An Equilibrium Model of Wage and Hours Determination: Labor Market Regulation in the Retail Sector *

Job Market Paper

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ABSTRACT: A recent initiative to limit the discretion large retailers have when setting the weekly schedule of employees aims to increase predictability but at an unmeasured cost to market efficiency. Understanding the implications such policies have for a labor market where hours vary and employees have limited control over their own scheduling requires a model of why such jobs exist and also why individuals accept them. This paper formulates and estimates an equilibrium search model with firm and worker heterogeneity that endogenously generates labor contracts, hiring decisions, and search behavior that matches observed patterns in wages, hours, and employment for the U.S. retail sector. I use a novel approach to separately identify the primitives of the supply and demand side optimization problems that incorporates a mixture of stated preference data collected from workers, data with equilibrium retail jobs, and aggregate employment data. The empirical results indicate a counterfactual policy that restricts the extent hours may vary in a given week shifts workers into jobs with varying hours and benefits a majority of workers. However, such a policy also causes a significant decline in aggregate production and negatively impacts the complementary portion of the labor force.

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I. Introduction

Technological advances offer firms increasingly finer control over employee scheduling. An algorithm sold by Kronos Incorporated computes on-demand employee scheduling to the fifteen minute mark while incorporating historical sales, holidays, events, local competition, and weather. This ability to fine-tune inputs may lead to more efficient firms but at a cost to the workers whose schedules are fine-tuned. The extreme example is on-demand scheduling where employers ask employees to maintain availability for a shift but decide later, sometimes hours before, whether they will actually work or not. A large public backlash to on-demand scheduling in the U.S. led firms to largely abandon the practice (see Nassauer (2016), White (2015), Tabuchi (2015)) and its downfall suggests the limits of the gig economy for some industries. However, the larger issue of control over scheduling continues to inspire regulation of the retail and food service sectors including recent measures in San Francisco, Seattle, and New York City to ensure a "Fair Workweek."[1] As the retail sector accounts for around ten percent of the U.S. labor force, the potential impact of these policies underscores the need to understand how regulation changes the way such labor markets operate.

To illustrate the extent of variability in hours I consider a sample of jobs drawn from the National Longitudinal Survey of Youth 1997 Cohort (NLSY97) which in 2011 (Round 15) began asking respondents not only what their typical hours per week were, but also what were the most and fewest hours they worked over the last four weeks.[2] Using this survey, Lambert et al. (2014) estimate that around three-quarters of the U.S. workforce in their early thirties experience variability in week-to-week hours. Figure 1 highlights this variability for workers in the retail sector. The solid line plots the median "usual hours per week" of jobs. Around each bin of usual hours are percentiles for the most and fewest hours. The (nearly coincident) dashed line plots median hours for jobs in the same sector but where hours do not vary. These jobs appear identical when summarized by median hours but can imply substantially different sequences of hours and compensation for workers. For example, within the sub-sample of part-time jobs with hours that vary, around twenty percent of work weeks have *actual* hours worked that differ by at least twenty percent from *usual* hours. This variability occurs in an industry where around eighty percent of employees have no direct control over when they work.[3]

The case for regulation often cites survey evidence describing the negative consequences of variability in

[1] The *Fair Workweek Initiative* is a prominent umbrella group that coordinates efforts. See more at http://www.fairworkweek.org

[2] The NLSY97 is a nationally representative sample of approximately 9,000 individuals born between 1980 and 1985. The Work Schedule questions are based on similar ones used in the Workplace and Employee Survey managed by Statistics Canada and the University of Chicago's Work Scheduling Study.

[3] Part-time job is defined as 35 or fewer usual hours per week. See Section IV for more information about the sample and job characteristics.

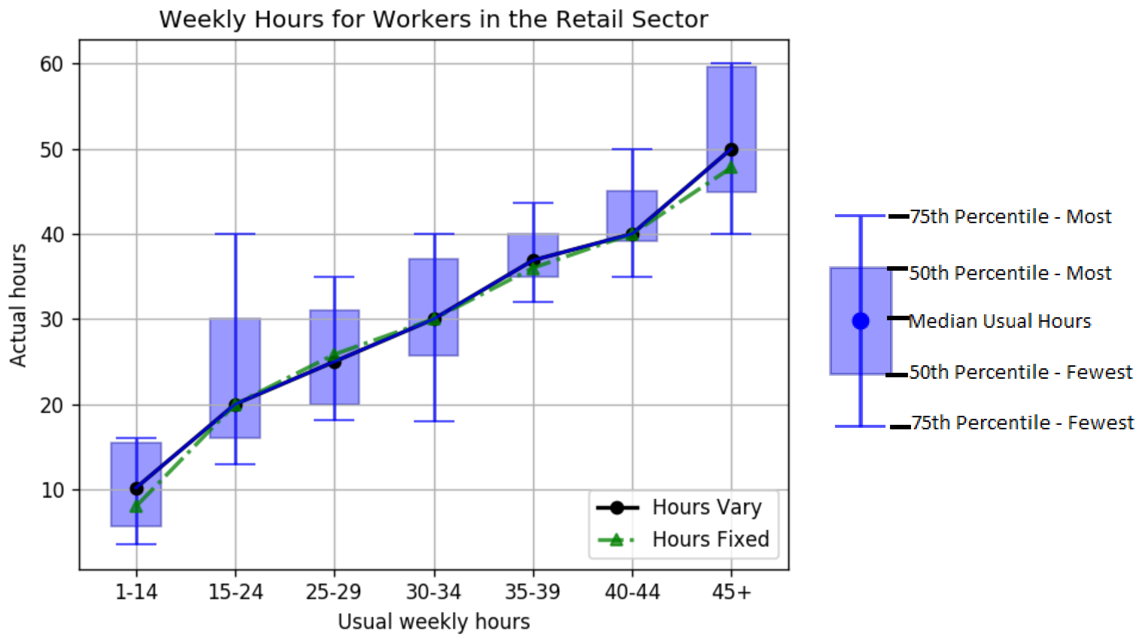


Figure 1: The distribution of actual hours conditional on usual hours for 405 retail employees from the 2013 round of the National Longitudinal Survey of Youth 1997 Cohort weighted to be nationally representative. Section IV provides additional information about the sample. Based on a similar figure in Lambert et al. (2014) for all industries and reproduced for comparison in Figure 16.

earnings, hours scheduling, and employee turnover on employee work-life balance.[4] The evidence on the importance of these job attributes from choice experiments is more mixed. Eriksson and Kristensen (2014) use the stated preferences of Danish employees from a discrete choice experiment and find a willingness to pay for flexibility in hours of around twelve percent of the average net wage. Mas and Pallais (2016) embed their discrete choice experiment within the actual hiring process for a call center and find substantial heterogeneity but small average valuations for flexibility and advanced notice of schedule. Some limited but growing evidence on the effect of policy comes from randomized control trials as in Bloom et al. (2015) who find an increase in both productivity and work satisfaction when randomizing the opportunity for Chinese call center employees to work from home.[5] While important, without a model of how these markets work this approach does not fully capture how and through what channels welfare changes. Equilibrium effects like sorting, search frictions, and changes in workforce composition, complicate attempts to estimate the valuations of non-wage attributes using observed jobs. Brown (1983) outlines the issues when using hedonic models for this purpose including that estimated valuations may have the wrong sign. Heckman et al.

[4] Reviews of survey evidence are Lambert et al. (2014) and Golden (2015). Examples of evidence from surveys include Golden et al. (2013), Henly and Lambert (2014), Ingre et al. (2012), Lambert (2008), Lambert et al. (2012), Reynolds and Aletraris (2006), Reynolds (2003), and Stewart and Swaffield (1997).

[5] See also the relevant study underway described in Lambert et al. (2015).

(2010) characterizes the scope of non-parametric identification of hedonic models for a single non-monetary attribute while noting that to separate the buyer's willingness to pay from the seller's willingness to accept requires specifying the underlying structural parameters of buyers and sellers. Fully disentangling the costs and benefits of policy that simultaneously reduces both firm efficiency and the uncertainty employees face over hours and compensation requires a structural model of the labor market that endogenously prices control over hours.

Given the above evidence on varying weekly hours, one important consideration is how to model the source of volatility. A standard neoclassical labor supply model has employees choosing hours free of constraints from the firm. Although this approach can generate schedules where hours vary or remain the same across weeks, the implication that observed labor hours are then optimal labor hours implies that any restrictions on how hours are set cannot be welfare enhancing. Alternatively, incorporating search frictions provides a way to generate sub-optimal contracts by imposing demand side restrictions on hours. The prototypical search model assumes individuals receive some number of job offers that consist of both a wage and a number of hours drawn from some exogenous joint distribution. Examples include van Soest et al. (1990), Blau (1991), Tummers and Woittiez (1991), Dickens and Lundberg (1993), Bloemen (2000), Bloemen (2008), and Cunha and Frazier (2016). In this framework, individuals choose between jobs that vary in offered compensation and hours but the friction resulting from not being able to freely choose hours leaves room for policy that increases welfare.

To understand the effect of regulations that restrict variation in hours I formulate an equilibrium search model of hours and wage determination in the retail labor market. In the model, a job offer is a wage and a distribution of hours that comes from one of two labor market sectors which differ in how employers choose hours. In one, the employer can adjust hours in response to a productivity shock so that from the worker's perspective total compensation and hours vary randomly from week to week. In the other, hours are fixed and jobs provide a degenerate distribution of weekly hours and compensation. For convenience I denote the former as the *variable contract sector* and the latter as the *fixed contract sector*. In both cases, wages are set before the shock-contingent marginal productivity of labor is known. These contracts occur between risk averse workers who are heterogeneous in how much they dislike variance in outcomes and risk neutral firms who are heterogeneous in their distribution of marginal productivities and thus vary in the cost of limiting discretion. Specifically, worker preferences exhibit constant relative risk aversion but differ in their implied coefficient of relative risk aversion. Firms produce using a Cobb-Douglas technology that converts labor hours into the economy's consumption good subject to a firm-specific distribution of productivity shocks. Search frictions in the economy generate imperfect sorting between workers and firm and cause unemployment in equilibrium. Though expected payoffs must satisfy participation constraints, actual hours worked are chosen by the employer given the wage and therefore not necessarily optimal from the perspective of the worker.

The model includes multiple channels for policy to affect outcomes and welfare. Workers direct their search towards a specific labor market sector which allows for sorting though search frictions presuppose a degree of mis-match. Jobs are matched worker-firm pairs where search frictions and worker and firm heterogeneity create variation in equilibrium labor contracts and the composition of observed jobs. The bargaining environment endogenously sets the offered wage while accounting for anticipated variation in hours, worker preferences, outside options, and aggregate market conditions. The model integrates endogenous firm entry and hiring decisions to capture how changes in market efficiency alter employment levels and equilibrium worker flows. These mechanism allows changes in regulation to cause equilibrium adjustments in wages, hours, employment levels, and worker-firm sorting. Quantifying the welfare impact of policy requires disentangling how the primitives of the firm, worker, and aggregate economy determine equilibrium outcomes. For example, low degrees of risk aversion in workers or large returns to adjustment for firms could equally result in high variability in hours with contrary implications for policy. Similarly, the scarcity of vacancies offering fixed hours could inflate their apparent value by reducing equilibrium wages.

My approach to separately identifying the primitives relating to worker preferences, firm technology, and search dynamics combines data from the retail sector on observed jobs and employment flows with data collected from workers containing their stated preferences over the kinds of contracts considered here. I use stated preferences data as a solution to the difficulty of identifying an equilibrium search model without firm data, as discussed in Flinn and Heckman (1982) and especially Flinn (2006) who describes it as a "a nearly impossible task." I elicit preferences using a purpose-made survey instrument that asks respondents to repeatedly choose their most preferred option between two hypothetical job offers and an explicit outside option tied to a monetary unemployment benefit. As in the model, job offers contain a wage and distribution of weekly hours which provides a way to trace out preferences over the entire contract space—including non-equilibrium combinations. Wage rates are tailored to the individual but vary randomly across offers for which all attributes are observed. Variation in observed choices allows the econometrician to distinguish and recover common preferences as well as heterogeneity across individuals.

To identify the primitives of firm and search technology I use data from the retail labor market in equilibrium. My data contains the wage and range of weekly hours for four hundred and five retail sector jobs taken from the nationally representative NLSY97. Around fifty five percent of these jobs report hours that vary week to week and department stores, supermarkets, and specialty stores comprise the majority of employers. Within the context of the model, variation in hours for a given wage provides information about the parameters of firm technology and the distribution of productivity shocks. The third source of data is the

Job Openings and Labor Turnover Survey which provides monthly measures of job openings, separations, and hiring rates specific to the retail sector. These moments combined with data on unemployment and labor market tightness pin down aggregate employment levels and flows in the model equilibrium which helps identify the parameters that determine search behavior.

I estimate the model in two stages where I first recover worker primitives from the stated preferences survey and then take those inputs as given when estimating firm and search technology. In the first stage, I estimate a random utility version of the preferences in the model that rationalizes the observed sequences of preferred options across choice sets in the survey. Since workers vary in their coefficient of relative risk aversion I use simulated maximum likelihood to separately recover common parameters from individual-specific heterogeneity. The recovered coefficients of relative risk aversion vary between 0.38 and 0.95 with a median value 0.59. The estimated values of Frisch elasticity range from 1.34 to 1.90 and resemble the rule of thumb value of between one to two used in the macro literature. Notably, these estimates come from the stated preferences of workers within a discrete choice experiment where jobs may involve exogenous variation in weekly hours rather than the more traditional neoclassical labor supply model applied to observed hours. I provide suggestive evidence that part of this variation is driven by demographic differences between workers.

The second stage of estimation involves solving for the steady state model equilibrium and simulating data to generate a cross-section of jobs and aggregate worker flows. Conceptually, the simulated data is directly comparable to the equilibrium jobs and employment measures I observe in my data from the retail sector. The parameters underlying firm and search technology are then chosen through a simulated method of moments estimator to match the model equilibrium to that observed in the data. I find an output elasticity with respect to hours of 0.66 which given the Cobb-Douglas production technology implies that labor costs equal sixty-six percent of firm revenue. This value matches the finding of Cooper et al. (2015) when applying a similar production technology with stochastic productivity to manufacturing data. My model is able to broadly match the observed patterns in wage, hours, and employment.

Given the structural parameters, I conduct a counterfactual policy experiment that limits an employee's hours in a given week to be within twenty percent of mean hours. This restriction reduces the ability of firms to adjust to productivity shocks and has implications for firm entry, hiring behavior, wages, hours, and employment levels. To measure welfare impact I simulate the new equilibrium and calculate the percentage change in utility across worker types as defined by their coefficient of relative risk aversion. The policy shifts workers from the fixed sector into the variable contract sector resulting in a ten percentage point increase in the share of jobs with varying hours. I find that sixty-five percent of the labor force is made better off but that workers with a high coefficient of risk aversion experience a lower average utility. A two and a half percentage point decline in aggregate production and a small increase in average welfare suggests that even the relatively light restrictions on firm discretion considered here have potentially unexpected equilibrium consequences and that aggregate changes do not fully reveal the uneven distribution of consequences across the labor force.

This paper contributes to a literature on estimating equilibrium search and bargaining models with heterogeneous agents that originates with Eckstein and Wolpin (1990) and is summarized in Mortensen and Pissarides (1999). My model introduces job offers that contain a wage and demand side restrictions on hours as well as a multi-sector labor market that allows for directed search and sorting. In terms of econometric approach this paper combines the simulated method of moment approach used in Postel-Vinay and Robin (2002) and Cooper et al. (2007) with an initial stage that recovers the heterogeneous preferences of workers then used as inputs when simulating the equilibrium in the second stage. My model uses the bargaining process developed in Dey and Flinn (2005) and Postel-Vinay and Robin (2002) though I make the simplifying assumption that the worker receives no portion of the match surplus. Incorporating demand side data provides a way to relax this assumption and still maintain identification as shown with on-the-job search in Postel-Vinay and Robin (2002) and through a worker bargaining weight as in Flinn (2006).

Perhaps the closest models to this paper are Dey and Flinn (2005) and Cooper et al. (2007). In Dey and Flinn heterogeneous workers have preferences over job contracts that include a wage and employer-provided health insurance. The firm's cost of provision is exogenously drawn and risk-neutral workers differ in how much they value having health insurance. They estimate worker and firm primitives using supply side data on equilibrium jobs and employment transitions as well as labor's share of firm revenue which pins down the bargaining power of workers. In contrast, by recovering worker preferences separately, my approach allows variation in observed job contracts to identify precisely how the choice in hours affects firm profitability and productivity without the incorporation of demand side data. In Cooper et al. homogeneous but risk averse workers face uncertainty over compensation and hours but contracts perfectly insure workers against firm- and aggregate-shocks by exactly satisfying their *ex-post* participation constraint. They calibrate primitives related to worker preferences and use a mixture of plant-level data and worker flows to estimate a set of firm and search primitives similar in value to those reported here.

The inclusion of hypothetical data in estimating structural search models has been explored in Bloemen (2008) who compares a stated preference over hours to observed hours and van der Klaauw (2012) who finds an increase in estimation efficiency when incorporating the subjective expectations of future occupation into a model of occupational choice. My paper introduces its use to the equilibrium search literature as a way to expand the scope of the labor contracts and policies that can be evaluated. My use of discrete choice experiments to recover worker preferences resembles the approach in Eriksson and Kristensen (2014) and Mas and Pallais (2016) who use the exogenous variation in the offered wage to recover distributional estimates of employee willingness to pay for non-monetary job attributes.

The plan of the paper is as follows. In Section II, I formulate my equilibrium model of the labor market. Section III discusses identification given data and outlines my approach to estimation. In Section IV, I describe the sample of retail jobs motivating the policy experiment. Section V describes the data, methodology, and results of estimating worker preferences and heterogeneity while SectionVI contains the analogous content for firm and search technology within the general equilibrium model. Section VII uses the estimated structural parameters to characterize the welfare costs of various policies and Section VIII concludes.

II. Model

There are two types of agents in the model: a unit measure of infinitely-lived workers and a large but finite measure of firms. Workers have an endowment of hours to split between labor and leisure and firms own exclusive rights to a technology that converts labor hours into the economy's sole consumption good. A single firm operates a production site where a single worker may work. Firms operate independently and production is a function of the worker's labor input and an idiosyncratic productivity shock.

Time is discrete and divided into four phases within each period. In the first phase, firms decide whether to enter and all unmatched agents search and meet through a frictional matching process described below. In the second phase, firm-worker pairs negotiate contracts that specify a wage and a distribution of possible labor hours. In the third phase firms see their idiosyncratic productivity shock and choose labor hours given the terms of the labor contract. In the fourth and final phase, some matches are exogenously destroyed. All agents discount future periods at the same rate β. The remainder of the section first describes the segmented structure of the labor market, the primitives of the workers problem, the primitives of the firm's problem, and then proceeds to the details and dynamics of the successive phases. The final subsection defines a steady state equilibrium and derives properties of the model.

A. Market Structure

The labor market consists of two independent sectors where workers choose a specific sector in which to look for employment. Labor contracts in the *fixed sector* specify a wage and a number of hours independent of the production phase shock. Contracts in the *variable sector* specify a wage independent of the shock but permit the firm to set hours during the production phase. Consequently, the aggregated labor market contains jobs with the same hours each week and others where hours vary across weeks. The sectors operate separately but concurrently with the stipulation that any contract signed in a sector must match the sector type. Therefore, a worker strictly preferring a fixed contract would only ever seek employment in the fixed sector. In this sense workers direct their search by choosing a specific sector which allows workers to sort based both on their own preferences and in response to differences in the equilibrium probability of finding a job.

