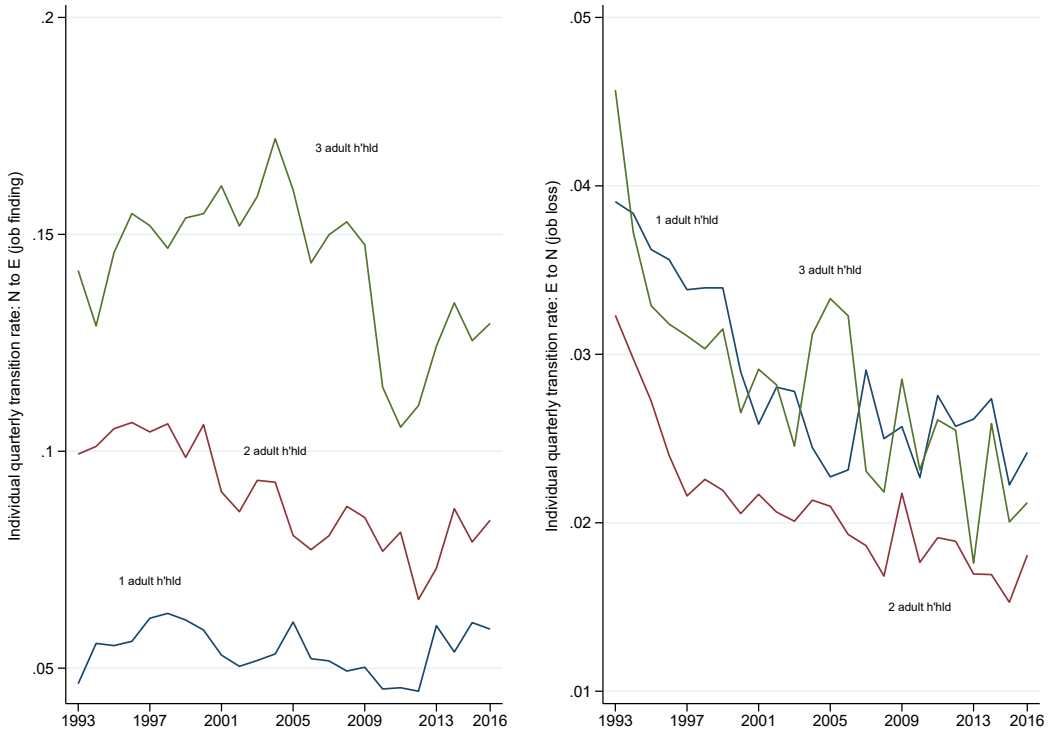
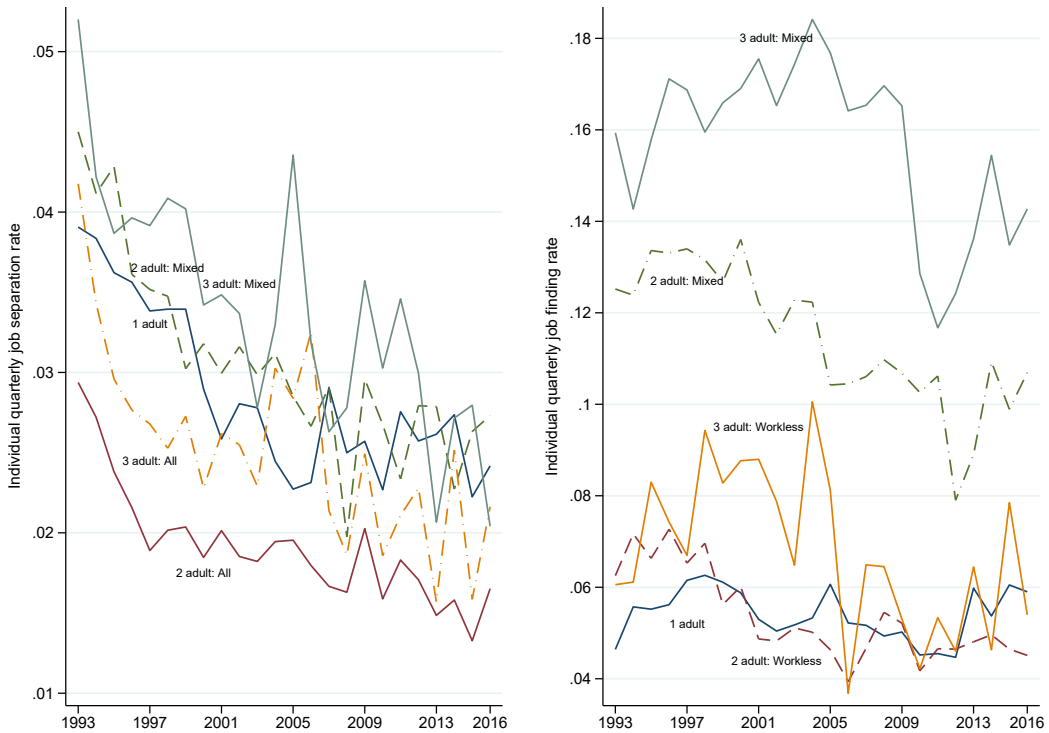