B. Workers

All workers have the same per-period endowment of hours normalized to unity which they divide between labor and leisure. In the production phase, employed workers receive compensation in return for hours worked. When unemployed workers receive a common unemployment benefit, b. Workers face a within period budget constraint such that consumption in any period must be less than or equal to compensation, wL, or b if unemployed. Equivalently,

$$C \leq wL + \mathbb{1}_{[ue]}b. \tag{1}$$

From the perspective of workers, contracts where hours vary across periods generate random sequences of consumption and labor hours and their inability to adjust their labor supply or borrow and save to smooth consumption embodies the primary friction in the model. Let the utility function $Z(C, L)$ describe their preferences of worker i over consumption C and labor hours L in any period as

$$Z(C, L) = \frac{\left(C^{\gamma}(1-L)^{1-\gamma}\right)^{1-\rho_i}}{1-\rho_i} - \mathbb{1}_{[ue]}g(z) \tag{2}$$

The $g(z)$ term captures an additional stigma cost of unemployment that depends on a vector of observable worker characteristics, z. I assume $g(z) > 0$ for all z which implies that all workers choose to work when otherwise indifferent. Utility over consumption and hours is time-separable in a Cobb-Douglas form with constant returns to scale where γ determines the relative weight given to consumption and ρ describes the risk aversion of worker. Workers are heterogeneous in their degree of risk aversion which is summarized by their type ρ_i with distribution F_ρ in the population. This specification has the appealing property that worker heterogeneity enters the implied relative risk aversion, $\rho_i\gamma + 1 - \gamma$, and the Frisch elasticity, $\left(\frac{1-\gamma(1-\rho_i)}{\rho_i}\right)\left(\frac{1-\ell}{\ell}\right)$, and so allows responses to uncertainty over contractual hours and wages to differ across individuals while remaining analytically tractable.

C. Firms

Firms are risk-neutral and consume the profits of production. When matched with a worker, firms use a homogeneous production technology, $y(\ell, \varepsilon)$, that converts labor hours, ℓ, into the economy's consumption good subject to an idiosyncratic productivity shock, ε. Let

$$y(\ell, \varepsilon) = e^{\varepsilon} \lambda \ell^{\alpha} \tag{3}$$

where the curvature parameter, $\alpha < 1$, captures the diminishing returns to scale from ignoring the fixed factors of production. The distribution of productivity shocks is firm-specific. Each period firm n receives an independent draw from $\varepsilon \sim N(\mu_n, \sigma_n^2)$ where I assume that $\mu_n = -\frac{1}{2}\sigma_n^2$ so that firms differ in the variance but not in the mean of their expected productivity shock.[6] Firms draw their type, σ_n, from density F_σ upon entry into the economy and their type stays fixed for the life of the firm. The firm's type determines the distribution of marginal productivity of labor in production and therefore their return from adjusting hours.

D. Phase 1: Entry and Matching

Firms may enter either sector at the beginning of any period by paying a one-time cost of creating a position. Concurrently, any firm may choose to destroy their position, exit the market, and receive a pay-off of zero forever. Firms may not enter or exit in any other phase. Once they have created a position, firms are not allowed to create a second nor switch to the other sector.[7] Formally, let Q be the value of creating a position

$$Q = \max\{-c_v + Q^v(\sigma), -c_f + Q^f(\sigma)\} \tag{4}$$

where, for sector $m \in \{v, f\}$, c_m is the fixed cost of creating a position and $Q^m(\sigma)$ is the value of holding a vacancy. Since firms are free to exit we have the equilibrium condition that $Q^m(\sigma) \geq 0$ for all firm types σ participating in sector m. An infinite number of potential firms may enter by paying the cost of creating a position, so in a stationary equilibrium we have the free entry condition $\mathbb{E}_\sigma[Q] \leq 0$ where the expectation is taken with respect to F_σ, the distribution of firm types. Taken together, these properties imply entry into each sector until the expected return from creating a position in either sector is less than or equal to zero, or $0 \leq \mathbb{E}_\sigma[Q^m(\sigma)] \leq c_m$. When deciding whether to enter, firms take market conditions as given.

After entry and exit, unmatched workers and firms meet through a frictional search process. Within a

[6] This fact follows from $\mathbb{E}[\exp(\varepsilon)] = \exp(\mu_n + \frac{1}{2}\sigma_n^2) = 1$. This assumption is stronger than the typical normalization when using a scale parameter since the scale parameter is not firm-specific. I discuss the (non-)identification of μ_n in Section III.

[7] Assuming firms pay a cost to learn their type and then choose which sector to enter and allows for firm sorting between the sectors. The identification of this sorting without demand side data is precarious and even more heavily leverages the assumption that the expected productivity shock is independent of firm type.

sector, search is random. Search is costless for unemployed workers who may search in either sector but not both. When choosing between the sectors workers know the probability they will meet a firm in either sector as well as the distribution of firms participating in the sector. Firms with an unfilled position must pay a cost at the beginning of the search phase to keep the vacancy open each period and must remain in the sector where they created their position. Firms know the distribution of participating worker types in each sector and the probability of a contacting a worker. I assume that search in the two sectors functions independently but using the same matching technology. Let u_m and v_m be the measure of unemployed workers and vacancies in sector m. An aggregate matching function, $M(u, v)$, governs the measure of meetings between vacancies and unemployed workers where a meeting is a chance for worker and firm to negotiate a labor contract. Accordingly, for sector m, $\phi_m = M(u, v)/u$ is the probability an individual applicant meets a firm with a vacancy while $q_m = M(u, v)/v$ is the probability that a particular vacancy contacts an unemployed worker. Though determined in equilibrium, all agents take these probabilities as given when searching.

To formalize the search decision let $J(\rho, \sigma)$ represent a worker's value of entering the period as employed with firm-type σ in sector m and $U(\rho)$ be the value of entering the period unemployed. Workers only have preferences over the realized hours and compensation during the production phase so the value of any match is the expected utility of the contract plus an expected continuation value. For a worker-type ρ in a variable contract with a firm-type σ this value is

$$J^v(\rho, \sigma) = \mathbb{E}_\varepsilon \left[Z(w_v \ell_v(\varepsilon), \ell_v(\varepsilon); \rho) \right] + \beta \left[(1-s) J^v(\rho, \sigma) + sU(\rho) \right] \tag{5}$$

where s is the probability the job is exogenously destroyed at the end of the period. Neither party may terminate an existing contract and all match destruction is exogenous. For workers holding fixed contracts all pay-offs are independent of the realized productivity shock as evidenced in

$$J^f(\rho, \sigma) = Z(w_f \ell_f, \ell_f; \rho) + \beta \left[(1-s) J^f(\rho, \sigma) + sU(\rho) \right]. \tag{6}$$

Consequently, the value of their match is also independent of the firm's type, *e.g.* $J^f(\rho, \sigma) = J^f(\rho)$, and their per-period utility pay-off is perfectly smooth for the duration of the match.

Let $M^m(\rho, \sigma)$ be the worker's value of a meeting a firm such that if both parties agree to the contract they get the value of the job, $J^m(\rho, \sigma)$, and the value of remaining unemployed otherwise. Equivalently,

$$M^m(\rho, \sigma) = \begin{cases} J^m(\rho, \sigma) & \text{if both parties accept} \\ Z(b, 0) - g(z) + \beta U(\rho) & \text{otherwise} \end{cases} \tag{7}$$

Let $U^m(\rho)$ be the value of searching in sector m where with probability ϕ_m the worker meets a firm so that

$$U^m(\rho) = \phi_m \mathbb{E}_\sigma \max\{M^m(\rho,\sigma), Z(b,0) - g(z) + \beta U^m(\rho)\} + (1-\phi_m)(Z(b,0) - g(z) + \beta U^m(\rho)). \quad (8)$$

The worker integrates the value of potential meetings over the distribution of unmatched firms. Having this notation, the value of unemployment for a worker of type ρ also describe the policy function for directed search in that the worker searches in the sector that satisfies

$$U(\rho) = \max\{U^f(\rho), U^v(\rho)\}. \quad (9)$$

At the beginning of a period, the set of vacancies in a sector is the set of firms entering the period unmatched plus new entries to the sector. Let $R(\rho,\sigma)$ be the value of a firm entering a period matched to a worker of type ρ. Again, pay-offs occur in the production phase so hiring decisions are made while integrating against the firm's own distribution of productivity shocks. Specifically, the value of a firm in the variable sector of type σ matched with a worker of type ρ is

$$R^v(\rho,\sigma) = \mathbb{E}_\varepsilon[y(\ell_v(\varepsilon),\varepsilon) - w_v\ell_v(\varepsilon)] + \beta\left[(1-s)R^v(\rho,\sigma) + sQ^v(\sigma)\right]. \quad (10)$$

The value of being unmatched next period depends on the sector they initially entered as switching is disallowed. Analogously, the firm's value in the fixed sector is

$$R^f(\rho,\sigma) = \mathbb{E}_\varepsilon[y(\ell_f,\varepsilon)] - w_f\ell_f + \beta\left[(1-s)R^f(\rho,\sigma) + sQ^f(\sigma)\right]. \quad (11)$$

I assume firms pay a sector specific cost of maintaining a vacancy, $\chi_m(u_m, v_m)$, that depends on the measure of unemployed workers and other vacancies in the sector but not on the firm's own characteristics. Let $\chi_m(u_m, v_m)$ be strictly increasing in v_m and strictly decreasing in u_m. Accordingly, the value of a firm of type σ entering the period unmatched in sector m is

$$Q^m(\sigma) = -\chi_m(u_m,v_m) + q_m\mathbb{E}_\rho \max\{R^m(\rho,\sigma), \beta Q^m(\sigma)\} + (1-q_m)\beta Q^m(\sigma), \quad (12)$$

where firms integrate against the known distribution of unmatched workers in the sector, F^m_ρ, and take as given, q_m, the probability of contacting a worker in sector m. Clearly, firms will reject any match where $\beta Q^m(\sigma) > R^m(\rho,\sigma)$, or the value of continued search exceeds the value of the match. Intuitively, a firm may prefer to search again in the hopes of meeting a different worker-type with a larger expected match surplus.

Given optimal search behavior of workers and firms, the determination of equilibrium and aggregate dynamics requires formulating how the worker and firm contact rates are related to market fundamentals. Define market tightness, θ, as the ratio of vacancies to unemployed workers so that for the variable and fixed sectors we have $\theta_v = v_v/u_v$ and $\theta_f = v_f/u_f$, respectively. I assume $M(u,v)$ has a Cobb-Douglas form with constant returns to scale such that the measure of meetings is determined by

$$M(u_m, v_m) = \mu u_m^{\tau} v_m^{1-\tau}.$$

The job contacting rate ϕ and worker contacting rate q are then conveniently written as functions of market tightness:

$$q = \frac{M}{u} = \mu \frac{u^{\tau} v^{1-\tau}}{v} = \mu\theta^{-\tau} \tag{13}$$

$$\phi = \frac{M}{u} = \mu \frac{u^{\tau} v^{1-\tau}}{u} = \mu\theta^{1-\tau}. \tag{14}$$

E. Phase 2: Negotiation

All newly met pairs negotiate contracts during the second phase in a full information environment such that each agent knows the other's type. The only uncertainty is over productivity shocks and whether the match will be exogenously destroyed. The firm proposes a wage and distribution of potential hours. The worker may choose to accept or reject this contract though neither party may terminate a signed contract in future periods. In the variable sector the firm's distribution of productivity shocks determines the distribution of potential hours. In the fixed sector hours are independent of the shock and the same across periods. In equilibrium, the wage and distribution of hours are set through firm optimization behavior described in the following section.

Either party may reject the match. Workers reject any match that does not satisfy their participation constraint. Firms reject a match if the expected (discounted) return from re-posting its vacancy next period is larger than the value of the match. Failed meetings result in firms receiving a pay-off of zero, workers receiving their unemployment benefit, and both parties entering the next period as unmatched. If neither party rejects the contract they enter the production phase and workers supply labor and receive compensation in accordance with their contract. All contracted hours and pay-outs are binding for both parties during the production phase.

I assume bargaining follows a version of the repeated infinite bargaining of Rubinstein (1982) which Cahuc et al. (2006) show results in an offer from the expected profit maximizing firm to the worker such that the value of working for a firm of type σ this period is no less than the worker's reservation value. Formally, the contract must satisfy

$$\mathbb{E}_{\varepsilon} Z(w_m \ell_m, \ell_m) + \beta[(1-s)J^m(\rho,\sigma) + sU(\rho)] \geq Z(b,0) - g(z) + \beta U(\rho) + \zeta S(\rho,\sigma), \tag{15}$$

where $S(\rho,\sigma)$ is the match surplus and ζ the worker's *bargaining parameter*. Let $S_F(\rho,\sigma) = R^m(\rho,\sigma) - \beta Q^m(\sigma)$ be the firms surplus from the match and $S_W(\rho,\sigma) = J^m(\rho,\sigma) - [Z(b,0) - g(z) + \beta U(\rho)]$ be the match surplus for the worker. The match surplus during the negotiation phase is

$$S(\rho,\sigma) \equiv \begin{cases} S_F(\rho,\sigma) + S_W(\rho,\sigma) & \text{if } S_F(\rho,\sigma) > 0 \text{ and } S_W(\rho,\sigma) > 0 \\ 0 & \text{otherwise} \end{cases} \tag{16}$$

For tractability and concerns regarding identification, I set $\zeta = 0$ which is tantamount to firms making take it or leave type offers that leave workers just indifferent between working and remaining unemployed. I discuss the difficulties of identifying ζ given available data and how this assumption affects counterfactuals in Section III.D.

Given the bargaining environment, in equilibrium workers are *ex-ante* indifferent between working under a fixed contract, working under a variable contract, and remaining unemployed. Clearly, an arbitrary tie-breaking rule has serious consequences for labor market sorting and therefore welfare analysis. To mitigate this issue I assume that firms are unable to contract on the stigma cost of unemployment, $g(z)$, and instead treat the worker's pay-off from unemployment as $Z(b,0)$. Equivalently, they act as though $g(z) = 0$ for all z. This assumption provides an intrinsic premium of employment where firms leave money on the table even when z is fully known by both parties. A rationale for this assumption is that z contains worker characteristics like race, sex, national origin, religion, and disability, over which firms are legally prohibited from considering in labor contracts in the United States. These characteristics plausibly affect the value of unemployment but are assumed irrelevant for a worker's productivity and, were a firm to write contracts that extract this additional surplus, evidence of this behavior invites legal penalties for labor discrimination.

F. Phase 3: Optimal Labor Contracts

In the production phase firms maximize profits subject to the agreed upon contract, namely a wage and whether they can adjust hours after seeing the period's production shock. A firm holding a variable contract with wage w_v solves

$$\max_{\ell} \; e^{\varepsilon} \lambda \ell^{\alpha} - w_v \ell, \tag{17}$$

implying a profit maximizing labor demand of

$$\ell_v(\varepsilon) = \left(\frac{\alpha\lambda e^{\varepsilon}}{w_v}\right)^{\frac{1}{1-\alpha}}. \tag{18}$$

In contrast, a firm in a fixed contract with wage w_f sets l_f before the ε realization and so maximizes expected profit

$$\max_{\ell} \ \lambda\ell^{\alpha} - w_f\ell \tag{19}$$

and therefore has a shock-independent labor demand of

$$\ell_f = \left(\frac{\alpha\lambda}{w_f}\right)^{\frac{1}{1-\alpha}}. \tag{20}$$

The optimal contract for a firm to offer during the negotiation phase leaves workers just indifferent between accepting the contract and their effective outside option. Workers know the firm's type and their rule for determining hours during the production phase. Therefore, the equilibrium wage offer during negotiation in sector m solves

$$\min_{w\in\mathbb{R}^+} w \quad \text{s.t.} \tag{21}$$
$$\begin{cases} \mathbb{E}_{\varepsilon}[Z(w\ell_v(w,\varepsilon),\ell_v(w,\varepsilon);\rho)] + \beta\Big[(1-s)J^v(\rho,\sigma) + sU(\rho)\Big] & \geq Z(b,0;\rho) + \beta U(\rho) \quad \text{for } m = v \\ Z(w\ell_f(w),\ell_f(w);\rho) + \beta\Big[(1-s)J^f(\rho,\sigma) + sU(\rho)\Big] & \geq Z(b,0;\rho) + \beta U(\rho) \quad \text{for } m = f \end{cases}$$

where constraint enforces that the worker's expected value of working be at least as great as the worker's effective outside option. Given the strict concavity of utility the constraint binds at interior solutions. Re-arranging terms we have that the wage offer satisfies the generalized wage setting equation:

$$\mathbb{E}_{\varepsilon}[Z(w\ell(w,\varepsilon),\ell(w,\varepsilon);\rho)] = Z(b,0;\rho) + \beta(1-s)[U(\rho) - J^m(\rho,\sigma)]. \tag{22}$$

While expected profits are independent of firm type, curvature in the production makes expected utility a function of the firm's type. As an example, consider the expected hours under a variable contract:

$$\mathbb{E}_{\varepsilon}[\ell(\varepsilon)] = \mathbb{E}_{\varepsilon}\left[\left(\frac{\alpha\lambda\exp\{\varepsilon\}}{w_v}\right)^{\frac{1}{1-\alpha}}\right] = \left(\frac{\alpha\lambda}{w_v}\right)^{\frac{1}{1-\alpha}} \exp\left\{\frac{\alpha}{2(1-\alpha)^2}\sigma^2\right\}.$$

The non-linearity of (22) means a solution, much less a unique solution, may not exist for a given set of parameters. However, given a set of solutions the following lemma establishes the optimal wage for a given firm.

Lemma II.1. For any set of solutions to (22), the smallest value in the set is the expected profit maximizing wage and therefore the firm's optimal wage offer.

Proof. Firms choose w to maximize expected profit which we can re-write as

$$\begin{aligned}
\mathbb{E}_\varepsilon[\pi(\ell(\varepsilon), w)] &= \mathbb{E}_\varepsilon\left[e^\varepsilon \lambda \ell^\alpha - w\ell\right] \\
&= \mathbb{E}_\varepsilon\left[\ell\left(\frac{w}{\alpha}\left(\frac{\lambda\alpha e^\varepsilon}{w}\right)\ell^{\alpha-1} - wl\right)\right] \\
&= \mathbb{E}_\varepsilon\left[w\ell\left(\alpha^{-1}\ell^{1-\alpha}\ell^{\alpha-1} - 1\right)\right] \\
&= \mathbb{E}_\varepsilon\left[w\ell\left(\alpha^{-1} - 1\right)\right] \\
&= \mathbb{E}_\varepsilon\left[w^{\frac{-\alpha}{1-\alpha}}(\lambda\alpha e^\varepsilon)^{\frac{1}{1-\alpha}}\left(\alpha^{-1} - 1\right)\right]
\end{aligned}$$

where clearly expected profit is strictly decreasing in w for $\alpha \in (0, 1)$. □

One interesting consequence of the above environment and the binding nature of the contracts is that outcomes for firms and workers are not always *ex-post* optimal given the realized shock. For example, with some probability firms operating with fixed labor contracts experience a productivity shock small enough to cause negative profit. Similarly, workers in variable contracts have no guarantee that the realized hours and compensation will provide more utility than the outside option of unemployment. Incorporating endogenous "quits" and "fires" into the model removes this potentially undesirable feature but distorts the primary welfare cost of interest. Fixed contracts inherit uncertainty absent from the variable sectors where hours freely adjust. Worse, requiring satisfaction of participation constraints *ex-post* removes the entire welfare cost of varying hours by providing full insurance.[8]

G. Phase 4: Exogenous Match Destruction

The set of unmatched agents entering the final phase are those who did not meet any potential partner plus those whose meetings failed to produce a viable contract. Subsequently, existing matches are destroyed with probability s which is independent of all firm and worker characteristics. Let $u_m(\rho)$ be the unemployment rate of worker-type ρ in sector m and $\eta_m(\rho)$ be the probability of meeting a compatible firm. The randomness of meetings within a sector implies that given the set of unmatched firms, the probabilities of contacting a

[8]For more on optimal contracting between risk averse workers and risk neutral firm see Cooper (1985).

firm and getting rejected are independent. The end of period unemployment for a worker of type ρ equals

$$u'_m(\rho) = s(1 - u_m(\rho)) + (1 - \phi_m \eta_m(\rho))u_m(\rho).$$

Similarly, let $v_m(\sigma)$ be the measure of vacancies from firm-type σ in sector m such that

$$v'_m(\sigma) = s(1 - v_m(\sigma)) + (1 - q_m \psi_m(\sigma))v_m(\sigma),$$

where $\psi_m(\sigma) = \int_{F_\rho^m} \max\{R^m(\rho, \sigma), \beta Q^m(\sigma)\}$, or the rate of non-viable meetings.