Figure A3. Individual Transition Rates by Number of Adults Resident in Household



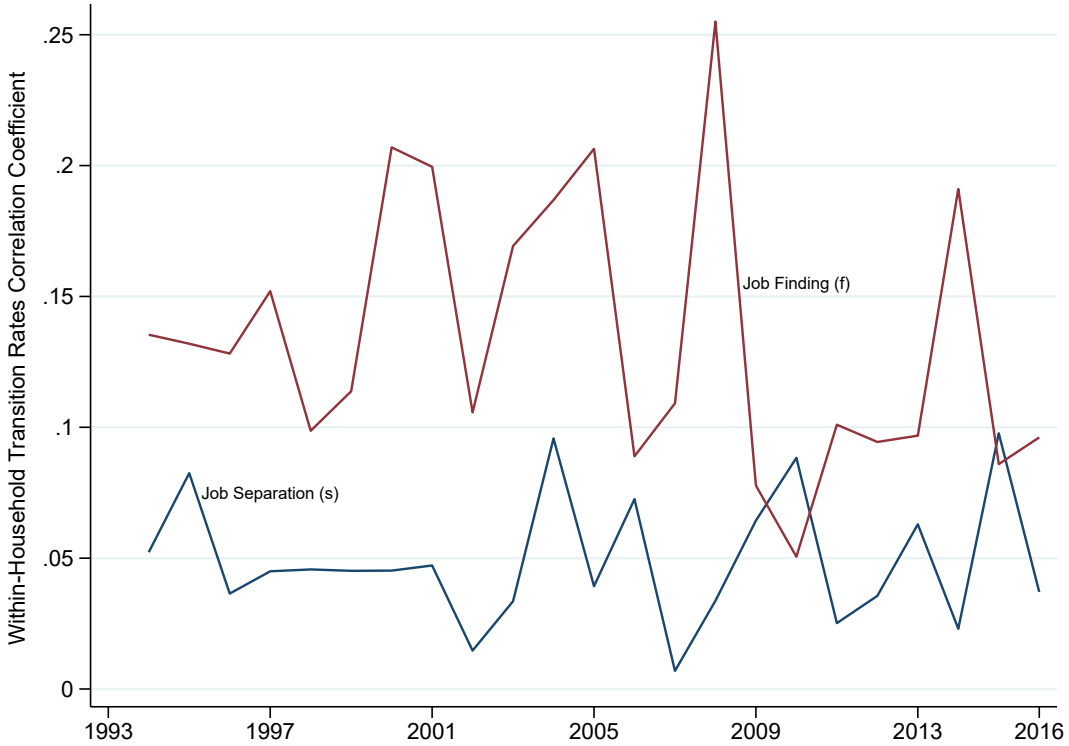
Source: LFS, author calculations.

Figure A4. Individual Transition Rates by Number of Adults and Employment Status of Others in Household



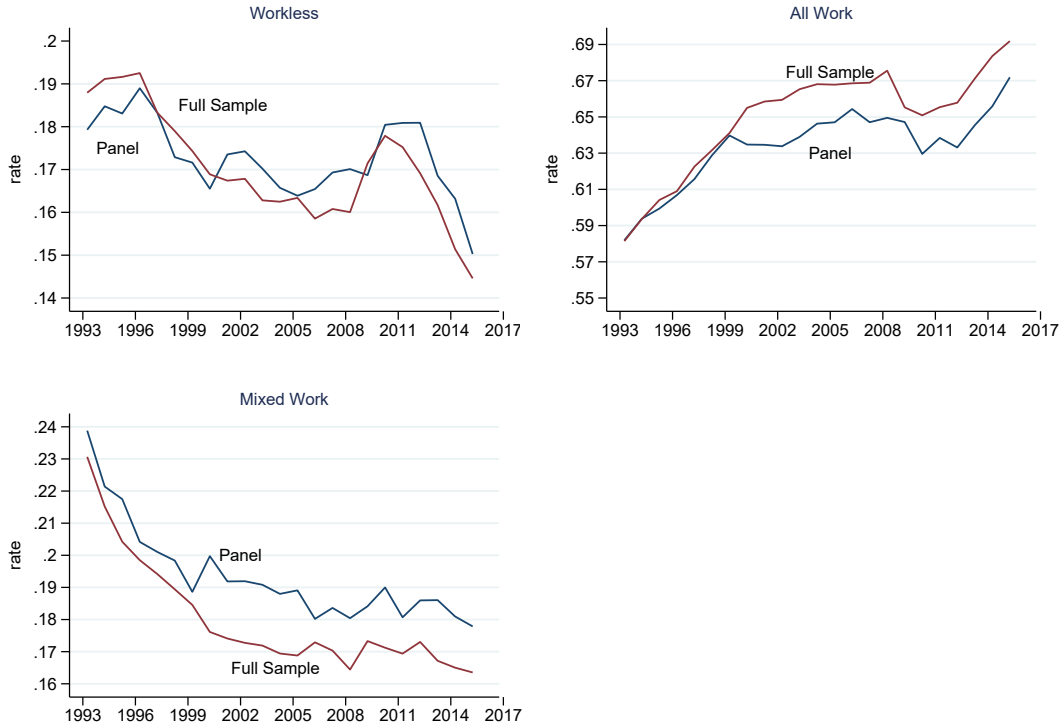
Source: LFS, author calculations.

Figure A5. Within-Household Transition Rate Correlations



Source: LFS, author calculations.

Figure A6. Workless Household Rates Compared: LFS Panel against LFS Full Sample



Source: LFS, author calculations.

Table A1. Characteristics of Indviduals by Household Size and Flow Type

	Individual	1 Adult	2 Adult	3+ Adult
Non-Employed				
Age (years)	43.4	44.6	43.9	40.1
Age 16-24	0.12	0.09	0.08	0.28
Age 50-64	0.40	0.43	0.40	0.37
Female	0.63	0.61	0.66	0.54
Age Left Education	16.7	16.4	16.9	16.6
South-East	0.32	0.32	0.33	0.31
Employed				
Age (years)	40.7	42.1	41.0	38.6
Age 16-24	0.10	0.05	0.05	0.28
Age 50-64	0.26	0.29	0.24	0.30
Female	0.47	0.53	0.46	0.45
Age Left Education	17.6	17.7	17.8	17.1
South-East	0.47	0.53	0.46	0.45
Small Firm	0.35	0.34	0.33	0.34
Non-Employed Job Finders				
Age (years)	36.5	39.7	38.6	30.1
Age 16-24	0.25	0.11	0.13	0.56
Age 50-64	0.28	0.35	0.30	0.28
Female	0.55	0.58	0.59	0.43
Age Left Education	17.5	17.3	17.6	17.5
South-East	0.36	0.35	0.37	0.35
Small Firm	0.49	0.50	0.50	0.48
Employed Job Loss				
Age (years)	39.9	43.1	41.3	33.7
Age 16-24	0.18	0.08	0.10	0.47
Age 50-64	0.31	0.37	0.32	0.24
Female	0.53	0.53	0.57	0.43
Age Left Education	17.4	17.2	17.5	17.2
South-East	0.35	0.36	0.36	0.34
Small Firm	0.44	0.44	0.44	0.47

Source: LFS author calculations. Notes: Table cells give the mean share of each demographic in each state. Means averaged over sample period 1992-2016.

Table A2. Transition Rates by Characteristics and Household Size

	Individual	1 Adult	2 Adult	3+ Adult
E to N (s)	0.023	0.033	0.028	0.026
Male	0.021	0.028	0.017	0.027
Female	0.026	0.028	0.026	0.026
Age 16-24	0.044	0.049	0.042	0.044
Age 50-64	0.027	0.035	0.027	0.022
Age Left Education $\leq$ 16	0.025	0.033	0.023	0.026
Age Left Education 17-20	0.022	0.024	0.020	0.028
Age Left Education 21-30	0.019	0.019	0.017	0.026
N to E (f)	0.077	0.041	0.165	0.217
Male	0.093	0.054	0.094	0.141
Female	0.067	0.047	0.069	0.091
Age 16-24	0.161	0.060	0.135	0.232
Age 50-64	0.039	0.028	0.041	0.048
Age Left Education $\leq$ 16	0.063	0.041	0.065	0.089
Age Left Education 17-20	0.106	0.071	0.101	0.165
Age Left Education 21-30	0.131	0.101	0.119	0.217

Source: LFS author calculations. Notes; Table cells give mean transition rate of demographic in each state. Means averaged over sample period 1992-2016

Table A3. Shift–Share Decomposition of Changes in Job Finding Rate (f)

	Total	Within	Between	Interaction
1992–1996				
Individuals	0.004	0.008	-0.005	0.001
Households	0.012	0.016	-0.004	-0.001
1997–2006				
Individuals	-0.019	-0.018	-0.001	-0.001
Households	-0.016	-0.016	0.000	-0.001
2006–2011				
Individuals	-0.017	-0.016	-0.001	0.001
Households	-0.003	-0.001	-0.002	-0.001
2011–2015				
Individuals	0.016	0.014	0.002	0.001
Households	-0.001	-0.001	-0.001	0.001

Source: LFS author calculations

Table A4. Shift–Share Decomposition of Changes in Job Separation Rate (s)

	Total	Within	Between	Interaction
1992–1996				
Individuals	-0.011	-0.011	-0.001	0.001
Households	-0.002	-0.002	0.001	-0.001
1997–2006				
Individuals	-0.004	-0.005	0.001	0.001
Households	-0.003	-0.003	0.001	0.001
2006–2011				
Individuals	0.001	-0.001	0.001	-0.001
Households	0.002	0.001	0.001	-0.001
2011–2015				
Individuals	-0.002	-0.002	-0.001	0.001
Households	-0.005	-0.004	-0.001	0.001

Source: LFS author calculations

Table A5. Percentage Contributions of Transition Rates to 2-Adult Household Labour Market State Variation: 3 State Decomposition

	1993-2016 (1)	1993-1997 (2)	1998-2006 (3)	2007-2011 (4)	2012-2016 (5)
Workless Household					
Job Separation s	44.3	24.8	42.7	41.6	60.3
% of which					
All to Workless (aw)	*13.6*	*17.0*	*10.4*	*22.3*	*17.6*
Mixed to Workless (mw)	*70.7*	*61.3*	*79.9*	*74.0*	*72.6*
All to Mixed, (am)	*15.6*	*21.6*	*9.6*	*3.7*	*9.7*
Job Finding f	55.7	75.2	57.3	58.4	39.7
% of which					
Workless to All (wa)	*7.4*	*12.1*	*-5.9*	*-12.5*	*29.4*
Workless to Mixed (wm)	*89.7*	*76.1*	*96.5*	*137.4*	*-21.5*
Mixed to All, (ma)	*2.9*	*11.8*	*9.5*	*-24.9*	*92.2*
All Work Household					
Job Separation s	50.2	40.7	53.6	53.9	55.8
% of which					
All to Workless (aw)	*1.1*	*-6.4*	*5.1*	*1.9*	*-5.7*
Mixed to Workless (mw)	*1.9*	*-0.1*	*0.1*	*7.9*	*0.1*
All to Mixed, (am)	*97.0*	*106.7*	*94.7*	*90.3*	*104.8*
Job Finding f	49.8	59.3	46.4	46.1	44.2
% of which					
Workless to All (wa)	*6.4*	*6.9*	*3.1*	*25.6*	*-1.9*
Mixed to All (ma)	*86.6*	*87.2*	*93.8*	*73.1*	*100.3*
Workless to Mixed, (wm)	*7.0*	*6.0*	*3.1*	*1.2*	*1.6*

Source LFS and authors' calculations.