H. Steady State Equilibrium

A steady state equilibrium requires the optimal behavior of agents taking as given both the exogenous components of the model and those determined in equilibrium as well as the consistency conditions enforcing stationarity.

The exogenous components of the model are the distributions of worker and firm types $\{F_\rho, F_\sigma\}$, the preferences parameters of the worker $\{\gamma, g(\cdot)\}$, the labor elasticity and scale of production $\{\alpha, \lambda\}$, the scale and elasticity of the matching function $M(\cdot, \cdot)$ $\{\mu, \tau\}$, the entry cost for the fixed and variable sectors $\{c_f, c_v\}$, the maintenance cost of a vacancy $\{\chi_f(\cdot), \chi_v(\cdot)\}$, the common unemployment benefit, b, the rate of job destruction, s, and the discount factor β.

The endogenous objects determined in equilibrium are (*i*) labor market tightness $\{\theta_v, \theta_f\}$, (*ii*) match acceptance rates for workers $\{\eta_f(\rho), \eta_v(\rho)\}$, (*iii*) the distributions of unmatched agents in each sector $\{F_\rho^f, F_\rho^v, F_\sigma^f, F_\sigma^v\}$, and (*iv*) the measure of participating firms in each sector determined in equilibrium by the free entry conditions.

The set of optimal firm and worker behavior outlined in (*i*) the entry decision of firms into the fixed and variable sector (4), (*ii*) the hiring decisions for firms (12), (*iii*) optimal labor contracts that maximize expected profit and satisfy participation constraints ((20), (18), and (21)), (*iv*) the worker's contract acceptance rule (15), and (*v*) the directed search choice of workers (9).

The assumption of stationarity implies that all inflows equal outflows for all worker and firms types whether measured by matched or unmatched status, type of contract, or sector participation. This property leads to following consistency conditions. Conditional on participation in sector m, the measure of unemployed workers of type ρ in sector m is

$$u_m(\rho) = \frac{s}{(s + \phi_m \eta_m(\rho))}. \tag{23}$$

Conditional on participation in sector m, the measure of vacancies from firm-type σ is

$$v_m(\sigma) = \frac{s}{(s + q_m \psi_m(\sigma))}. \tag{24}$$

In order to pin the dynamics of the economy in steady state equilibrium I first derive a few useful implied properties. Since the paper is motivated by applying counterfactual policy to an equilibrium with a mix of contract types I restrict analysis to the case where both sectors have participating workers and firms which motivates the following definition:

Definition II.1. Let sector m be *in operation* if the sector has a positive finite measure of unmatched firms and workers, or $\theta_m \in (0, \infty)$.

One consequence of the bargaining environment is that the *ex-ante* value of working is fully insured against the realized productivity shock, the firm's type, and even the contract type.[9] Substituting the participation constraint (15) into the value of working in sector m we have

$$\begin{aligned} J^m &= \mathbb{E}_\varepsilon Z(w_m \ell_m, \ell_m) + \beta[(1-s)J^m + sU] \\ &= Z(b, 0) + \beta(1-s)[U - J^m] + \beta(1-s)J^m + s\beta U \\ &= Z(b, 0) + \beta U. \end{aligned} \tag{25}$$

In other words, the equilibrium value of any job is equal to the pay-off from the common unemployment benefit plus the discounted value of being unemployed next period, both of which are independent of any characteristic of the current match aside from the worker's type. However, despite *ex-ante* equivalence, actual pay-offs may cause the *ex-post* values of jobs to differ substantially in any finite set of periods.

In the steady state equilibrium the stationarity of θ_m implies that for any given type ρ, if $U^f(\rho) > U^v(\rho)$ in one period then it will true for all periods and workers will always continue to search in the same sector next period. Consider the case where all firms are willing to match with workers, or $M^m = J^m$ and $\eta_m(\rho) = 1$ for all ρ. Workers direct their search to the sector satisfying $U = \max\{U^f, U^v\}$. If we substitute the value of

[9] When workers have positive bargaining weight they remain insured against the shock but pay-offs depend on the sector and firm type.

a job (25) into the value of unemployment we get

$$
\begin{aligned}
U^m &= \phi_m \mathbb{E}_\sigma \max\{J^m, Z(b,0) - g(z) + \beta U^m\} + (1-\phi_m)(Z(b,0) - g(z) + \beta U^m) \\
U^m &= \phi_m \max\{Z(b,0) + \beta U^m, Z(b,0) - g(z) + \beta U^m\} + (1-\phi_m)(Z(b,0) - g(z) + \beta U^m) \\
U^m &= \phi_m \max\{Z(b,0), Z(b,0) - g(z)\} + (1-\phi_m)(Z(b,0) - g(z)) + (1-\phi_m+\phi_m)\beta U^m \\
U^m &= \phi_m Z(b,0) + (1-\phi_m)(Z(b,0) - g(z)) + \beta U^m \\
U^m &= \frac{Z(b,0) - (1-\phi_m)g(z)}{1-\beta}, \qquad (26)
\end{aligned}
$$

where the equilibrium value of entering a period unemployed in a particular sector is just the pay-off from unemployment less stigma cost of unemployment weight by the long-run expected portion of time spent in unemployment. For comparison, if firms could write contracts incorporating z then the value of unemployment is

$$U^m = \frac{Z(b,0) - g(z)}{1-\beta}.$$

Since entry is determined by $\max\{U^f, U^v\}$, (26) implies that $U^f = U^v$ if and only if $\phi_f = \phi_v$ where $U^f = U^v$ is a necessary condition to have both sectors operating. However, the assumption that firms never reject a match is restrictive as firms may prefer to take the pay-off of zero this period and re-post their vacancy next period. Intuitively, firms with greater variance in shocks in the variable sector may prefer less risk averse workers. The firm's value of a vacancy (12) embeds the firm's decision rules for accepting or rejects matches, *e.g.* $\max\{R^m, \beta Q^m\}$.

Since search operates in a full information environment a worker of type ρ knows the probability they will meet a firm unwilling to match with them in sector m. Let this probability be $\eta_m(\rho) = \eta(\theta_m, F^m_\rho, \rho)$ which is a function of their own types, labor market tightness, and the distribution of other unmatched worker-types. Intuitively, the firm's expected return from continued search directly relates to the likelihood of another meeting $q_m(\theta_m)$ and the expected type to be encountered (F^m_ρ) which are both equilibrium objects. Re-writing (26) to account for rejected matches we have

$$U^m(\rho) = \frac{Z(b,0) - (1-\phi_m\eta_m(\rho))g(z)}{1-\beta}. \qquad (27)$$

Since this relationship varies across ρ we no longer require $U^f(\rho) = U^v(\rho)$ for all ρ to have both sectors operating which in turn introduces scope for sorting between sectors.

Another useful property of the economy closely related to the equilibrium value of unemployment (27) is the worker's surplus from employment. A little algebra shows that the difference $J - U$ can be written as

$$\begin{aligned} J - U &= Z(b,0) + \beta U - U \\ &= (1 - \phi_m \eta_m(\rho)) g(z) \end{aligned} \tag{28}$$

which is just the premium from employment weighted by the long run expectation of time spent unemployed. The surplus disappears if finding a viable job is a certainty or if $g(z) = 0$. The negative of this term shows up prominently in the wage setting equation (22) where intuitively the wage is increasing in the size of the stigma cost, though at a rate decreasing in the probability of finding a viable match. In this manner, the firm does recover some portion of the "excess" worker surplus even though in any given period the contracted pay-off is independent of z. As $g(z)$ increases so does the intrinsic and protected premium employment provides to the worker. As labor market tightness θ_m increases, the job contact rate $\phi_m(\theta_m)$ goes up which also raises the value of unemployment, $U^m(\rho)$ and by the wage setting equation (22) and (28) increases the required wage offer.

The stability of search dynamics depends on the optimizing behavior of workers and firms which includes sorting by workers, the entry (and exit) decision of firms, and the endogenous distribution of unmatched agents. In general, a worker may be rejected by all firms in the economy which creates an ambiguity over whether such a worker is *unemployed* or *discouraged*. This distinction has bite as in the estimation of equilibrium search models, the unemployment rate often disciplines search dynamics and there may be multiple equilibria with different rates of discouraged workers. In the fixed sector, a firm's value of a match and vacancy are independent of the firm's type and so a worker rejected by one firm will be rejected by all firms. To avoid this uncertainty, I assume that for any worker in the fixed sector, at least one firm type, and therefore all, are willing to match which prohibits the occurrence of an unemployable worker. This condition amounts to enforcing a positive match surplus in estimation and is not without loss of generality when taking the model to data as the distribution of worker heterogeneity matters when fitting the observed profile of hours and wages.

Given the restriction on match surplus, firm entry is set by the free entry condition where given a distribution of unmatched workers in the steady state, as firms enter the labor market tightness θ_m necessarily increases driving up the vacancy contact rate $\phi_m(\theta_m)$ and down the worker contact rate $q_m(\theta_m)$. Substituting the value of holding a vacancy (12) into the free entry condition and re-arranging yields

$$q_m(\theta) \mathbb{E}_\sigma \mathbb{E}_\rho \max\{R^m(\rho,\sigma), \beta Q^m(\sigma)\} + (1 - q_m(\theta)) \mathbb{E}_\sigma \beta Q^m(\sigma) \leq c_m + \chi_m(\theta) \tag{29}$$

Table 1: Model Primitives

Primitive	Description	Estimation Method
Worker Type and Preferences: $\frac{\left(C^{\gamma}(1-\ell)^{1-\gamma}\right)^{1-\rho_i}}{1-\rho_i} - \mathbb{1}_{[ue]}g(z),\ \rho \sim (m\rho, s\rho)$		
γ	Utility weight on consumption	Vignettes
$m\rho$	Mean of worker types	Vignettes
$s\rho$	Variance of worker types	Vignettes
$g(\cdot)$	Stigma cost of unemployment	Vignettes
Firm Type and Technology: $y = e^{\varepsilon}\lambda\ell^{\alpha},\ \sigma_n \sim (m\sigma, s\sigma)$		
α	Labor output elasticity	SMM
λ	Scale of production	SMM
$m\sigma$	Mean of firm types	SMM
$s\sigma$	Variance of firm types	SMM
Matching function: $M = \mu u^{\tau} v^{1-\tau}$		
τ	Elasticity of M w.r.t. u	SMM
μ	Scale of M	SMM
c_f	Entry cost for fixed market	SMM
c_v	Entry cost for variable market	SMM
$\chi_f(\cdot)$	Vacancy cost for fixed market	SMM
$\chi_v(\cdot)$	Vacancy cost for variable market	SMM
b	Unemployment benefit	SMM
Other		
s	Probability of job destruction	Calibrated
β	Discount factor	Calibrated

A list and description of model primitives and the approach to estimation. Vignettes refers the first stage estimation using stated preferences from a discrete choice experiment. SMM stands for the second stage simulated method of moments estimator that takes first stage estimates as given when simulating the model equilibrium and matching observed moments from equilibrium jobs and worker flows.

for $m = v, f$. This condition limits the value of entry so that in equilibrium an operating sector contains only a finite set of firms.

III. Identification

Solving for the model's equilibrium requires specifying the set of exogenous components relating to worker type and preferences, firm type and technology, and search dynamics. These primitives map to the structural parameters summarized in Table 1 and represent the key to disentangling the competing effects of policy on welfare and efficiency. The wage setting equation (22) involves parameters from each category and illustrates the difficulty of separately identifying their influence using only observed wages and hours from equilibrium jobs. The standard approach is to add firm or matched employee-employer data to capture independent variation as in, for example, Postel-Vinay and Robin (2002), Flinn (2006), and Lise et al. (2016), though in each case preferences are limited to the fixed wage a job offers. Cooper et al. (2007) develop a search model where risk neutral multi-worker firms fully insure risk averse but homogeneous workers against uncertain hours and compensation and use panel data on firms to identify firm technology and heterogeneity for a set of calibrated preference parameters. In Dey and Flinn (2005) a contract is a wage and whether the employer provides health insurance and workers vary in how much they care about the latter. They use the incidence of observed jobs with employer-provided health insurance and paired wages to identify the heterogeneity in preferences but model the firm's cost of provision as an exogenous random variable. In constrast, given the premise in my model that observed hours are not necessarily optimal hours from the perspective of the employee the actual sequence of hours provides limited information about worker preferences. However, they are informative, given wages, about the firm's production technology. The primary obstacle is how to distinguish the influence of preferences, firm technology, and aggregate market conditions that all factor into setting the optimal wage.

I propose an identification strategy novel to the equilibrium search literature that permits not only multi-attribute jobs but also worker heterogeneity in endogenous wage determination by isolating the preferences of workers in a controlled environment. Specifically I use an experiment where participants choose from multiple sets of hypothetical jobs that map directly to the multi-attribute contracts in my model. The use of stated preferences has been used in the search literature by Bloemen (2008) who uses stated "desired hours" to look at frictions where employees are not allowed to choose their hours. van der Klaauw (2012) incorporates the expected future occupation of respondents when estimating a dynamic discrete choice model and shows the addition improves the efficiency of the estimator. I view my approach as one solution to the difficulties of identifying equilibrium search models without firm data, as described in Eckstein and Wolpin (1990) and Flinn (2006), and as a strategy particularly well-suited to models where jobs have multiple attributes and their specific value to firm and worker are of primary interest. The method requires an assumption about how these attributes enter worker preferences and firm profit which is largely a scenario-specific issue. Given preferences, the variation in the hours of observed jobs and worker flow moments pin down firm technology and search dynamics much the same way as in the equilibrium search papers cited above.

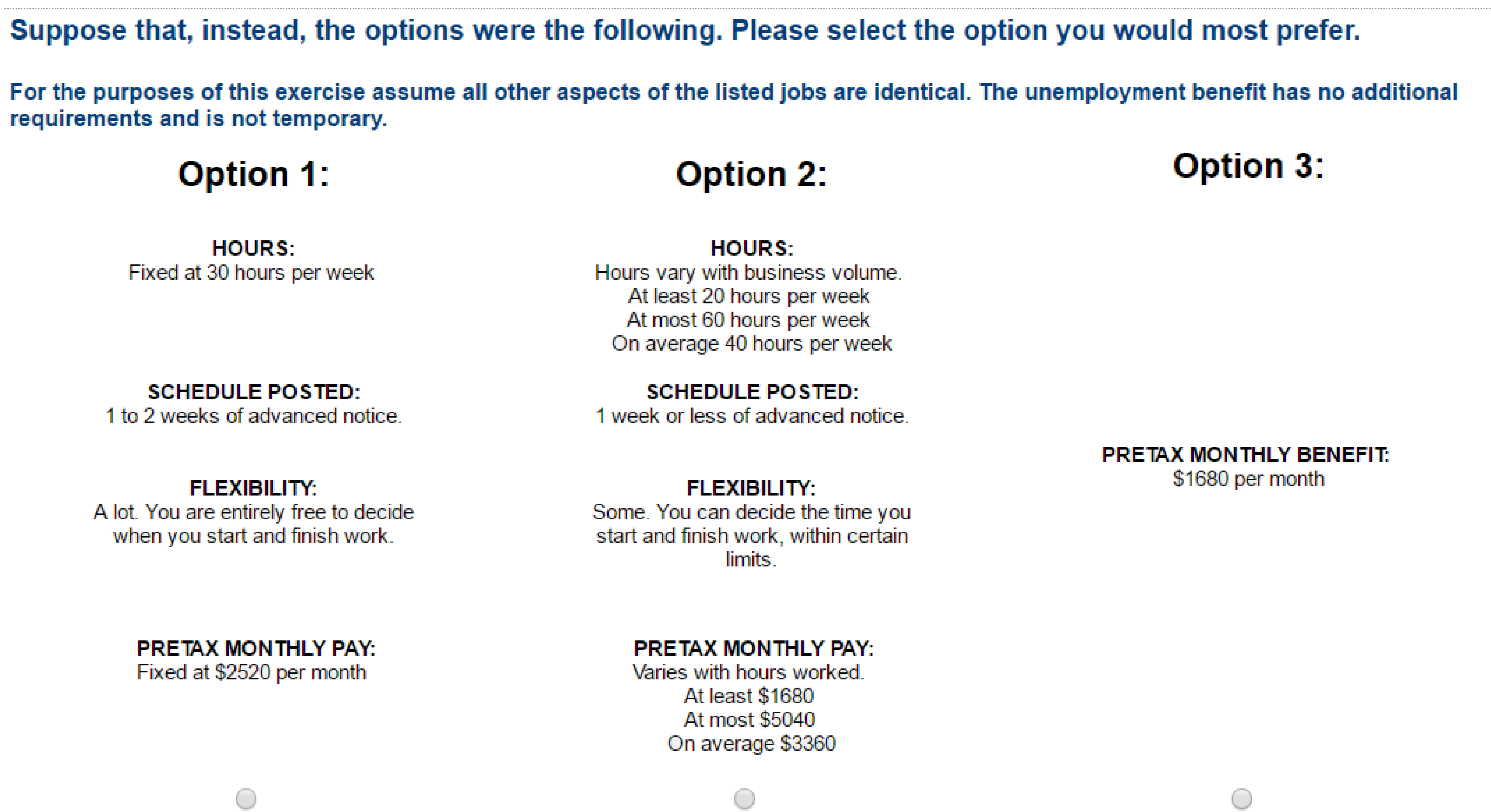
The following sections consider the three categories of structural parameters and further develop my identification strategy while the final section discusses the non-identification of the bargaining weight parameter.

A. Preferences

To identify the primitives underpinning heterogeneous preferences in the model I use the Understanding Work Schedule Forecastability (UWSF) survey. The UWSF is a survey instrument designed by myself and Flávio Cunha to estimate the willingness to pay for the kind of job attributes in the Work Schedule questions from the NLSY97. The crucial section contains a series of vignettes where on each vignette respondents choose between three distinct options—two job offers and a monthly unemployment benefit. Each respondent sees the same first vignette with jobs set to resemble entry-level job offers and thirteen subsequent vignettes randomly selected from a pool of fifty one which balances the desirability of getting multiple responses to the same vignette with the need to sufficiently vary offered contracts and capture the correlation between attribute values. Figure 2 presents an example vignette from the survey. In the first column the job has no variation in weekly hours and an implied wage rate of $21.00. The second job has hours that vary between 20 to 60 hours per week though the wage rate here happens to be the same. Respondents weigh those jobs relative to a $1,680 unemployment benefit with no additional conditions. By varying the outside option the survey captures the decision to participate in the work force. The following section describes the construction of the survey instrument. Information about the sample used for estimation is provided in Section V.