Appendix B: Derivation of Household Transition Probabilities

B1: Household-Level Employment Separation Probability

Individuals are distributed across households of varying sizes $n = 1, 2...N$.

There are h = 1, 2...H households in the household population.

Each individual i = 1... P has a separation probability at time t, $s_{it} \in (0,1)$ and $s_{it} \sim (\mu_{si}, \sigma_{si}^2)$

Individual transitions are assumed, initially, to be heterogeneous but independent.

Given this, the probability that all n individuals in the household separate in a given period is the product of these individual probabilities:

$$s_{hn_ht} = \prod_{i=1}^{n_h} s_{it} = s_{it}^{n_h} \qquad \sim \left(\mu_{sh}, \sigma_{sh}^2\right) \tag{B1.1}$$

Under independence, the expected value of s_{hnt} falls as n increases. Larger households have lower separation probabilities.

The mean separation probability for any individual household of size n_h is

$$m_{shn_ht} = \frac{1}{n_h} \sum_{i \in h} s_{it} \tag{B1.2}$$

For any individual household of size n, the household separation rate $s_{hn_ht} \leq m_{shn_ht}$ - using the arithmetic-geometric mean inequality rule: $(\prod_{i=1}^{n_h} s_{it})^{\frac{1}{n_h}} \leq \frac{1}{n} \sum_{n_h} s_{it}$

Hence

$$s_{hn_ht} = \prod_{i=1}^{n_h} s_{it} \leq \left(\frac{1}{n_h} \sum_{i \in h} s_{it}\right)^{n_h} \implies s_{hnt} \leq \left(m_{shn_ht}\right)^{n_h} \qquad < m_{shn_ht} \quad for \quad n_h > 1 \tag{B1.3}$$

Each household's observed separation rate is less than or equal to the average individual transition probability in the household. For multiple occupancy households, the product effect pushes the household separation probability below the individual separation probability.

Aggregating to the level of the whole economy, the respective means are:

$$\mu_{sit} = \frac{1}{P}\sum_{i} s_{it} = \frac{1}{P}\sum_{h=1}^{H}\sum_{i\in h} s_{it} \tag{B1.4}$$

and

$$\mu_{sht} = \frac{1}{H}\sum_{h=1}^{H} s_{ht} = \frac{1}{H}\sum_{h=1}^{H}(\prod_{i=1}^{n} s_{it}) \tag{B1.5}$$

The product effect does not guarantee that $\mu_{sht} < \mu_{sit}$. To see this, realise that the aggregate mean individual separation rate in (B1.4) can also be written as a weighted average of the individual *household* mean separation rates, $m_{shn_h t}$. Since

$$m_{shn_h t} = \frac{1}{n_h}\sum_{i\in h} s_{it} \implies \sum_{i\in h} s_{it} = n_h * m_{shn_h t} \tag{B1.6}$$

the aggregate individual mean separation rate is now

$$\mu_{sit} = \frac{1}{P}\sum_{i} s_{it} = \frac{1}{P}\sum_{h=1}^{H} n_h * m_{shn_h t} = \sum_{h=1}^{H} \beta_h * m_{shn_h t} \tag{B1.7}$$

where $\beta_h = \frac{n_h}{P}$

The individual aggregate separation rate gives larger weights to households with more occupants. The household aggregate mean gives the same weight to all households regardless of size. While larger households typically have lower separation rates under the product rule, the mean separation rate will, under independence, not vary with household size. These weighting differences alone do not therefore generate a systematic difference between the two aggregations.

However, the arithmetic-geometric mean inequality ensures that the mean aggregate household separation rate is

$$\mu_{sht} = \frac{1}{H}\sum_{h=1}^{H} s_{ht} = \frac{1}{H}\sum_{h=1}^{H}(\prod_{i=1}^{n_h} s_{it}) \leq \frac{1}{H}\sum_{h=1}^{H}\left(m_{shn_h t}\right)^{n_h} \tag{B1.8}$$

and the difference between the individual and household mean aggregate separation rate

$$\mu_{sit} - \mu_{sht} \geq \frac{1}{P}\sum_{h=1}^{H} n_h * m_{sn_h t} - \frac{1}{H}\sum_{h=1}^{H} (m_{sn_h t})^{n_h} \tag{B1.9}$$

Under the assumption of independence, the mean individual separation probability is the same across household sizes and because

$$\frac{1}{P}\sum_{h=1}^{H} n_h * m_{sn_h t} = \frac{1}{H}\sum_{h=1}^{H} (m_{sn_h t}) \tag{B1.10}$$

then, as long as some households have $n_h > 1$, then (B1.9) ensures $\mu_{sh} < \mu_{si}$

The mean aggregate household separation probability under the independence assumption is always less than the aggregate mean of the individual separation probabilities: $\mu_{sht} < \mu_{sit}$ given the existence of households with $n_h > 1$

Dependence and Sorting

Positive (assortative) sorting of high (low) separation probability individuals into the same households *within* household size groups will not change this result. The mean of any separation probability product will be less than the arithmetic mean of the household separation rate, m_{sht}, and hence the aggregate individual separation probability, μ_{sit}. If sorting occurs only within household-size groups, there is no systematic relationship between household size and the mean individual separation probability. The aggregate household separation probability therefore remains below the aggregate individual separation probability.