The use of vignettes to trace out preferences has a long history in the marketing literature but has recently emerged in labor economics to measure the willingness to pay for job attributes. Hanley et al. (1998) shows this type of discrete choice experiment performs better than traditional stated preference methods when estimating willingness to pay. Because vignettes allow the econometrician to see the full set of attributes for each option, the set of observed choices map out the preferences for any given respondent. Eriksson and Kristensen (2014) use the choices of Danish employees to estimate willingness to pay for fringe benefits like flexibility in scheduling, training, and health insurance and even suggest that human resource departments may find this method useful in reducing informational frictions in contract negotiations. Mas and Pallais (2016) embed such an experiment in a recruiting process and non-parametrically estimate the willingness to pay for attributes like scheduling flexibility and the opportunity to work from home by exogenously varying the wage offer.

To make the hypothetical jobs as realistic as possible, the initial stage of the survey prompts respondents to suppose they receive twenty job offers over the next three months and provide the the largest, smallest, and mostly likely wage offers to occur. The vignettes contain four possible wage values created from convex combination of these person-specific moments. Even if the respondents vary the non-wage job attributes in their thought exercise they are still tracing out a distribution of feasible wage rates that allow the vignettes



Suppose that, instead, the options were the following. Please select the option you would most prefer.

For the purposes of this exercise assume all other aspects of the listed jobs are identical. The unemployment benefit has no additional requirements and is not temporary.

Option 1:	Option 2:	Option 3:
HOURS: Fixed at 30 hours per week	**HOURS:** Hours vary with business volume. At least 20 hours per week At most 60 hours per week On average 40 hours per week	
SCHEDULE POSTED: 1 to 2 weeks of advanced notice.	**SCHEDULE POSTED:** 1 week or less of advanced notice.	**PRETAX MONTHLY BENEFIT:** $1680 per month
FLEXIBILITY: A lot. You are entirely free to decide when you start and finish work.	**FLEXIBILITY:** Some. You can decide the time you start and finish work, within certain limits.	
PRETAX MONTHLY PAY: Fixed at $2520 per month	**PRETAX MONTHLY PAY:** Varies with hours worked. At least $1680 At most $5040 On average $3360	

Figure 2: An example vignette from the UWSF survey instrument used to estimate worker preferences. Each respondent saw one vignette with entry level type jobs and an additional 13 randomly selected vignettes to trace out their preferences across the set of attributes as well as their participation decision. The wage offers are tailored to the individual though all other attributes are specific to the vignette. Appendix B provides additional details.

to tailor the wage offers and unemployment benefits to the individual. Notably, this feature also permits unemployed respondents to participate and thus potentially captures work force compositional effects within the larger model. Appendix B contains details of how the hypothetical wages are constructed from the expected wage offers.

All jobs are fully characterized by 6-dimensional attribute vector that describes hours, variation in hours, wage rate, variation in wage rate, flexibility, and degree of advanced notice. Each dimension has a discrete set of possible values. For example, a job may provide the worker with less than one week, two to three weeks, or three or more weeks of advanced notice of their schedule. For the purposes of the survey a job is vector with one value from each of the six possible dimensions where Table 10 describes the set of possible values. By constructing a closed set of possible attributes the econometrician generates a variety of choice sets that exogenously vary compensation while observing the entire set of alternative-specific characteristics and the outside option. This approach also permits assessment of combinations that may not exist in the equilibrium market, particularly for a given wage. The inclusion of such jobs is important as the absence of such a job does not provide any information on whether the job is dis-preferred by workers, firms, or both. In this way, using vignettes overcomes many of the standard issues when recovering willingness to pay from observed jobs like unobserved outside options, unobserved attributes, and potentially insufficient variation.

The vignettes vary both the effective wage rate and the distribution of possible hours independently which provides identifying information about the risk aversion over consumption and over labor hours, ρ, while the relative weight γ is pinned down by variation in levels. The outside option on each vignette, described as an unemployment benefit with "no additional requirements" and as "not temporary," represents a version of the model's common unemployment benefit though nothing in the survey disciplines the offered benefit to be an equilibrium value. Therefore, I do not use the vignettes to estimate b but respondents who dis-prefer the benefit to an obstensible worse job offer provide information about the model's stigma cost of unemployment, $g(\cdot)$. The apparent disinclination is modeled as a utility stigma cost of unemployment that may vary across individuals. The degree to which the stigma cost influences decisions is an empirical question. Finally, since the full set of attributes is observed, variation in observed choices within a random utility framework can be decomposed into specific sources. Variation in observed choices within a vignette traces out preferences across job attributes, variation across respondents pins down the degree of heterogeneity in such preferences, and anything else is a person, vignette, and alternative specific preference shock.

B. Labor Contracts

Given worker preferences and heterogeneity, I use a set of equilibrium jobs from the NLSY97 described in Section IV to identify the firm's primitives. Respondents report a wage and distribution of hours that I interpret as a wage and realizations originating from optimal labor contracts, as in the model, and that workers knew the distribution of potential hours and wage when accepting the job. A review of the optimal labor contracting problem makes clear that the wage setting equation drives the majority of the dynamics. To a first order approximation the unemployment benefit b, scale of the production function λ, and elasticity of labor supply α set the wage level for any given firm-worker pair. Firm technology, in α and λ, further determines the distribution of hours for a given wage. These relationships are non-linear but well-defined and so a comparison between the jobs in the simulated model and observed jobs from the retail sector is informative about their value.

The relationship between firm type σ_n and moments from observed jobs is perhaps best illustrated by the variance of log hours given by

$$\text{Var}(\ln \ell) = \frac{\sigma_n^2}{(1-\alpha)^2}.$$

The independence of the variance of log hours from the worker's type is a property of the parametric assumptions. In equilibrium all firm types participate in the variable market so F_σ with parameters $m\sigma$ and $s\sigma$ is directly related to the variance of hours in observed jobs. Even if we could condition on the set of worker types that participate in the variable market, not all firm-worker pairs form viable matches which further necessitates the use of the general equilibrium model to incorporate the selection effect in estimation. One limitation of estimating the model without firm level data is the restriction that $\mu_n = -\frac{1}{2}\sigma_n^2$. Ignoring the complexity that allowing expected profits to differ by firm type adds to firm equilibrium behavior, the identification of a separate firm type without strong parametric assumptions is tenuous. Consider the expected hours of a variable contract which with some manipulation can be written as

$$\mathbb{E}_\varepsilon \left[\ell_v(w,\varepsilon)\right] = (\alpha\lambda)^{\frac{1}{1-\alpha}} w^{\frac{-1}{1-\alpha}} e^{\frac{\mu_n}{1-\alpha}} e^{\frac{\sigma^2}{2(1-\alpha)^2}}. \tag{30}$$

Since we cannot condition equilibrium jobs on the type of worker, without some fixed relationship between σ_n and μ_n multiple combinations of w and μ_n generate the same level of expected hours. Lacking a strong prior or demand side data to pin down this relationship I make the simplification that $\mu_n = -\frac{1}{2}\sigma_n^2$.[10]

[10] As an aside, from (30) the mean of the firm type in μ_n is not separately identified from λ and can be safely normalized to 1.

C. Search

The final ingredient necessary to map equilibrium jobs to the optimal labor contracts of the model is the worker's match surplus appearing in the wage setting equation (22) which in the steady state equilibrium simplifies to a function of vacancy contact match acceptance rates as in (27). The contact and firm acceptance rates are governed by an aggregate matching technology that though treated here as structural parameters are perhaps better though of as a reduced form approximation of market dynamics. For any given set of firm technology parameters, the matching technology and search costs largely determine the level of firm entry into a sector which in turn drives worker sorting through the search decision in (27). My approach to estimating these parameters resembles that in Cooper et al. (2007) and Lise et al. (2016) who discipline the equilibrium to match observed moments from hiring, separations, vacancy creation, and unemployment in the labor market.

Differences in the matching probabilities of the two sub-markets factor into the wage settings equations which involve the probability of exogenous match destruction, the vacancy contact rate, and the firm acceptance rate. The probability of match destruction is independent of all firm, worker, and match characteristics and in a steady state equilibrium must exactly equal the flow of new matches per period. I directly observe the latter in the data as the measure of monthly hires in the retail sector in the Job Openings and Labor Turnover Survey. I treat this rate an a known quantity and calibrate the probability of job destruction outside of estimation. A parallel calculation of match contract rates is thwarted by the possibility that firms reject some matches and failed meetings are unlikely to be reliably recorded. Moreover, the relationships between the aggregate moments in the data and sector-specific moments of the labor market model complicate a straightforward calibration. Instead, identification relies on the influence these rates have on unemployment levels, the level of vacancies, unexplained differences in labor contracts, and indirect inference on worker sorting. For any given set of sector specific labor market tightness, the scale of the matching function directly translates to the distributions of unmatched firms and workers which in turn imply rates of steady state unemployment and vacancies. The elasticity of matches with respect to unemployment plays a role in sorting dynamics as the more elastic the technology the greater the scope for large movement of workers between the markets for a comparatively small change in labor market tightness.

In contrast, while the matching technology pins down dynamics for a given labor market tightness, the costs of search set equilibrium labor market tightness. The costs of creating a position, c_m, determine the set of workers for whom a match is sufficiently profitable through the indirect mechanism of restricting firm entry, and vacancy contact rates, when the distribution of participating workers is relatively less profitable for entering firms. This property provides a mechansim to drive worker sorting and the observed ratio of variable to fixed contracts. Conversely, the costs of maintaining a vacancy provide a way to fine-tune the sector specific labor market tightness as the costs are proportional to the level of unemployment and vacancies. Given the scale of the matching technology, the labor market tightness determines the levels of steady state unemployment and vacancies and so the most informative moments in estimation are unemployment, job openings, and aggregate labor market tightness.

The primary complication in the search primitives underlying model search dynamics to moments from the retail sector is the implication that observed moments are in fact aggregations across the two sectors. For example the notion of aggregate labor market tightness is in fact $\theta = \frac{u_v + u_f}{v_v + v_f}$ which does not immediately map to the equilibrium objects θ_v and θ_f. While focusing on the retail industry increases the plausibility of the model, one drawback of considering only one sector is the lack of industry-specific unemployment rates. Unemployment not only helps pin down contact rates in the model but also the notion of labor market tightness. The labor market tightness proves an important moment to identifying the scale and elasticity of the matching function $M(u, v)$. Lacking a less objectionable alternative, I assume the retail market has the same unemployment rate, and consequently aggregate labor market tightness, as the larger U.S. labor market.

D. A Note on Worker's Bargaining Power

Setting the worker's bargaining power to zero is not without loss of generality. Providing all workers with a positive share of match surplus translates through the wage setting equation (22) to a strictly larger wage which through the variable (18) and fixed (20) labor demands reduces the expected level and variance of hours and therefore has implications for welfare in of itself. It also produces a premium to employment that varies with firm and contract type. This feature removes the necessity of the exogenous premium provided by $g(z)$ but significantly complicates the equilibrium search dynamics. Without bargaining weight, the (expected) value of a job is independent of productivity shocks, firm type, and even contract type which means the distribution of unmatched firms in a particular market is effectively irrelevant to the worker's decision. When workers receive part of the firm's surplus this distribution becomes important to the directed search decision and solving for the equilibrium requires simultaneously solving for the distributions of unmatched firm and worker types. The directed search decision of workers and the consequent match rejection rules for both firms and workers create endogeneity between these objects and may imply multiple equilibria. Setting the parameter to zero simplifies the solution and provides a unique equilibrium.

A related concern is the identification of the parameter given the data used here, since the structural parameters of firm type and technology are estimated by matching the wage and hour profiles of equilibrium jobs, in principle, for any value of the worker's bargaining parameter ζ a set of parameters, particularly those that affect levels like $\{b, \lambda, \alpha, m\sigma\}$, could be found to rationalize observed jobs. Moreover, because the transfer of match surplus to the workers enters additively with the unemployment benefit the separate identification relies on the variation of surpluses across matches to isolate the bargaining weight from a common equilibrium outside option. The literature has long recognized the difficulty of identifying the parameter using only supply-side data (see Eckstein and Wolpin (1995) and Flinn (2006)). Flinn (2006) and Dey and Flinn (2005) estimate models without labor hours and use labor's share of total revenue from demand side data as an informative moment about the bargaining weight. In my model labor's share equals the output elasticity of labor α by virtue of the Cobb-Douglas specification of production which limits the usefulness of this approach. Given the high rate of turnover in the retail sector, a different tactic is to add on-the-job search which the literature suggests has more explanatory power when trying to match the wage profile within and between employment spells (see Lise et al. (2016)). This addition would increase the outside option of workers but adds considerable complexity to the steady state distributions of worker flows and matches and requires additional assumptions to extend to an environment with two separate sectors.

To provide a reference value on the possible range of the parameter, perhaps the most relevant estimates come from Flinn (2006) and Cahuc et al. (2006). Flinn looks at the U.S. labor market population that would be affected by the minimum wage and finds a precisely estimated bargaining weight of 0.42. This estimate may represent an upper bound if his model, by ignoring the non-wage job attributes of minimum wage jobs used for estimation allows the bargaining weight to capture compensating differentials that differ across jobs and so would not be fully accounted for by a common unemployment benefit. Cahuc et al. estimate bargaining weights for four sectors and find the uniformly lowest values for the service industry where they are approximately zero. However, their model incorporates on-the-job search and estimates parameters using French data which limits the direct comparability. Evidence presented in the next section shows the observed retail sector jobs typically have limited control over scheduling and relatively low wage rates which suggests a lack of bargaining power.

IV. Observed Jobs

The primary sample in this paper consists of jobs reported in Round 16 of the National Longitudinal Survey of Youth 1997 Cohort (NLSY97) which was conducted between November 2013 and July 2014. Respondents were born between 1980 and 1985 meaning they range in age from 28 to 33 years at the end of 2013. I filter the sample to respondents who are not self-employed and report their current or most recent job as being

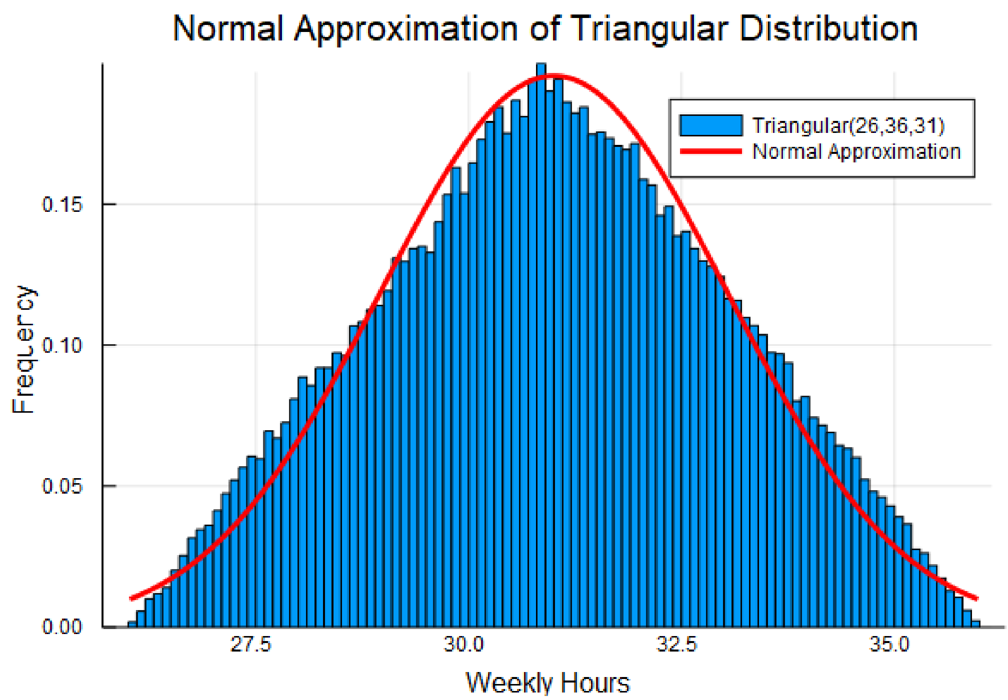


Figure 3: The weekly hours described by a Triangular distribution are well-approximated by a Normal distribution with the same mean and variance. The histogram has identically and independently distributed realizations from a Triangular distribution where hours range between 26 and 36 hours per week with 31 being the most likely.

in the retail sector with a 2002 Census Industry Codes between 4670 and 5580.[11] The bulk of these jobs are with department stores, supermarkets, and specialty stores. Table 9 contains a more detailed breakdown of the retailers by census code. Filtering for a complete set of job characteristics and demographic information leaves 405 jobs characterized by a wage and a distribution of hours. I assume these jobs represent equilibrium observations from a single labor market with dynamics and structure equivalent to that of the model.

I view the retail sector as maximizing the plausibility of my model of labor contracting while minimizing additional un-modelled features such as overtime, unions, and productivity pay. I ignore minimum wage considerations as the common unemployment benefit should capture some degree of bunching at low wage values and to avoid a zero likelihood issue as around 9% of observations have an imputed wage smaller than the 2013 federal minimum wage of $7.25. To avoid incorporating observations where the wage was contractually random I use the provided measure of hourly wage excluding tips, commissions, and overtime pay. For 79% of the population there was no difference between this measure and the one containing additional compensation.

The NLSY97 has always asked respondents their usual hours per week but beginning in Round 15

[11] I exclude observations with census industry codes between 5580–5790, which includes electronic retail, vending machine operators, and direct selling to maintain the homogeneity of the sample.

respondents were further asked to report what were the most and fewest hours they worked over the last four weeks. These moments typify a common device in surveys to succinctly capture the main features of a distribution as they are easy for respondents to identify and readily translate to a Triangular distribution. I use these moments to construct my measure of week to week variation in hours. To be clear, any job with all three moments the same has a fixed schedule. Since hours in the model are a continuous variable with support over the positive real line I adapt this reported measure into a continuous distribution with the same support. I assume usual, fewest, and most hours are sample statistics from some finite set of periods for labor contracts generated according to the model. I then make use of the convenient fact that independent and identically distributed realizations from a Triangular distributions are well-approximated by a Normal distribution with the mean and variance of the Triangular distribution. The degree of approximation is illustrated in Figure 3.

For tractability my model uses the friction created by employer discretion over weekly hours as the source of unpredictability in labor scheduling. I motivate this approach by looking at jobs in the retail sector where workers have little control over hours as other labor markets that exhibit as much if not more variability in hours would require a decidedly different model (see Barlevy and Neal (2017)). Moreover, the literature identifies many possible sources of instability other than variation in hours. Evidence from surveys and discrete choice experiments discussed earlier suggest that the degree of flexibility in the timing of hours and advanced notice of schedule play an important role in the valuation of a particular job. Intuitively, both of these attributes mitigate the scheduling burden of not knowing the number of hours they will work in any particular week but do not innately aid in smoothing compensation across periods. For this sample, 82% of employees have at most some input but no direct control over when they work. Similarly, when you condition on employees with schedules that actually vary from week to week 68% have at most two weeks of advanced notice of their schedule. Finally, 60% of the sample have together at most two weeks advanced notice and at most some input into their hours schedule. I interpret this evidence as consistent with the labor contracting framework in the model where workers have little bargaining weight and no control over the exact number of hours in any week.

Table 2 contains descriptive statistics for the sample of jobs. Around 54% of the observed jobs report hours that vary from week to week. This moment is robust to re-weighting the sample using the nationally representative weights provided by the NLSY97 as seen in the third column. Figure 1 plots the variability in hours across the spectrum of usual hours but the instability ratio (IR) from Lambert et al. (2014) provides a better measure of the extent of variability in hours for any particular job. The IR ratio divides the range of hours by usual hours to capture the principle that a given range of fluctuation in hours has a larger impact on jobs where mean hours are smaller. To illustrate, conditional on hours that vary the mean IR is 0.34 but

Table 2: Characteristics of Observed Retail Jobs

	Variable			Fixed			Total (Weighted)		
	Mean	Median	Std. Err.	Mean	Median	Std. Err.	Mean	Median	Std. Err.
Wage									
Wage	14.81	12.0	9.0	14.0	11.08	9.85	14.83	12.0	9.55
No Reported Tips, etc.	77%			81%			79%		
Tips, etc. as % of Wage	31%	7%	0.58	13%	10%	0.13	23%	8%	0.46
Hours									
Usual Hours	36.63	40.0	10.45	35.97	40.0	10.7	36.38	40.0	10.73
Hours vary	100%			0%			55%		
Hours < 35	32%			24%			28%		
Hours > 40	19%			6%			15%		
Most Hours in a Week	42.42	40.0	11.39				39.6	40.0	11.74
Fewest Hours in a Week	31.65	35.0	11.71				33.7	39.0	11.3
Instability Ratio (IR)	0.34	0.25	0.32				0.19	0.08	0.3
IR (Hours < 35)	0.58	0.4	0.44				0.36	0.2	0.48
Overtime Hours > 0	12%			4%			8%		
Overtime Hours (if > 0)	4.0	2.5	4.23	8.29	5.0	7.52	3.91	2.0	4.36
Flexibility (when some control possible)									
No Input	43%			59%			45%		
At most Input	40%			26%			37%		
Some Control	13%			11%			13%		
A lot of Control	4%			4%			5%		
Advanced Notice (when schedule varies)									
$\leq$ 1 Week	53%			30%			43%		
1–2 Weeks	21%			34%			25%		
3+ Weeks	15%			8%			15%		
Job Satisfaction (1-Like Very Much $\rightarrow$ 5-Dislike very much)									
Job Satisfaction	2.2	2.0	1.07	2.22	2.0	1.15	2.24	2.0	1.14
Job Satisfaction (IR>0.34)	2.53	2.0	0.99				2.6	2.0	1.02
Sample Size		219			186			405	

Selected summary statistics for the primary sample of retail jobs reported in the NLSY97. The third column uses the nationally representative weights. All monetary values are in 2013 dollars. The *instability ratio* provides a measure variation in week-to-week hours and is defined as the range of hours divided by usual hours.

jumps to 0.58 for part-time workers demonstrating that absolute deviations are not necessarily the most appropriate measure of salience.

The average job in the sample pays around twice the minimum wage at $14 an hour for around 35 hours per week of work. The similarity between mean hours and wages for fixed and variable schedules belies dynamics suggested by some simple correlations. For example, the OLS coefficient from a regression of wage on IR has a statistically significant coefficient of -3.27 hinting at the importance of accounting for higher order moments when describing a job. Around 57% of the sample reports usual hours between 35 and 40 hours underscoring that these jobs are not necessarily entry level or minimum wage type jobs and that varying hours and lack of control over schedule are features of the wider retail labor market. Recall that since sample selection conditions on labor force participation and age profile the average respondent is around thirty years old which puts into perspective that fifty-seven percent of respondents have at least one child (see Table 3).

V. Estimation of Preferences

The survey instrument described in Section III.A collects a set of background information on respondents who are then asked to choose between two job offers and an unemployment benefit on fourteen vignettes with thirteen randomly selected from a pool of fifty-one. Figure 2 provides an example of one such vignette. All respondents saw the same first vignette with two jobs meant to resemble entry level jobs and the lowest value of unemployment benefit. The sample used here to estimate worker preferences took the survey over the internet in January 2016. All respondents were selected members of a panel maintained by Qualtrics, a private survey institute. Potential respondents were screened by gender and for a birth year between 1980 and 1984 so that the resulting sample had a roughly even gender split and matched the age profile of the NLSY97. The data contains the stated preferences over the fourteen vignettes as well as information on demographics and the job characteristics of employed respondents. These auxiliary questions were intentionally similar if not identical to those asked by the NLSY97 to maximize comparability. Respondents in the final sample were verified using several quality controls in addition to the monitoring and panel maintenance performed by Qualtrics.

To detect inattentiveness on the part of respondents and improve the quality of responses the survey mechanism employs three methods. To be included in the sample respondents must have an IP address located in the United States, take no less than twenty-five percent of the mean total time to finish the survey, and pass an attention filter described in Figure 12 in Appendix B. These measures screened out around sixty percent of potential respondents with the vast majority failing the attention filter. In fact, around sixty-five

Table 3: UWSF Sample Statistics

	Vignette (unweighted)		NLSY97 (unweighted)		NLSY97 (weighted)	
	Females	Males	Females	Males	Females	Males
General						
% of Sample	50%	50%	54%	46%	52%	48%
Mean Age	33.1	32.9	31.0	30.8	31.0	30.8
Cohabitating	67%	61%	49%	44%	56%	43%
Student	8%	10%	9%	6%	7%	7%
Avg # Jobs	0.9	1.2	1.1	1.1	1.1	1.1
Any Kids	67%	50%	68%	43%	63%	42%
Avg # Kids	1.5	1.0	1.5	0.9	1.3	0.8
Race and Ethnicity						
White	85%	85%	56%	61%	74%	75%
Black	9%	9%	25%	24%	13%	15%
Hispanic	10%	10%	25%	25%	13%	16%
Education: Highest Degree						
< High School	3%	3%	11%	7%	9%	7%
High School	16%	16%	66%	67%	62%	65%
A.A. Degree	12%	12%	6%	6%	7%	7%
B.A.	27%	27%	15%	18%	18%	20%
> B.A.	13%	13%	3%	1%	4%	1%
N	518	508	218	187	218	187

A comparison of selected demographic statistics for the USWF and NLSY97 samples as well as the NLSY97 with nationally representative weights.

percent of male and fifty-two percent of female respondents who began the survey failed the attention filter. The remaining 1026 respondents are described in Table 3 which presents selected statistics of the sample as compared to the unweighted and weighted NLSY97 sample of retail jobs from the previous section.

The NLSY97 over-samples minorities to maximize the quality of their data and provides nationally representative weights that allow extrapolation from their sample to the United States. However, to be included here, NLSY97 respondents must report a primary employer in the retail sector which introduces a non-trivial sample selection that is not corrected in the weighted statistics and as such should be interpreted accordingly. Comparatively, the UWSF respondents are slightly older, more highly educated, and more likely to report their race as white or Caucasian. Additional summary statistics are available in Tables 11 and 12 in Appendix B which show that around seventy-two percent of respondents report a primary job of which a third are part-time with instability ratios higher than found in primary sample of jobs. However, a degree of caution is warranted as, for example, respondents were mixed on whether their time spent taking surveys qualified as employment.

Other than matching the age profile and residing in the U.S., the sampling procedure used for the UWSF survey does little to ensure a similar sample to that in the NLSY97. Even if the panel of potential

Table 4: Re-weighting variable.

	UWSF		NLSY97		NLSY Wtd.	
	Females	Males	Females	Males	Females	Males
Children Under the Age of 6						
White & $\geq$ B.A.	11%	12%	3%	5%	4%	6%
Non-White & $\geq$ B.A.	2%	3%	2%	2%	2%	1%
White & $<$ B.A.	12%	11%	19%	12%	23%	14%
Non-White & $<$ B.A.	3%	2%	14%	12%	7%	8%
No Children Under the Age of 6						
White & $\geq$ B.A.	21%	24%	9%	10%	12%	12%
Non-White & $\geq$ B.A.	4%	4%	4%	3%	3%	2%
White & $<$ B.A.	41%	36%	25%	34%	34%	43%
Non-White & $<$ B.A.	6%	8%	24%	22%	14%	14%
% of Sample	50%	50%	54%	46%	52%	48%

The UWSF sample was re-weighted for estimation along four demographics characteristics to more closely match the sample of retail jobs. $\geq$ *B.A.* indicates the respondent has a B.A. degree or higher. This table compares the moments of the weighting variable to the un-weighted sample and nationally weighted NLSY97 sample. The unweighted NLSY97 sample is used for second stage estimation.

respondents was nationally representative, the over-sampling of minorities and selection on retail jobs makes it essentially infeasible to replicate in cost efficient manner since the NLSY97 respondents come from across the United States and from multiple retailers.[12] To help mitigate differences between the samples I weight observations from the UWSF sample in the first stage estimation of preferences to match observed proportions in the NLSY97 sample. To create the weights, I choose four demographic characteristics available in both samples that hopefully capture major sources of worker heterogeneity and correct for differences in sample composition so that the estimated preferences more closely resemble what you find if you gave the survey to the NLSY97 sample. The characteristics used are binary indicators for gender, non-white, having a B.A. degree or higher, and the presence of a child under age six. This creates sixteen bins where the frequency in the NLSY97 of a given bin determines the weight on the contribution of the relevant bin in the vignette sample. See Table 4 for a summary of the characteristics in both samples.

I interpret the first three characteristics as plausibly exogenous conditions from the perspective of individuals in their late-twenties or early-thirties choosing between jobs. The fourth, having a young child, stands apart since there is likely an (un-modelled) endogenous relationship between labor participation and fertility decisions. I consider incorporating the fertility decision beyond the scope of this paper as it adds little to the proposed counterfactuals after accounting for consequent heterogeneity and requires a separate

[12] One possibility would be to draw the entire dataset from a large single retailer where employees take both the vignette survey and report job characteristics. This approach helps mitigate the concern of heterogeneity in the structural parameters underlying firm technology but at a cost of making counterfactuals specific to that retailer and its employees.

identification strategy for preferences over children. However, in recognition of the presumed importance the presence of a young child has over preferences for the kind scheduling instability found in the jobs of this model, I attempt to allow the unexplained heterogeneity to capture this effect by weighting the sample accordingly. No bins are empty from either sample. Estimated preferences reflect the re-weighted UWSF sample.

To comment on the reliability of the discrete experiment approach, consider the well-known critique of stated preference data in Diamond and Hausman (1994) who observe that when considering hypothetical options there is no guarantee that respondents have preferences over all options or respect budget constraints when providing answers. Their analysis primarily considers surveys soliciting monetary willingness to pay point estimates for a public good and outline serious concerns for extrapolating from this type of data. More recently, the literature has adopted the vignette-style discrete choice experiment used here that measures willingness to pay using a revealed preferences type argument and potentially reduces the noise inherent in soliciting points estimates. Nevertheless it remains to be shown that the constructed jobs do not have attributes that would be unfamiliar or irrelevant to the respondents. Table 10 describes the set of possible attributes for vignette jobs. An examination of the reported characteristics of NLSY97 jobs in Table 2 confirms that the attributes are well-represented in equilibrium jobs and, more directly, Table 11 summarizes the characteristics of jobs reported by the UWSF sample which similarly suggests that respondents would find the vignette attributes realistic independently if not necessarily in every particular combination.[13] Together, this evidence suggests that the non-wage attributes of vignette jobs were plausible draws from the set of equilibrium jobs and that the UWSF sample would have experience and preferences over the set of attributes.

The object of estimation is to recover the structural parameters underlying preferences, the extent of heterogeneity in population, and the stigma cost of unemployment. The sequence of observed choices for any individual is revealing about common preferences as people weigh the relative valuations of attribute combinations. Variation in choices across individuals recovers heterogeneity in preferences which, in line with my model, will be captured in the risk aversion parameter ρ_i. The choice between the two job offers and the unemployment benefit identifies the participation decision of workers and, in particular, any reluctance to choose employment despite a relatively attractive value of unemployment informs the stigma cost of unemployment. In the model the stigma cost depends on a set of demographic characteristics that employers are legally prohibited from using to discriminate in labor contracting. However, since the exact relationship between the stigma cost and these characteristics is neither of first order importance for the dynamics of the model nor something that the survey was designed to reveal, I make the simplifying assumption in

[13] Very few respondents report 3–4 weeks of advanced notice in either the NLSY97 or the UWSF sample. To maximize statistical power the survey instrument reduces the set of options to $\leq$ 1 week, 1–2 weeks, and 3 or more weeks.

estimation that the stigma cost is $g(z) = \overline{g}$, or a fixed dis-utility independent of observed characteristics.

To map the worker's preferences over consumption and hours worked to the jobs in the vignette let the utility of a vignette job be

$$Z(C, L, X; \rho_i) = \frac{\left(C^{\gamma}(1-L)^{1-\gamma}\right)^{1-\rho_i}}{1-\rho_i} + \psi X$$

where X contains indicators for the level of advanced notice and flexibility. The parameter ψ captures the valuation of these secondary job attributes which represent incidental parameters to the larger paper. I assume a worker has an endowment of eighty-four hours per week to split between labor and leisure so that the value of L will always be normalized as a fraction of that endowment. Analogously, the utility of the unemployment option on a vignette is

$$Z(C, 0, 0; \rho_i) = \frac{C^{\gamma(1-\rho_i)}}{1-\rho_i} - \overline{g}.$$

When choosing between alternatives on a vignette, respondents make decisions without knowing the actual sequence of future pay-offs so the value of alternative k for person i on vignette j is

$$V_{ijk} = \mathbb{E}\left[Z(C_{ijk}, L_{jk}, X_{jk}; \rho_i)\right] + \nu_{ijk}$$

where ν_{ijk} is an unobserved choice shock specific to individual, vignette, and alternative. Since the wages for each choice are adapted to the individual, C_{ijk}, varies by individual but hours, L_{jk} and secondary attributes, X_{jk}, are known given the vignette and alternative. I assume that the distribution of F_ρ is LogNormal with an unknown mean and scale so that

$$\ln \rho_i \sim N(m\rho, s\rho)$$

where the logarithm forces ρ_i to reside in the set $(0, \infty)$.

For a respondent to choose alternative k from the set of three possibilities on each vignette it must satisfy

$$V_{ijk} = \max\{V_{ij1}, V_{ij2}, V_{ij3}\} \tag{31}$$

where the first two options are job offers and the third option is an unemployment benefit. As econometricians, we observe the full set of characteristics of all alternatives and the functional forms of $Z(\cdot)$ up to a set of parameters but not the individual's ρ. Given ρ, if we assume that ν follows a Type 1 Extreme Value distribution then the difference, $\nu_{ijk} - \nu_{ija}$ has a logistic distribution and the solution to (31) is probabilistic. These assumptions motivate the mixed Logit model where the unobserved but fixed individual-specific ρ_i

Table 5: Estimated Preference Parameters

Parameterization

$$\frac{\left(C^{\gamma}(1-\ell)^{1-\gamma}\right)^{1-\rho_i}}{1-\rho_i} + \mathbb{1}_{ue}\overline{g} + \psi X \qquad \ln \rho_i \sim \ln N(m\rho, s\rho)$$

Estimates

	γ	$m\rho$	$s\rho$		$\overline{g}$
Estimate	0.90	-0.61	0.19		1.27
SE	(0.01)	(0.02)	(0.01)		(0.01)

	Advanced Notice		*Flexibility*		
ψ :	1–2 Weeks	3+ weeks	A little	Some	A lot
Estimate	0.04	0.10	0.10	0.32	0.80
SE	(0.02)	(0.04)	(0.05)	(0.04)	(0.04)
N=1026			Log-Likelihood: -1453.9		

Estimates for the structural parameters underlying worker preferences and heterogeneity. Parameters were estimated using simulated maximum likelihood on data from a purpose-made discrete choice experiment within the UWSF survey. Observations were weighted by four demographic characteristics to more closely matched the NLSY97 sample of jobs. Simulation used 1,000 Halton draws and standard errors were calculated using the outer-product method.

allows for arbitrary correlation across alternatives for individual i while mapping to the heterogeneity of workers in the model. Let L_{ij} be the probability of person i's observed choice on vignette j and collect all observables into W. Define θ as the preference parameters excepting ρ. An individual's contribution to the likelihood is their sequence of observed choices across J vignettes, or

$$\mathbb{L}_i(\theta, \rho) = \prod_{j=1}^{J} L_{ij}(\theta, \rho; W).$$

To estimate the model I use simulated maximum likelihood estimator and integrate out the unobserved ρ. Formally, let Θ be the set of preference parameters θ and the mean and variance parameters $(m\rho, s\rho)$, then the estimator finds Θ to maximize the simulated log-likelihood

$$L(\Theta; X) = \sum_{i=1}^{N} \log \left(\sum_{s=1}^{S} \prod_{j=1}^{J} L_{ij}(\theta, \rho^s(m\rho, s\rho); W) \right), \tag{32}$$

where S is the number of simulations used in Monte Carlo integration.

Table 5 presents the results of estimation. All parameters are statistically significant at the five percent level. Table 13 reports the very similar results when estimating without re-weighting observations. The Cobb

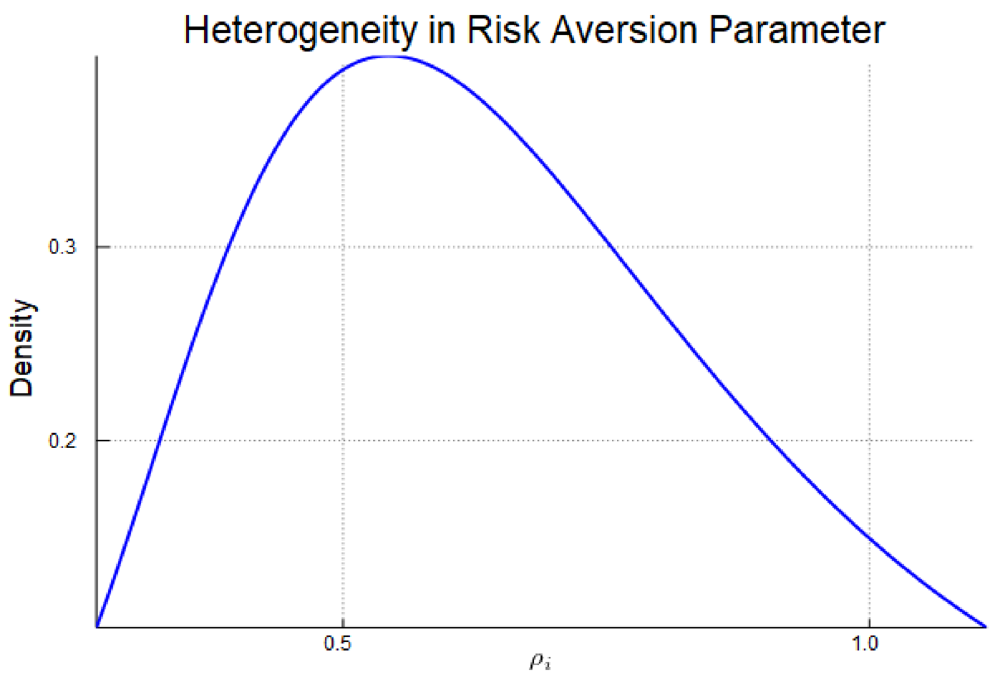


Figure 4: The distribution of the risk aversion parameter, ρ_i, in the population. Values reflect the re-weighted UWSF sample.

Douglas weight on consumption relative to leisure is 0.90. The coefficient of risk aversion ranges from 0.31 to 0.95 between the tenth and ninetieth percentiles with a median value 0.54. Figure 4 plots the exact density where the long right tail suggests the potential importance of accounting for heterogeneity when considering the welfare costs of variable hours for the labor force at large. The stigma cost of unemployment is perhaps most easily interpreted when translated into dollar values. An individual with the median risk aversion parameter who receives a three hundred dollar per week unemployment benefit has the utility equivalent to a thirty-nine dollar loss of income from the stigma. The skewness of the risk aversion parameter results in a comparable skew of stigma where the tenth and ninetieth percentiles are around twelve and two hundred dollars, respectively.