However, positive assortative sorting narrows the size of this gap. Positive sorting increases the aggregate household separation probability relative to random assignment of the same individuals to households of the same size. Since the aggregate individual separation probability is unchanged by a reallocation of individuals across households, this reduces the individual–household gap.

To see this, rewrite the household separation probability for one household as

$$s^1_{ht} = (\prod_{i=1}^{n} s_{it}) = (\prod_{i=1}^{n-1} s_{it})x = a * x \tag{B1.11}$$

where x is the marginal separation probability of the nth individual in the household and $a = (\prod_{i=1}^{n-1} s_{it})$.

Compare this to another household

$$s^2_{ht} = (\prod_{i=1}^{n} s_{it}) = (\prod_{i=1}^{n-1} s_{it})y = b * y \tag{B1.12}$$

with a $>$ b, so that household 1 is the high separation probability household

The household mean separation probability is based on the sum of these products

$$s^1_{ht} + s^2_{ht} = (a * x) + (b * y) \tag{B1.13}$$

If the marginal workers swap households, the new sum of products is

$$s^{11}_{ht} + s^{22}_{ht} = (a * y) + (b * x) \tag{B1.14}$$

and the difference in the product sums is

$$(s^1_{ht} + s^2_{ht}) - (s^{11}_{ht} + s^{22}_{ht}) = (a * x) + (b * y) - [(a * y) + (b * x)] = (a - b) * (x - y) \tag{B1.15}$$

Given a $>$ b and x $>$ y, assigning x to the high product household increases the sum of household separation probabilities. Consequently, $\mu^{+sort}_{sht} > \mu^{random}_{sht}$ The individual aggregate separation rate μ_{sit} is unchanged by the reassignment of individuals across households. Positive assortative sorting therefore narrows the gap but always less than, the individual mean separation rate, (as long as there are some households with $n > 1$ given equation B1.9).

This also implies that the more equal (unequal) the separation probabilities in a household, the smaller (greater) the gap between the household product and its average separation probability. Greater within-household heterogeneity raises the gap between individual and household ag-

gregate separation probabilities.

Sorting by Household Size

Suppose now that sorting occurs across household sizes - so that, for example, high separation individuals are sorted into smaller households. This ensures the individual household mean separation probabilities $m_{s1t} > m_{s2t} > m_{s3t}$ The individual aggregate mean in B1.7 gives more weight to the lower separation rate larger households and so reduces the individual aggregate relative to the household aggregate separation probability. This reinforces the sorting effect within household types and works to offset the product effect. Sorting across household size groups could be sufficient to ensure the household separation probability is greater than the individual aggregate and even ensure the two means move in opposite directions.

Positive dependence, $s_{ih} = \bar{s}_i + \varepsilon_{ih}$, $s_{jh} = \bar{s}_j + \varepsilon_h$, $\qquad Cov(\varepsilon_{ih}\varepsilon_{jh}) > 0$

If individuals in the same households receive shocks to separation probabilities that are positively correlated, then the effect on the gap between household and individual aggregate means is similar to that of sorting. High separation probabilities tend to appear in the same households and low separation probability individuals tend to appear more often in the same households. This will also tend to reduce the difference between the geometric and arithmetic means in any household and hence at the aggregate level. As with sorting, if positive dependence is more likely as household size rises, this will re-enforce the product effect. It follows that ***negative dependence*** will tend to widen the gap between the two aggregates.

State dependence

Suppose instead there is negative state dependence, $s_i = f(n_h)$, $f'(n_h) < 0$

Higher separation rates are concentrated in smaller households because the size of the household influences the likelihood of separation in some way. The product structure of the household separation probabilities outlined above and the arithmetic-geometric inequality rule still

holds, $s_h <= m_h^{n_h}$.

When individuals in larger households have lower separation probabilities, the within household gap generated by the product is smaller. However, the aggregate gap also depends on the weighting effect. Recall that the individual aggregate mean gives larger weights to larger households. Lower separation rates in larger households due to state dependence will therefore lower the individual aggregate relative to the household aggregate separation. Positive state dependence will work in the opposite directions. Consequently, the effect of state dependence on the aggregate individual-household gap is ambiguous.

Cyclicality in the Individual-Household Gap

In a recession, the job separation probability s_{it} typically rises along with its dispersion. The product structure of household separation in (B1.3) implies that, under independence, the probability of household separation responds less than proportionately to an increase in individual separation probabilities for multi-person households. Given independence and no sorting, the difference between the two aggregate mean separation rates can be written:

$$\Delta_s = \mu_{sit} - \mu_{sht} = \mu_{sit} - \sum_{h=1}^{N_h} \alpha_h * m_{sht} = \mu_{sit} - \sum_{h=1}^{N_h} \alpha_h * \mu_{sit}^{n_h} = \sum_{h=1}^{N_h} \alpha_h * (\mu_{sit} - \mu_{sit}^{n_h}) \tag{B1.16}$$

where $\alpha_h = H_n/H$ is the share of household size n among all households.