The most relevant statistics for interpreting how these individuals behave in the general equilibrium model are the relative risk aversion and the Frisch elasticity. These values also provide a way to compare the results for this utility specification to others more commonly estimated. Figure 5 plots the implied coefficients of relative risk aversion. The median value is 0.59 though the range from the tenth to ninetieth percentiles of 0.38 to 0.95 suggests a small skewness of more risk averse individuals. These estimates come from data that is demographically more diverse than a sample of white males though still matches other estimates from the literature that incorporate long term uncertainty. For example, Joubert and Todd (2016) find a coefficient of 0.42 when estimating a labor participation and pension funding model and Navarro and

Zhou (2017) report a value of 0.49 when estimating a life-cycle model of labor participation and schooling choices under credit constraints. This range is slightly lower than the typical calibrations in the macro literature (see Thimme (2017)). One important caveat when comparing these values with the literature is that the data and estimation method both impose that observed hours are potentially not optimal hours such that we would observe different compensation and consumption behavior if, like in the neoclassical labor supply model, workers were allowed to adjust their labor supply given the wage. The set-up here is perhaps more comparable to Metrick (1995) who uses the betting decisions of players on Jeopardy! to estimate a risk aversion parameter of 1.02.[14]

To look at risk aversion of varying hours and associated labor supply responses I consider a job with thirty-five hours per week out of an endowment of eighty-four possible hours such that $L = 0.42$. Figure 6 plots the implied variation in the Frisch elasticity which varies with the risk aversion parameter. The median value is 1.53 with range from 1.34 to 1.90 in the tenth to ninetieth percentiles. These values are higher than the typical rule of thumb though again the jobs considered here are designed to provide a large amount of exogenous variability with hours varying as much as fifty percent around usual hours. Therefore, the typical interpretation of the Frisch elasticity as an intertemporal substitution effect understates the direct influence of risk aversion over fluctuating hours and so thus limits comparability to results from models that assume hours were freely chosen. For comparison, Navarro and Zhou (2017) estimate a Frisch elasticity of around 1.0 and Keane and Rogerson (2012) propose a reconciliation between the small estimates from micro data and the elasticities that fall in the range of 1 to 2 more common in the macro literature which more closely coincide with the magnitudes estimated here.

The estimated preference parameters of interest are robust to changing which secondary attributes are included in X. Estimating the model with ψ_i where each secondary attribute has an unobserved person-specific value drawn from a joint Normal distribution that is entirely independent of ρ improves model fit but has little effect on the primary parameter estimates. Since the coefficients on advanced notice and flexibility are not of immediate interest to this paper I will limit discussion of the results. The estimates are increasing in the intuitive direction and seem plausible given the nature of the vignette jobs and related literature (see Eriksson and Kristensen (2014) and Mas and Pallais (2016)). For a job entailing 35 hours a week at $12.50 an hour, the median individual would accept a two and a half percentage point wage reduction to move from one week or less of advanced notice to at least two weeks. For a similar set up, a person will forgo six percent of their wage to have some input over the timing of their hours and a twenty-seven percent reduction to have some direct control over when they start and stop working. In both cases, once a job has some advanced notice or some flexibility the returns to additional degrees of control are substantially smaller

[14] Cohen and Einav (2007) translate the absolute risk aversion parameter from Metrick (1995) to its relative risk aversion equivalent.

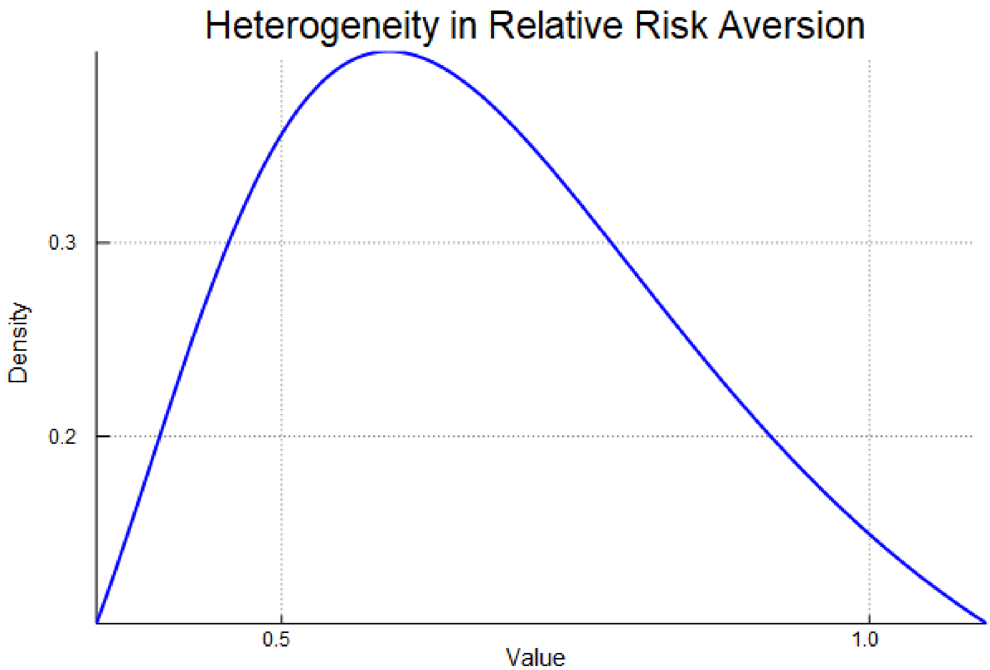


Figure 5: The estimated heterogeneity in relative risk aversion. These values are directly related to the risk aversion parameter through $-\frac{cU_{cc}}{U_c} = \rho_i\gamma + 1 - \gamma$.

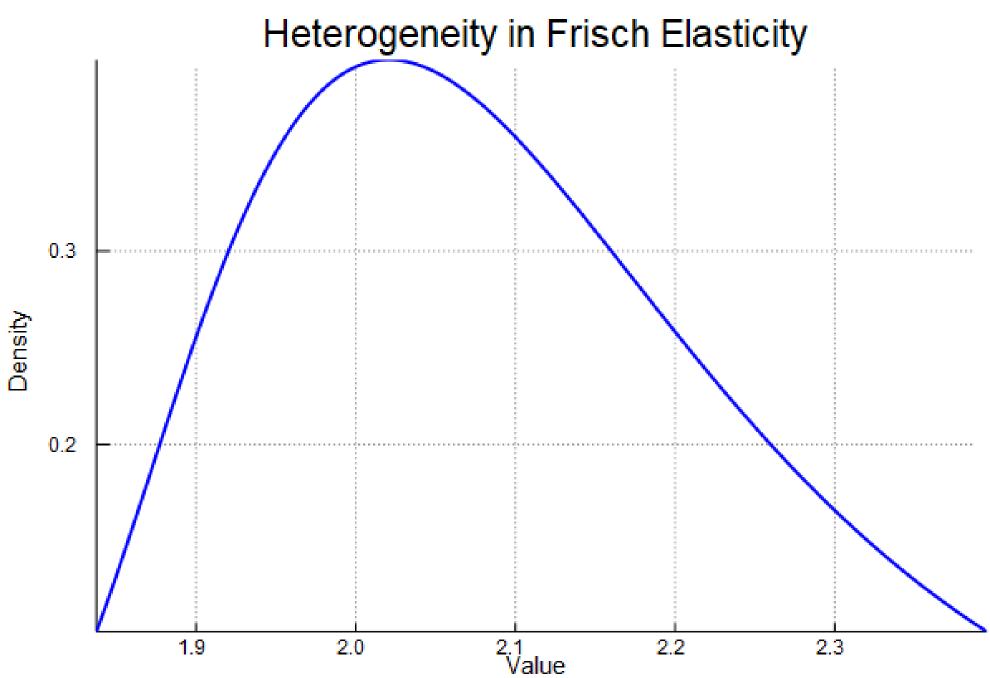


Figure 6: The estimated heterogeneity in the Frisch elasticity. The calculations here assume a labor supply of thirty-five out a possible eighty-four hours per week. For $L = 0.42$ These values relate to the worker primitives through the following identity: $\frac{1-\gamma(1-\rho_i)}{\rho_i}\frac{1-L}{L}$.

than the initial move from no control to some control.

VI. Estimation of General Equilibrium Model

To estimate the remaining structural parameters relating to firm technology and matching dynamics I solve the equilibrium model of the labor market given the preferences and worker heterogeneity estimated in the first stage. The solution generates a set of equilibrium labor contracts and worker flow statistics that I fit to comparable moments from the retail sector. Table 6 summarizes the seventy-six moments used in estimation. While the observations from the first stage estimation were weighted to match the demographic characteristics of the NLSY97 sample of retail jobs, nothing fundamental to the UWSF survey ties the respondents to the retail sector other than the characteristics of the jobs offered in the discrete choice experiment. In the second stage of estimation the moments are specific to the retail sector whenever possible and so the technology, heterogeneity in productivity shocks, and search dynamics should be interpreted accordingly.

The primary structural parameters in firm technology are the scale and labor elasticity of the production function. These parameters are identified by matching the moments of hours and wages in observed and simulated jobs. In practice, given a set of parameters the model generates optimal labor contracts for all observed firm-worker pairings which in turn implies a wage and a distribution of weekly hours. The common unemployment benefit factors into setting the level of compensation and is therefore helpful in matching observed wages. I assume the distribution of firm types is LogNormal and known up the mean and scale parameters such that $\sigma \sim \ln N(m_\sigma, s_\sigma)$. The distribution of firm types is recovered from the observed variance in hours. The relationship between firm type and the distribution of hours for a particular labor contract is nicely captured in the following identity:

$$\text{Var}(\ln \ell) = \frac{\sigma_n^2}{(1-\alpha)^2}.$$

Therefore, even though firm type is not observed in the data, the distribution of firm types is recoverable.

The equilibrium search dynamics are governed by the set of parameters specifying the costs of opening a position, the costs of maintaining a vacancy, the matching technology, and the exogenous rate of job destruction. Though treated here as structural parameters, the matching technology is better understood as a reduced form approximation of how search produces meetings between potential pairs. The cost of creating a position controls the sorting of workers between the fixed and variable sectors by controlling firm entry. Mechanically, as firms enter the probability of a worker contacting a vacancy increases which attracts

Table 6: Moments Used for Simulated Method of Moments

Description	Statistic	Comments
Search Dynamics		
Unemployment	Rate	Aggregated portion of unmatched workers at the end of a period. Set at the aggregate unemployment rate in the U.S. economy
Labor Market Tightness	Ratio	Aggregated ratio of job openings (vacancies) to unemployed (unmatched) workers. Set to the total number of job openings (all industries) in JOLTS divided by the level of unemployed workers
Job Openings	Rate	Aggregated measure of job openings (vacancies). Set to the total number of job openings in the retail sector from JOLTS. Equal to the number of job openings divide by the sum of employment and job openings.
$\frac{\text{variable jobs}}{\text{fixed jobs}}$	Ratio	Ratio of jobs in variable market to fixed market. Set using ratio in observed jobs in NLSY97 sample.
Wage and Hour Moments from Fixed Sector		
Wages	Quantile	Taken from NLSY97 sample of jobs.
Hours	Quantile	Around 60% of observations are 40 hours per week. Taken from NLSY97 sample of jobs.
$\frac{\text{Wages}}{\text{Hours}}$	Quantile	Captures correlation between wages and hours across jobs. Taken from NLSY97 sample of jobs.
Wage and Hour Moments from Variable Sector		
Wages	Quantile	Taken from NLSY97 sample of jobs.
Hours	Quantile	Mean of distribution of actual hours. Taken from NLSY97 sample of jobs.
Variance of Hours	Quantile	Variance of distribution of actual hours. Taken from NLSY97 sample of jobs.
$\frac{\text{Wages}}{\text{Hours}}$	Quantile	Captures correlation between wages and hours across jobs. Taken from NLSY97 sample of jobs.
$\frac{\text{Variance of Hours}}{\text{Hours}}$	Quantile	Captures correlation between mean and variance of the distribution of actual hours across jobs. Taken from NLSY97 sample of jobs.

A description of the 76 moments used in estimation. All quantiles are the tenth to ninetieth deciles.

workers. Since firms are free to enter if they anticipate a positive return, entry occurs until the free entry condition is satisfied which in turn varies directly with the cost of creating a position. An increase in the costs of creating a position, c_f and c_v, reduces the firm's expected value of entering the sector for any given set of participating workers and thus helps determine whether a particular $\{\sigma, \rho\}$ pairing is sufficiently valuable for the firm to accept the match. Non-viable pairings determine the values of $\eta_m(\rho)$ and the division of the workers between the sectors.

I assume the costs of maintaining a vacancy $\chi_f(u, v)$ and $\chi_v(u, v)$ depend on the labor market tightness of the sector where $\chi_m(\theta) = \chi_m^1 \theta$ with $\chi_m^1 > 0$ such that the costs of maintaining a vacancy are increasing in labor market tightness. The movement of workers from one sector to another has consequences for the profitability of participating firms and, in practice, the maintenance costs help fine tune the equilibrium value of θ_m and thus the measure of vacancies created in sector m. Though the cost parameters do influence labor contracts through the wage setting equation, the salient moments for the estimation of the cost parameters are the ratio of contract types, aggregate labor market tightness, the aggregate unemployment rate, and the rate of job openings which all depend directly on the job and worker contacts rates which in turn are functions of the sector specific labor market tightness and related costs.

The fixed and variable sectors operate independently but use the same technology which for a Cobb-Douglas matching function with constant returns to scale is fully summarized by the scale and the elasticity of matches with respect to the unemployment rate. Since not all meetings result in viable matches the observed set of jobs must be corrected for selection which estimation enforces by solving for model equilibrium. These parameters will largely be identified by how they affect the vacancy and worker contact rates for a given θ which in turn drive the unemployment and job opening rates.

One useful consequence of the steady state equilibrium is that since employment inflows must match outflows I can confidently calibrate the exogenous rate of job destruction, s, to the rate observed in the data. To measure inflow I take the average of the JOLTS non-seasonally adjusted monthly rate of hires in the retail industry between November 2013 and July 2014. The resultant value of 4.7 has a sample variance of 0.08 over the same period. Ultimately the choice to use the reported hires over the equally valid series measuring total separations (with a mean rate of 4.6) is motivated by the endogenous hiring decision in the model and the absence of endogenous firing decisions. I plot both series in Figure 15 which shows that while not exactly stationary and coincident the series do appear closely related.

The estimation concept is a simulated method of moments estimator where for some set, g^d, of moments calculated from the equilibrium jobs and worker flows there is comparable mapping, g^s, from the structural parameters listed above to analogous moments from a simulated equilibrium. Let Ω be the set of simulated method of moments parameters and Γ be the preferences estimated in the first stage. $g^s(\Omega; \widehat{\Gamma})$ is the mapping of the structural parameters into simulated moments taking as given the first stage estimates. As a result, the estimated structural parameters minimize

$$\min_{\Omega}(g^d - g^s(\Omega;\widehat{\Gamma}))^T\Sigma(g^d - g^s(\Omega;\widehat{\Gamma}))$$

where Σ is the weighting matrix. When calculating the limiting distributions of the second stage estimates $\widehat{\Omega}$ I ignore any additional error introduced by using the first stage estimates $\widehat{\Gamma}$.

My approach to estimation involves solving for the model equilibrium for a given set of parameters and then simulating the data that generates the moments above. Specifically, I discretize the set of worker and firm types and solve for the steady state equilibrium fully characterized by $(\theta_v, \theta_f, \eta_v(\rho), \eta_f(\rho)$ using the algorithm in Appendix C. These sector-specific θ_m and acceptance rate $\eta_m(\rho)$ imply a division of workers between the sectors as a result of their optimizing behavior and directed search. The equation for the steady state value of $u_m(\rho)$ defined in (23) also fully determines the distribution of unmatched workers in sector m, F^m_ρ, the set of vacancies $v_m = \theta_m u_m$, and thus the distribution of steady state matches H_m. To simulate the moments I draw a large sample of jobs from H_m for both sectors from which I can calculate the quantiles of wage and hours and the ratio of variable to fixed jobs. The remaining moments have specific formulas that aggregate up from sector-specific rates like u_m, v_m, and the implied contact rates. Given the moments I can evaluate the loss function and search over the convex parameter space until convergence.

The efficient simulated method of moments estimator uses the inverse variance-covariance matrix of the moments as a weighting matrix. In this application, computing the variance-covariance matrix has proven problematic and sensitive to the underlying approach and assumptions. The moments related to the 405 equilibrium jobs are quantiles of the distributions related to hours and wages where, since the quantile statistics may not have well-defined limiting distributions, the variance-covariance matrix can be constructed through bootstrapping the sample. However, in practice, the sector-specific moments require the sub-division of the sample which reduces the statistical power when bootstrapping which in turn has implications for estimates and model fit. The workforce flow moments are computed as the mean across the monthly series for the nine months between November 2013 and December 2014 which corresponds to the period over which the NLSY97 interviews occurred. While the sample variances and covariances can be computed for these series, the point estimates rely on nine observations. Moreover, the model implies a correlation between search dynamics and observed wages and hours though there is no straightforward way to calculate such moments.

To minimize the sensitivity of the estimates to the assumptions needed for optimal simulated method of moments I choose a weighting matrix where all moments are of the same order of magnitude. I interpret this approach as trying to match all moments as closely as possible in light of the concern that using the optimal weighting matrix may de-emphasize moments that pin down primitives crucial to analyzing counterfactual policy. Given the assumption of a steady state equilibrium the sampling error for all of the moments should be zero which motivates an attempt to try and match each point estimate as closely as possible. To make the argument more concrete, consider the ratio of variable to fixed jobs where through bootstrapping with replacement the statistic has a standard error such that a ratio of less one is within two standard deviations. The possibility that the optimal estimator generates a simulated economy with fewer fixed jobs than variable raises the issue of whether this equilibrium is an appropriate economy in which to run the kind of counterfactual policy experiment under consideration here.

One feature of the data poses a particular problem for model fit. The set of observed jobs with fixed schedules has a large mass point at forty usual hours per week. This feature is illustrated in Figure 7 which plots the quantiles for mean hours in fixed contracts where around sixty percent of all observations report forty hours as usual. Given the curvature of the production function the only feature in the model that would generate a comparable mass point in the simulated set of jobs is a mass for some particular ρ value that participates in the fixed sector though this occurrence would further imply a (non-existent) corresponding mass point in wages as well. Either way, the assumptions used to estimate worker heterogeneity in the first stage effectively rule out this possibility. More generally, even if estimation allowed for this possibility, this mechanism does not provide a satisfactory explanation of how this feature arises from the economy's primitives.

The results from estimation are presented in Table 7. The elasticity of labor demand is relatively elastic at around 0.66 which coincides with the estimate in Cooper et al. (2015) who model a similar production technology that abstracts away from the fixed factors of production and incorporates stochastic productivity but estimated with data from manufacturing plants. The elasticity of the matching function with respect to the unemployment rate is 0.37 which again closely matches what Cooper et al. find using data for the entire U.S. labor force. The scale of the matching function is largely determined by trying to match the unemployment and job opening rates. The value of 0.49 is most easily interpreted by noting that unemployed workers in the variable and fixed sectors both have around a fifty percent chance of contacting a vacancy in a given week.