If s_{it} is small then $\mu_{sit}^{n_h} \to 0$ and

$$\Delta_s \approx \mu_{sit}(1 - \alpha_1) \tag{B1.17}$$

The gap is approximately equal to the individual separation rate multiplied by the share of multi-person households. The product nature of household separation implies that employment separation is more likely for smaller households, other things equal. A shift toward smaller households will therefore raise the mean household separation rate for any given individual mean and narrow the gap between the individual and household means.

In general, the gap changes with μ_{sit} according to

$$\frac{\delta \Delta_s}{\delta \mu_{sit}} = 1 - \sum_h \alpha_h * n_h * \mu_{sit}^{n_h - 1} \tag{B1.18}$$

The derivative is non-monotonic, but falls as $\mu_{sit} \to 0$ (or as $\mu_{sit} \to 1$) with a maximum somewhere between. Hence, as long as separation rates remain below this maximum, the recessionary rise in individual separation rates will tend to widen the household-individual separation rate gap.

However, because changes in sorting or co-dependence or state dependence or shifts in household shares can affect either the household mean or individual means, changes in these mechanisms over the cycle can cause the two aggregate separation measures to move differently. Changes in the relative strength of each or all of these factors could generate a situation in which aggregate household and individual mean separation rates move in different directions over the cycle.

B2: Household-Level Job Finding Probability

Assume, initially, that the individual outflow probability, $f_{it} = f_t$ are independent but homogeneous. The expected household transition rate out of the workless state is just one minus the probability of staying workless. For a household with n occupants this is

$$f_{ht} = 1 - Pr[W_{h,t+1}, W_{h,t}] = 1 - \begin{pmatrix} n_h \\ 0 \end{pmatrix} f_t^0 (1 - f_t)^{n_h - 0} = 1 - (1 - f_t)^{n_h} \geq f_t \tag{B2.1}$$

and monotonically increasing in f_t. The household job finding probability is weakly greater than the individual job finding probability. Expanding $(1 - f_t)^{n_h}$

$$= 1 - n_h f_t + \frac{n_h(n_h - 1)}{2} f_t^2 - ... \tag{B2.2}$$

then

$$1-(1-f_t)^{n_h} \approx n_h f_t - \frac{n_h(n_h-1)}{2} f_t^2 \tag{B2.3}$$

The second term corrects for the fact that two or more people can find jobs simultaneously, which doesn't generate any additional household outflow. If f_t is small, the chance of a household finding work is approximately $n_h f_t$. It only needs one individual from a workless household to find a job, whatever the household size, to generate a household outflow from the workless state. The more adults who live in the household, the greater the chance that any of them find work.

The aggregate mean household job finding probability is then

$$\mu_{f_{ht}} = \sum_{n\geq 1} \gamma_n [1-(1-f)^n] \approx \sum_{n\geq 1} \gamma_n \left[nf - \frac{n(n-1)}{2} f^2 \right] = \bar{n} f - \frac{f^2}{2}\Omega \tag{B2.4}$$

where γ_n is the share of workless households with n occupants, $\bar{n}$ is mean household size and $\Omega = \sum_n \gamma_n n(n-1)$.

The household job finding probability relative to the individual mean job finding rate f, is then

$$\Delta_f = \mu_{fit} - \mu_{fht} \approx f - \left[\bar{n} f - \frac{f^2}{2}\Omega \right] = f(1-\bar{n}) + \frac{f^2}{2}\Omega \tag{B2.5}$$

The first term is non-positive, since $n >= 1$, and the second term positive. This suggests that there are diminishing marginal returns to household size in job finding that may eventually become decreasing. However, for small f and given multiple adult households, the gap will be negative, so that the mean aggregate household job finding rate is greater than the mean individual job finding rate $\mu_{fit} < \mu_{fht}$.

Heterogeneity

Replacing the homogeneity assumption with heterogeneity in individual job finding probabili-

ties, the aggregate household mean becomes, $f_{it} \sim (\mu_{If}, \sigma^2_{ift})$, implies that

$$\mu_{Hf} = \frac{1}{H_w} \sum_{h=1}^{H_w} [1 - \prod_{ih} (1 - f_{it})] = \sum_{n \geq 1} \eta_n \mu_{Hnf} \tag{B2.6}$$

where μ_{Hnf} is the mean job finding probability for households of size n.

The existence of heterogeneity in job finding probabilities raises the mean aggregate household job finding probability. For an individual household with mean job finding probability m_{fht}, Jensen's inequality implies that,

$$\frac{1}{n_h} \sum_{i \in h} log\,(1 - f_{iht}) \leq log \left(1 - \frac{1}{n_h} \sum_{i \in h} f_{ih} \right) = log(1 - m_{fht}) \tag{B2.7}$$

Exponentiate both sides

$$exp[\sum_{i \in h} log(1 - f_{ih})] \leq exp[n_h log(1 - m_{fht})] \tag{B2.8}$$

so that

$$\prod_{i \in h} (1 - f_{it}) \leq (1 - m_{hf})^{n_h} \tag{B2.9}$$

and so the household job finding rate with heterogeneity

$$1 - \prod_{i \in h} (1 - f_{it}) \geq 1 - (1 - m_{hf})^{n_h} \tag{B2.10}$$

Heterogeneity raises the chance that someone in the household finds a job for the same mean individual job finding probability. Thus, holding the distribution of household means and household sizes fixed, greater within-household heterogeneity raises the the aggregate household job finding rate relative to the individual aggregate job-finding rate.

Sorting Positive sorting increases homogeneity within households and raises heterogeneity across households. Sorting can however reduce the mean household job finding probability. To see this, consider a household with two job finding probabilities a and b, and a $>$ b

For household containing one individual of each type, the household job finding probability is

$$f_h = 1-(1-a)(1-b) = a+b-ab \tag{B2.11}$$

The aggregate household mean job finding rate is then

$$\mu_{fht} = \frac{1}{H}\sum_{h=1}^{H} f_{ht} = \frac{1}{H}\left[\sum_h (a_h+b_h) - \sum_h a_h b_h\right] \tag{B2.12}$$

The first sum on the right hand side is fixed given the set of individual transition probabilities. Sorting therefore affects the aggregate household job-finding rate only through the second term.

By the rearrangement inequality, the sum of products of two series is maximised when both series are ordered in the same direction. Pairing high job finders in the same households, (a types in the same household in the example above), and low probability job finders in other households, (b types in the other household), maximises the product in the second term and so minimises the aggregate household mean job finding probability. Conversely, mixing high- and low-job-finding individuals lowers the product of their non-finding probabilities, thereby raising the probability that at least one household member finds a job.

This result is conditional on the household-size distribution held fixed and sorting occurring only within household-size groups. Figure A3 and Table A4 suggest that job finding rates vary with household size such that $\mu_{f1t} < \mu_{f2t} < \mu_{f3t}$. Sorting across household sizes could generate such an observation. If so, this also introduces an additional weighting effect similar to that seen in the discussion on job separation rates above. Since the individual aggregate job finding rate can also be written

$$\mu_{fit} = \frac{1}{P}\sum_i f_{it} = \frac{1}{P}\sum_{h=1}^{H}\sum_{i\in h} f_{it} = \frac{1}{P}\sum_{h=1}^{H} n_h * m_{fhn_h t} = \sum_{h=1}^{H} \beta_h * m_{fhn_h t} \tag{B2.13}$$

where $\beta_h = \frac{n_h}{P}$

The individual aggregate job finding rate also gives larger weights to households with more occupants and the household aggregate job finding mean gives the same weight to all households regardless of size. If high f individuals sort into larger households then the individual aggregate mean gives these households more weight. This will tend to raise the individual mean relative to the household mean. This goes in the opposite direction to positive sorting within household size groups.

Positive dependence $f_{ih} = \bar{f}_i + \varepsilon_{ih}, f_{jh} = \bar{f}_j + \varepsilon_h \qquad Cov(\varepsilon_{ih}\varepsilon_{jh}) > 0$

In this case, shocks to job finding occur more within the same households. A positively correlated shock to job finding outcomes across individuals will either raise the likelihood of all individuals in the household finding work or raise the chances of no individuals finding work. Households leave the workless state whenever at least one individual finds work. An increase in everyone leaving does not change the household-level exit rate after the first worker finds a job. An increase in the probability of the all-stay outcome, however, reduces the household job-finding probability

Negative dependence is needed to increase the probability that any person in the household finds works. To see this, consider a 2-person household. The probability that any in the household find work is again

$$f_h = 1 - (1 - f_{1h})(1 - f_{2h}) = f_{1h} + f_{2h} - f_{1h}f_{2h} \tag{B2.14}$$

Taking expectations

$$E[f_h] = E[f_{1h}] + E[f_{2h}] - E[f_{1h}f_{2h}] = \bar{f}_{1h} + \bar{f}_{2h} - E[f_{1h}f_{2h}] \tag{B2.15}$$

Using the rules on covariances

$$E[f_h] = \bar{f}_{1h} + \bar{f}_{2h} - \bar{f}_{1h}\bar{f}_{2h} - Cov(f_{1h}f_{2h}) \tag{B2.16}$$

Positive dependence reduces the probability of at least one person finding a job, because it makes two individual job finding failures more likely to occur together. In contrast, negative dependence reduces this likelihood of joint failure and so raises the household job finding rate. The dependence effect is weakened if there is different strength dependency across household size groups.

State Dependence $f_i = g(n_h), \quad g'(n_h) > 0$

Higher job finding rates are concentrated in larger households because the size of the household influences the likelihood of job finding for any individual in some way. The job finding rate for a household is now $1-(1-g(n_h))^{n_h}$. Similar to sorting, positive state dependence in job finding puts high f individuals in larger households that already have the larger household job finding probabilities. The aggregate household job finding rate is now

$$\mu_{fht} = \sum_{n_h} \alpha_{n_h}[1-(1-g(n_h))^{n_h}] \tag{B2.17}$$

where α is the share of workless households of size n_h. For given α, the effect of positive state dependence is to raise the aggregate household mean job finding probability . With regard to the gap between household and individual means, the effect of state dependence is ambiguous. Since larger households receive greater weight in the aggregate individual mean but equal weight in the household aggregate, the effect on the household-individual gap depends on both the household-size distribution and the strength of state dependence.