The common unemployment benefit is estimated to be around four hundred dollars per week which is higher than the average U.S. figure of three hundred dollars but below the maximum of four hundred and fifty per week. I interpret the large value as resulting more from choices in model parameterization than a solid identification of the outside option for retail workers. Within the model the unemployment benefit largely serves to set levels of labor compensation though the heterogeneity in worker preferences imply

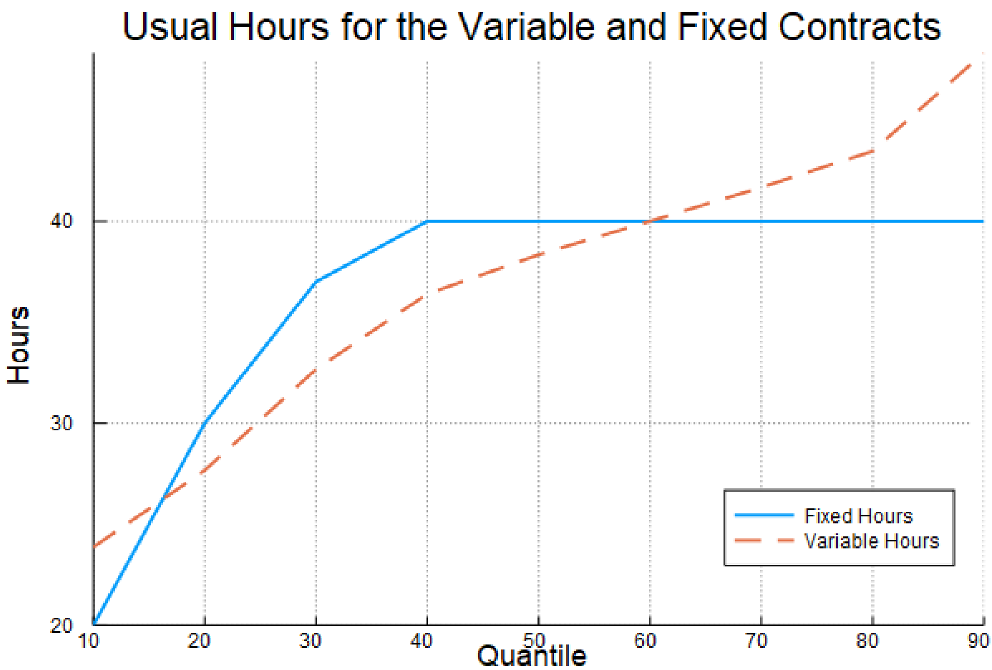


Figure 7: The observed profile of usual hours in equilibrium jobs for variable and fixed contracts. The set of fixed jobs have a mass point of around sixty percent of observations at forty hours per week that the model cannot endogenously replicate.

Table 7: Estimated Firm and Matching Parameters

Parameterization

$$y = e^{\varepsilon}\lambda\ell^{\alpha}$$
$$\sigma_n \sim \log N(m\sigma, s\sigma)$$
$$M = \mu u^{\tau} v^{1-\tau}$$

Firm Technology and Heterogeneity

	α	λ	$m\sigma$	$s\sigma$	b
Estimate	0.66	56.84	-5.01	1.05	406.26
SE	(0.01)	(1.35)	(0.04)	(0.07)	(6.82)

Search

	c_f	c_v	χ_f^1	χ_v^1	τ	μ
Estimate	2654.12	6236.04	1188.98	11.87	0.34	0.49
SE	(123.31)	(151.97)	(84.58)	(3.31)	(0.02)	(0.02)

Number of Moments = 76 Minimum Value: 1138.0

Estimates for the structural parameters underlying firm technology, firm heterogeneity, and aggregate matching. Parameters were estimated using Simulated Method of Moments where the structural parameters were used to solve for the model equilibrium and simulate a series of wage and hours profiles as well as aggregate moments with observable analogues in data from the retail sector.

that workers are willing to accept average labor compensation up to a hundred dollars per week less. The operative mechanism is that ρ_i amplifies the dis-utility $\overline{g}$ which appears in the net value of employment term within the participation constraint (equation (15)) which binds in contract bargaining. The direct implication is that more risk averse workers will accept a lower amount of labor compensation all else equal. Therefore, I view the estimated unemployment benefit as closer to a model fitting parameter than a minimum value of sustenance. Figure 8 plots the implied distribution of firm types where the median value is approximately zero but the long right skew implies that a small percentage of firms see considerable variability in productivity shocks.

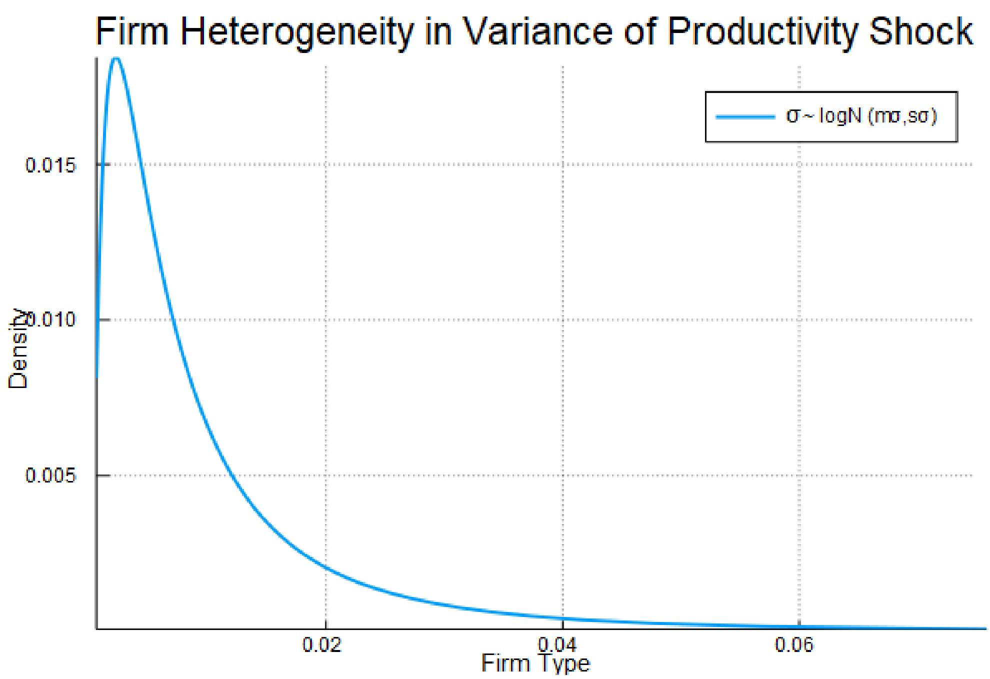
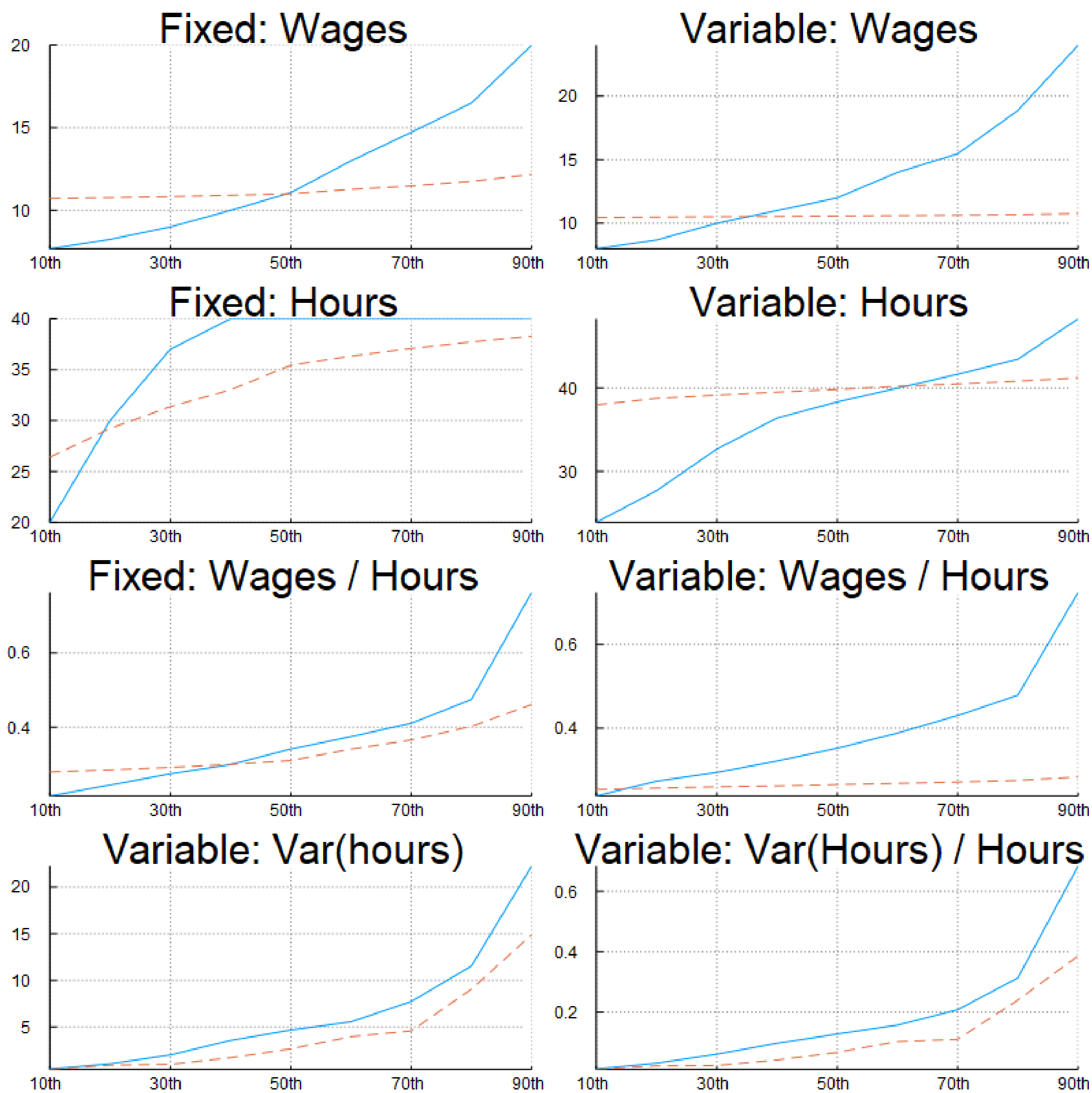


Figure 8: A plot of estimated firm heterogeneity in the variance of their productivity shock. In estimation, the density is discretized between the tenth and ninetieth deciles.

Finally, regarding the costs of creating a position and maintaining a vacancy the main message is the difference across the two sectors. The cost of entering the variable sector is around twice as large as that for entering the fixed sector. On the other hand, the cost of maintaining the vacancy in the variable sector is effectively zero versus around four hundred and fifty dollars per week in the fixed sector $(\chi_f^1 \theta_f)$. These costs reflect the profitability of firms only after abstracting away from all fixed costs of production and any other overhead not captured in the model. The cost of posting a vacancy is roughly equal to the expected discounted stream of profits from the infinite lifetime of the vacancy and accordingly we see that holding such a vacancy in the variable sector is worth around twice as much as in the fixed sector.

Regarding model fit, Figure 9 plots the observed and simulated moments while Table 6 provides all

Figure 9: Plots Indicating Moment Fit



Fit of moments. The blue solid line is the data and the orange dashed line traces out the simulated counterpart.

seventy-six point estimates. The concise summary is that there is insufficient variation in the levels of hours and wages in the variable sector. A brief study of the optimal labor demand for the variable sector in equation (18) suggests that the lack of variation in wages largely implies the lack of variation in hours. The alternative channel is through the heterogeneity in the firm type, σ, which is estimated as relatively small in value to match weekly variation in hours. This property of the simulated data follows from the way sorting occurs in equilibrium in that the least risk averse individuals end up in the variable sector but also have relatively small differences in their outside option even adjusting for worker heterogeneity. To illustrate this issue, notice the wages in the fixed sector largely start at the highest wage found in the variable sector and increase from there. This feature is a product of the model set-up where wages are set before hours are realized and all workers have the same effective outside option and so, if all firms were identical, the wage would only vary in ρ_i. The aggregate search moments and the ratio of fixed to variable contracts can be fit relatively well by the parameters of search technology and the magnitudes of the search costs are largely driven by the implied profits of labor contracts.

The estimated model fits the higher order moments relatively well. For example, the cross-sectional variance in weekly hours directly relates to firm types to observed labor contracts and suggests that the variability of firm productivity shocks provides a reasonable explanation for observed variation. However, other moments constructed as the ratio of wages to hours and ratio of mean hours to variance in hours pin down the correlation between jobs and avoid an equilibrium where, for example, wages were decreasing in mean hours. I interpret the fit of these moments as evidence that fundamental dynamics of the model are plausible even if, perhaps, the current parameterization does not provide sufficient variation to fit the full cross-section of wages and hours.

VII. COUNTERFACTUALS

One important distinction about the scope for welfare improving policy is that the employment contracts in this model are optimal given the environment. The model has two inherent frictions. The first is a search friction that prevents full employment and sorting. The second and primary friction is that workers and firm must negotiate a fixed wage before seeing productivity shocks. As shown in Cooper (1985), an alternative optimal contract contains a shock-contingent wage and hours where the contractual hours and compensation in any period just satisfies the worker's *ex-post* participation constraint under the same bargaining environment found here. This contract allows the risk-neutral firm to fully extract the surplus of the match while insuring the risk-averse worker against productivity shocks. I rule out this contract by requiring firms and workers to fix a wage independent of the productivity shock which allows the market to endogenously price the firm's control over hours and leaves room for welfare increasing policy that limits the firm's discretion.

Having estimated the model primitives that drive the dynamics of the equilibrium labor market, I now consider the implications of policy designed to reduce the unpredictability workers face in compensation and hours. Specifically, I conduct a counterfactual policy experiment that prohibits firms from varying an employee's hours more than twenty percent of mean hours. This restriction reduces the ability of firms to adjust to productivity shocks and has implications for firm entry, hiring behavior, wages, hours, and employment levels. The non-linearity implied by worker-sorting between sectors and adjustments in wage and hours determination makes an analytical approach to determining the effect intractable. Instead to measure the welfare impact I simulate the equilibrium under the counterfactual policy and calculate the percentage change in utility across worker types as defined by their coefficient of relative risk aversion.

The policy generates a small increase in average welfare that corresponds to a negligible monetary value. A relative increase in the labor market tightness of the variable sector induces more workers to shift from the fixed sector into the variable sector resulting in a ten percentage point increase in the share of jobs with varying hours. The policy causes a two and half percentage point decline in aggregate production which provides a proxy measure for firm welfare. The policy differentially impacts worker-types. Sixty-five percent of workers are made better off but workers with a coefficient of risk aversion larger than 0.63 are made strictly worse off. I plot the distribution of changes in Figure 10. The gains to the variable sector are indicated by the workers on the left hand side of the plot where the spike towards the middle is the set of workers who move to the variable sector. Any wavering in the line reflects the error in simulation rather than small differences in changes. Overall, the exercise demonstrates that even relatively light restrictions on firm discretion may have potentially unexpected consequences and that aggregate statistics may hide uneven changes in the overall welfare across the labor force.

Given the importance of the distribution of net welfare effects, a second and potentially equally important question facing policy-makers is the identities of the winners and losers. While the model deals in the simplification of single-index heterogeneity in risk aversion it remains largely silent on its source. A high valuation for predictability could equally come from a relatively high-paid individual willing to pay more for the stability of hours and compensation or a single mother trying to arrange child care around her work schedule. While precise estimation through the conditioning on observable characteristics is beyond the scope of the larger estimation scheme of the model, the identification strategy from the first stage estimation of preferences does provide a framework for inference through implied choice probabilities.

The likelihood of an individual's observed choices across vignettes given a value of ρ the likelihood in equation (32) has, through Bayes' rule, a complementary probability of a ρ value given the sequence

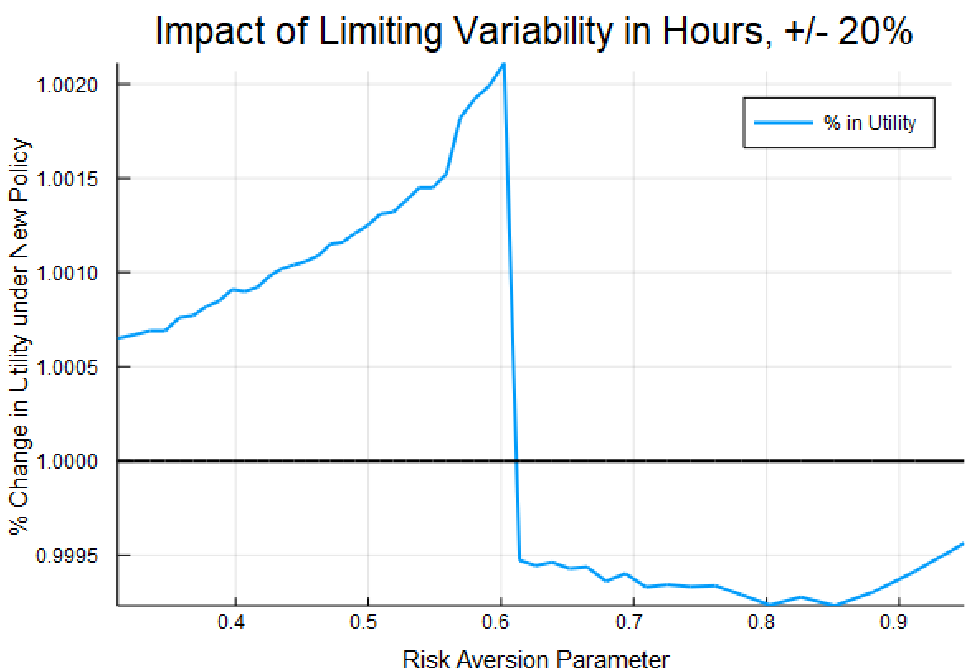


Figure 10: The percentage change in utility for worker-types under the counterfactual equilibrium where firms are prohibited from choosing hours that differ by more twenty percent from the job's mean hours. The central line indicates no required change and all values above (below) are positive (negative) changes. The results indicate the importance of accounting for the distributional impact of policy as though average impact is small and positive the policy leaves the workers with the largest coefficient of risk aversion worse off.

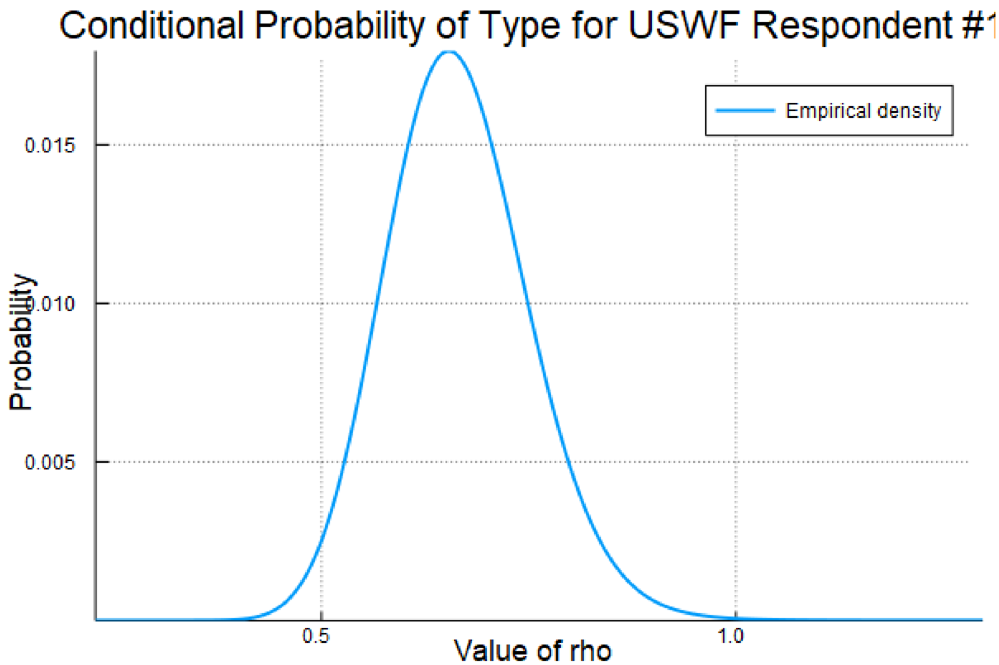


Figure 11: The conditional probability that a particular value of ρ rationalizes the observed sequence of choices across vignettes for USWF respondent #1. A comparison of this density with Figure 4 suggests that this respondent is slightly more risk averse than the median individual (a value of 0.59).

of observed choices. We can trace out the probability that any particular value of ρ rationalizes a given observed choice through implied conditional probabilities as

$$\Pr\{\rho_i|\text{Obs. Choice}\} = \frac{\Pr\{\text{Obs. Choice}|\rho_i\}\Pr\{\rho_i\}}{\Pr\{\text{Obs. Choice}\}}.$$

which given the original parametric assumptions and the estimated preference parameters has a closed form solution. To illustrate, Figure 11 plots the probability of the observed sequence of choices for a given value of ρ for a particular respondent. The smooth parametric forms are a consequence of the assumptions used in first stage estimation. This exercise can be repeated for every respondent producing 1,026 densities of ρ which produces a range of values covering the domain of values seen in Figure 4.