Cyclicality

In a recession, the individual job finding rate f_{it} typically falls, along with its dispersion. Given independence and no sorting the difference between the two aggregate job finding means is

$$\begin{aligned}\Delta_f = \mu_{If} - \mu_{Hf} = \mu_{If} - \sum_{n_h=1}^{N_h} \alpha_{n_h} * m_{fht} &= \mu_{If} - \sum_{n_h=1}^{N_h} \alpha_{n_h} * [1-(1-\mu_{If})^{n_h}] \\ &= \sum_{n_h=1}^{N_h} \alpha_{n_h} * (\mu_{If} - [1-(1-\mu_{If})^{n_h}]\end{aligned} \tag{B2.18}$$

where $\alpha_{nh} = H_n/H$ is the share of household size n among all households. As long as there are some $n_h > 1$, the household job-finding probability exceeds the individual probability, so $\Delta_f < 0$

Consider the contribution of household size n_h to the gap $\Psi = \mu_{If} - [1-(1-\mu_{If})^{n_h}]$ in (B2.18)

Differentiating with respect to the mean individual job finding probability f

$$\frac{d\Psi}{d\mu_{If}} = 1 - n_h(1-\mu_{If})^{n_h-1} \tag{B2.19}$$

Since the second term may be greater or less than one, the sign of the derivative is ambiguous. If, however, as we observe in the data, f_{it} is small and close to zero, then

$(1-\mu_{If})^{n_h} \approx 1 - n_h\mu_{If} + \frac{n_h(n_h-1)}{2}\mu_{If}^2$

and so

$\Psi \approx \mu_{If} - n_h\mu_{If} \approx \mu_{If}(1-n_h)$

When the chances of finding a job are low, the probability of multiple household members all finding jobs is small, and the household job finding probability is approximately $n_h f$, the sum of the individual probabilities.

The difference between the two aggregate job finding rates $\Delta_f \to 0$

i.e. the gap between household and aggregate individual job finding rates narrows.

Substituting Ψ into B2.18, the household-individual job finding gap can be written

$$\Delta_f \approx \sum_{n_h=1}^{N_h} \alpha_{n_h} * [\mu_{If} - \mu_{If})^{n_h}] \approx \mu_{If} \sum_{n_h=1}^{N_h} \alpha_{n_h} * [(1-n_h)] \tag{B2.20}$$

Since household size shares sum $\sum_{n_h} \alpha_{n_h} = 1$ and mean household size $\bar{n} = \sum_{n_h} \alpha_{n_h} * n_h$ then

$$\sum_{n_h=1}^{N_h} \alpha_{n_h} * [(1-n_h)] = \sum_{n_h=1}^{N_h} \alpha_{n_h} - \sum_{n_h=1}^{N_h} \alpha_{n_h} * n_h = 1 - \bar{n} \tag{B2.21}$$

and

$$\Delta_f \approx \mu_{If}(1-\bar{n}) \tag{B2.22}$$

The household job-finding rate is approximately proportional to mean household size. A rise in the share of single adult households therefore reduces the household mean job finding rate and narrows the gap between the household and individual job finding rates.

Once again, changes in sorting or co-dependence or state dependence or shifts in household shares can affect either the household mean or individual means. Changes in these mechanisms over the cycle can cause the two aggregate job finding measures to move in different directions over the cycle.

B3: Decomposition of Household Markov Transition System

Write the matrix system (15) as

$$s_t = P_t s_{t+q_t} \tag{B.1}$$

The steady state equilibrium household labour market rates are given by

$$\bar{s}_t = P_t \bar{s}_t + q_t = (I - P_t)^{-1} q_t \tag{B.2}$$

Using the fact that

$$\Delta s_t = (s_t - \bar{s}_t) - (s_{t-1} - \bar{s}_{t-1}) + (\bar{s}_{t-1} - \bar{s}_{t-1}) \tag{B.3}$$

i.e. the change in the stock at time t equals the deviation from the (new) steady state minus the deviation from last period's steady state plus the change in the steady state.

and

$$(s_t - \bar{s}_t) = (P s_{t-1} - P \bar{s}_{t-1}) = P(\bar{s}_{t-1} - \bar{s}_{t-1}) - P(\bar{s}_t - \bar{s}_{t-1}) \tag{B.4}$$

Substitute (B.4) into (B.3) to give the change in the actual household rates over time as a partial adjustment framework to the flow steady state.

$$\Delta s_t = A_t \Delta \bar{s}_t + B_t \Delta s_{t-1} \tag{B.5}$$

where $A_t = (I - P_t)$ and $B_t = (I - P_t) P_{t-1} (I - P_{t-1})^{-1}$

Which is a type of partial-adjustment model ie changes in the transition probabilities change the steady state and the speed of adjustment to it. To work out the contribution of the transition probabilities on the observed household labour market states, (rather than on the steady state),

iterate backwards by repeated substitution for Δs_{t-1} in (B.5) to give

$$\Delta s_t = \sum_{k=0}^{t-1} C_{k,t} \Delta \bar{s}_{t-k} + D_t \Delta s_0 \tag{B.6}$$

where $C_{k,t} = (\prod_{n=0}^{k-1} B_{t-n}) A_{t-k}$ and $D_t = \prod_{n=0}^{t-1} (B_{t-n})$ The steady states in this distributed lag adjust immediately to any change in the transition probabilities p_{ijt}. The C_{lt} coefficients then capture the effect of the historical values of the transition probabilities.

Contribution of Household Labour Market Transition Rates

The influence of changes in each transition probability on household labour market stocks can be measured by taking a first-order approximation to the change in steady states in (B.5).

ie since the steady state level is a function of all the six transition probabilities

$\bar{s}_t = s(wm, wa, mw, ma, aw, am) = s(p_{ij})$, take a first-order Taylor vector approximation around the steady state, so the change in the steady state is

$$\Delta \bar{s} = \bar{s}_t - \bar{s}_{t-1} \approx \sum_{i \neq j} \frac{\delta \bar{s}}{\delta p_{ij}} \Delta p_{ij} \tag{B.6}$$

The derivatives $\frac{\delta \bar{s}}{\delta p_{ij}}$ can then be calculated analytically.