To provide some description of how observable characteristics are related to values of ρ I regress the median value from each respondent's empirical density on a set of relevant demographic variables. Table 8 reports the results of the regression of ρ values while Tables 15 and 16 have the equivalent results for a regression on the distribution of relative risk aversion coefficients and Frisch elasticities, respectively. Increasing values imply greater risk aversion and, given the model, determines sorting into fixed and variable contracts. The correlations imply workers without a high school degree and young mothers are over-represented among workers in with high risk aversion parameters and therefore among workers in

Table 8: Regression of Demographic Characteristics on $10 \times \rho$

	β	*s.e.*	t-stat	p-value
Household				
Cohabitating	-0.37	(0.16)	-2.31	0.02
Mother	0.25	(0.23)	1.07	0.29
Child < 3	-0.81	(0.26)	-3.09	0.00
Mother*(Child <3)	1.22	(0.39)	3.15	0.00
Race and Ethnicity				
Black	0.04	(0.32)	0.12	0.91
Hispanic	-0.25	(0.27)	-0.90	0.37
White	-0.45	(0.37)	-1.21	0.23
White Male	-0.02	(0.22)	-0.07	0.94
Non-White Female	-0.55	(0.41)	-1.32	0.19
Education (Highest Degree Completed)				
HS	-0.86	(0.42)	-2.04	0.04
College Degree	-0.88	(0.42)	-2.08	0.04
Graduate Degree	-0.69	(0.46)	-1.52	0.13
Currently a Student	0.39	(0.27)	1.43	0.15
r^2: 0.03			Sample size 1026	

A regression of demographic characteristics on the median ρ value recovered using the estimated parameters.

fixed contracts. While individuals with higher degrees and young fathers are likely to be less risk averse with respect to the kind of contracts in the model. The r-squared value of 0.03 indicates a large share of heterogeneity is not well explained by demographic differences.

VIII. Conclusion

This paper formulates and estimates an equilibrium search model to evaluate how limiting employer discretion over hours impacts market efficiency and welfare. To provide an environment where policy intervention may improve outcomes I assume a contracting friction where the wage is set before the marginal productivity is known. Firms set hours given the shock and wage which generates variability in the worker's leisure and consumption across periods. The model specifies firm and worker primitives and allows for bargaining with bilateral heterogeneity as a way to price how control over hours matters in employment contracts within an equilibrium market setting. I also assume the existence of two sectors within the labor market that allow for directed search in a tractable manner. To identify the primitives of the model I use a novel approach that allows identification and estimation of worker and firm primitives without firm data. My strategy involves combining stated preference data collected from workers with data from equilibrium jobs and employment measures specific to the retail sector. I first estimate worker preferences and then take these primitives as inputs when estimating the parameters underlying firm and search technology. The estimated model broadly matches observed patterns in wages, hours, and employment in the U.S. retail sector whose labor markets exemplify many of the key features of my model. Using the recovered structural parameters I evaluate the impact of a counterfactual policy that prohibits employers from varying employee hours more than twenty percent from mean hours. My results indicate that while such a policy benefits a majority of workers it also causes a significant decline in aggregate production and makes some workers worse off in equilibrium.

Looking forward, the model appears to capture some of the higher order dynamics of the labor contracts though does not fully fit the cross-section of hours and wages. The issues in fit stem at least partially from parameterization choices and in particular that workers perfectly sort between markets on their risk aversion parameter. A second possible direction gives workers a positive bargaining weight which would provide them with a share of the match surplus. This approach may also to improve model fit and inform counterfactual welfare analysis. More generally, further work is needed on how attributes like advanced notice of schedule and flexibility in the timing of hours can mitigate the welfare costs of these types of schedules at a potentially smaller cost to market efficiency. In answering this question, helpful evidence may come from the randomized control trials described in Lambert et al. (2015).

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A. Appendix: Optimal Labor Contracts

For reference I provide various moments of labor contracts implied by the parameterization in the equilibrium model.

$$
\begin{aligned}
L_v &= \left(\frac{\lambda\alpha e^{\varepsilon}}{w_v}\right)^{\frac{1}{1-\alpha}} \\
\mathbb{E}[L_v] &= \left(\frac{\lambda\alpha}{w_v}\right)^{\frac{1}{1-\alpha}} \exp\left\{\tfrac{1}{2}\sigma^2\left(\frac{1}{(1-\alpha)^2} - \frac{1}{1-\alpha}\right)\right\} \\
&= \left(\frac{\lambda\alpha}{w_v}\right)^{\frac{1}{1-\alpha}} \exp\left\{\frac{\alpha}{2(1-\alpha)^2}\sigma^2\right\} \\
\mathrm{Var}(L_v) &= \left(\frac{\lambda\alpha}{w_v}\right)^{\frac{2}{1-\alpha}} \left(\exp\left\{\frac{(1+\alpha)\sigma_f^2}{(1-\alpha)^2}\right\} - \exp\left\{\frac{\alpha\sigma_f^2}{(1-\alpha)^2}\right\}\right) \\
\mathbb{E}[L_v^{\delta}] &= \left(\frac{\lambda\alpha}{w_v}\right)^{\frac{\delta}{1-\alpha}} \exp\left\{\tfrac{1}{2}\sigma^2\left(\frac{\delta^2}{(1-\alpha)^2} - \frac{\delta}{1-\alpha}\right)\right\} \\
\ln L_v &= \frac{1}{1-\alpha}\left(\ln\lambda + \ln\alpha + \varepsilon - \ln w_v\right) \\
\mathbb{E}[\ln L] &= \frac{1}{1-\alpha}\left(\ln\lambda + \ln\alpha - \frac{1}{2}\sigma_f^2 - \ln w_v\right) \\
\mathrm{Var}(\ln L) &= \left(\frac{1}{1-\alpha}\right)^2 \sigma_f^2
\end{aligned}
$$

B. Appendix: Additional Information about the UWSF Vigenttes

From each respondent we collect, if employed, their current job characteristics including wage, range of hours, and degree of advanced notice and flexibility. The latter permits verification that the jobs in our vignettes resemble the jobs these individuals hold. We also ask respondents to suppose hypothetically that if in the next month they were to receive thirty jobs offers from employers who hold a vacancy that matches the respondent's qualifications. From that distribution, we ask respondents to report the minimum w^{p}, maximum w^{o}, and most likely wage w^{r} from which we can construct a triangular distribution of expected job offers. These moments are then used to adapt the wage offers from the jobs into offers that necessarily correspond to an individual-specific set of of low w_{lo}, low to mid w_{m1}, mid to high w_{m2} and high w_{hi} wage offers. Each job has one of four possible wage levels created from the following set of equations:

$$w_{i,lo} = 0.9 \times w_{i,p} + 0.1 \times w_{i,r}$$
$$w_{i,m1} = 0.6 \times w_{i,p} + 0.4 \times w_{i,r}$$
$$w_{i,m2} = 0.4 \times w_{i,r} + 0.6 \times w_{i,o}$$
$$w_{i,hi} = 0.1 \times w_{i,r} + 0.9 \times w_{i,o}$$

C. Appendix: Algorithm for Finding Steady State Equilibrium

First I discretize the set of κ and σ into N_κ and N_σ intervals between the tenth and ninetieth quantiles. I limit myself to the inner deciles to avoid letting types in the tail drive dynamics as behavior in the tails is primarily identified through parametric assumption.

1. Calculate θ_m and $\eta_m(\kappa)$ for both markets assuming all workers participate in that market. Label the market with the higher θ_m as Market A and the other as Market B. Let $\mathscr{A}$ ($\mathscr{B}$) be the set of workers in Market A (B).
   - In practice, this will almost always be the variable market as a match for any given κ and σ always has a higher expected profit in the variable market. Intuitively, a firm in the fixed market is solving a constrained version of the problem in the variable market.
2. Take the least profitable worker, κ_j, in $\mathscr{A}$ and compute θ_B and $\eta_B(\kappa_j)$ for Market B where only κ_j participates.
3. Check if $U^B(\kappa_j) \geq U^A(\kappa_j)$ using the θ_m and $\eta_m(\kappa_j)$ where j participates in both markets.
   - Note that if any firm accepts j in the fixed market then all will since R^f and Q^f are independent of firm type.
   - Without loss of generality, to break ties I assume a worker prefers the variable market if and only if $U^v(\kappa_j) > U^f(\kappa_j)$.
4. If so, put $\kappa_j \in \mathscr{B}$ and take her out of $\mathscr{A}$. Then find the next least profitable worker in $\mathscr{A}$ and repeat from step 2 until $U^B(\kappa_j) < U^A(\kappa_j)$
   - As workers transfer from $\mathscr{A}$ to $\mathscr{B}$ both θ_A and θ_B will rise. Market A has higher expected profit as the least profitable κ has left. Market B is also has higher expected profit as the new κ will always be more profitable than the other workers already in $\mathscr{B}$. More profitable markets encourages firm entry which drives the vacancy contact rates and thus the value of unemployment.

The resultant $\theta_v, \theta_f, \eta_v(\kappa)$, and $\eta_(\kappa)$ imply a division of workers between the two markets where optimizing behavior in directed search by workers implies a worker cannot be better off by searching in the other market. Using this division and θ_m and $\eta_m(\kappa)$ we know the steady state distribution of unmatched workers F_κ^m for both markets. Integrating against the discretized worker types we know u_m which implies the measures of vacancies $v_m = \theta_m u_m$ and the distribution of matches. To simulate the sample of observed jobs I draw a large sample from the distribution of equilibrium matches and calculate the wage, hour, and worker flow moments.

D. Appendix: Additional Tables and Figures

Table 9: Types of Retailers in Observed Jobs

%	Description	Census ID
10%	Autombile Related	4670–4690
17%	Furniture, Appliances, & Hardware	4770–4890
30%	Food and Drug	4970–5080
6%	Gas Stations	5090
13%	Clothing	5170–5280
16%	Music, Book, & Department stores	5290–5390
8%	Other	5470–5580

A further breakdown of the 2002 Census Industry codes for the 405 retail jobs in the sample.

Table 10: Job Attributes in the UWSF Vignettes

Dimension	Values	Notes
Hours	10	hours per week
	20	hours per week
	30	hours per week
	40	hours per week
Variance in Hours	Fixed	e.g. always $\overline{h}$ hours/week
	$\pm$20%	Hours vary between $.8\overline{h}, \overline{h}, 1.2\overline{h}$
	$\pm$50%	Hours vary between $.5\overline{h}, \overline{h}, 1.5\overline{h}$
Pre-Tax Wage	Low	$0.9 \times w_{low} + 0.1 \times w_{mid}$
	Mid1	$0.6 \times w_{low} + 0.4 \times w_{mid}$
	Mid2	$0.4 \times w_{mid} + 0.6 \times w_{hi}$
	High	$0.1 \times w_{mid} + 0.9 \times w_{hi}$
Variance in Pay	Fixed	Always w per hour.
	$\pm$10%	Weekly wage varies between $.9\overline{w}, \overline{w}, 1.1\overline{w}$
Advanced Notice	$\leq$ 1 week	"1 week or less of advanced notice"
	1–2 Weeks	"1 to 2 weeks of advanced notice"
	3+ weeks	"3 weeks or more of advanced notice"
Scheduling Flexibility	None.	"Starting and finishing times are decided by your employer and you cannot change them on your own"
	A little.	"Starting and finishing times are decided by your employer but with your input"
	Some.	"You can decide the time you start and finish work, within certain limits"
	A lot	"You are entirely free to decide when you start and finish work"

A breakdown of the possible attributes for a job within a vignette. A job is characterized by having one value from each categorey. The description of the job is then an implied description of those attributes. For example, a distribution of compensation since wage and/or hours may vary. For a description of how wages were set see Appendix B.

Table 11: Reported Job Attributes in the UWSF Survey

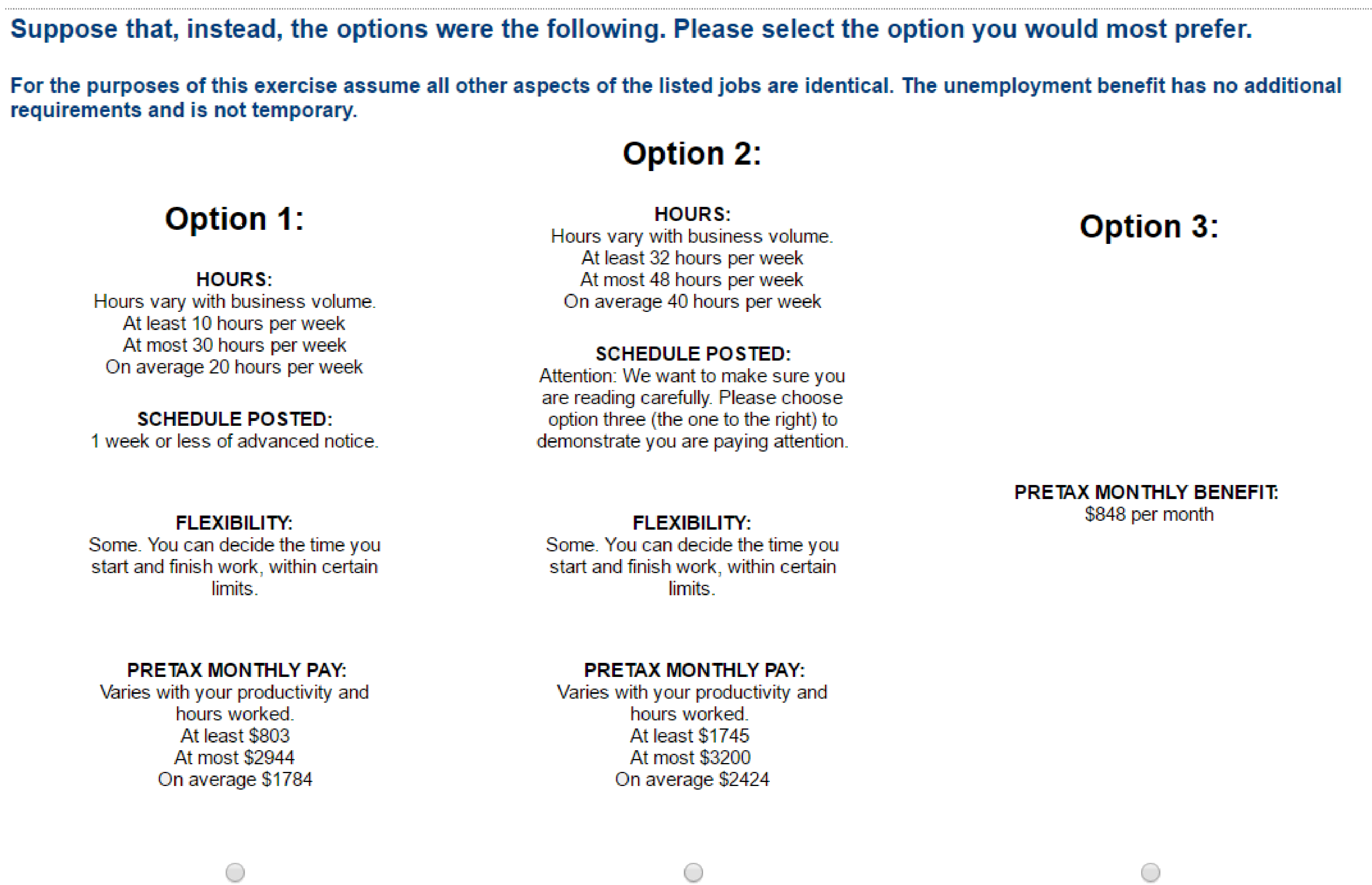
Flexibility	None	A little	Some	A lot
All	47%	24%	21%	8%
Hourly	56%	26%	14%	3%
Female	48%	23%	22%	8%
Male	47%	26%	19%	8%
Part-Time	48%	26%	17%	9%
Full-Time	47%	23%	23%	7%
Advanced Notice	$\leq$ 1 Week	1–2 Weeks	3–4 Weeks	4+ Weeks
All	37%	21%	6%	36%
Hourly	38%	26%	6%	30%
Female	37%	22%	6%	35%
Male	36%	20%	6%	38%
Part-Time	45%	32%	7%	17%
Full-Time	32%	16%	6%	46%
Variability in Hours	None	$\pm$10%	$\pm$50%	Mean IR
All	30%	70%	35%	0.7
Hourly	31%	69%	37%	0.73
Female	30%	70%	36%	0.75
Male	31%	69%	34%	0.63
Part-Time	16%	84%	60%	1.21
Full-Time	38%	62%	23%	0.45

Attributes of reported jobs from Understanding Work Schedule Forecastability sample. This table suggests that the attributes contained in our hypothetical jobs resemble those of equilibrium jobs. IR, or instability ratio, is a measure of the degree of variation in hours for any particular job defined as the range of hours divided by usual hours.

Table 12: Additional UWSF Sample Statistics Conditional on Reporting Employment

	Females	Males	Part-Time	Full-Time	All
General					
% of Total Sample	40%	32%	24%	48%	72%
Male	0%	100%	47%	43%	44%
Mean Age	32.9	33.1	32.9	33.0	33.0
Cohabitating	64%	68%	60%	68%	66%
Currently a Student	9%	10%	13%	8%	9%
Any Children	53%	63%	53%	59%	57%
Any Children Under 6	47%	37%	47%	41%	43%
Total Time on Survey	31.7	29.9	27.1	32.8	30.9
Employment					
Number of Jobs	1.5	1.4	1.7	1.4	1.5
Mean Usual Hours	36.2	33.4	20.3	42.3	35.0
Mean Min Hours	29.5	26.3	14.7	34.7	28.1
Mean Max Hours	50.4	43.3	34.3	53.7	47.2
Suppose you recieved 20 job offers in the next 2 months, what do you think would be the...					
Lowest Expected Wage	17.6	14.2	12.9	17.7	16.1
Most Likely Wage	28.3	20.1	19.9	27.0	24.6
Highest Expected Wage	40.4	29.1	29.8	38.2	35.4
Since you turned 20, how many years were you primarily a...					
Full-time Worker	8.5	7.9	6.5	9.1	8.2
Part-time Worker	1.7	1.7	3.2	0.9	1.7
Student	1.3	1.9	1.7	1.6	1.6
Other	0.7	0.7	1.2	0.4	0.7
Race and Ethnicity					
Black	8%	11%	11%	9%	10%
Hispanic	9%	9%	9%	9%	9%
White	83%	85%	82%	85%	84%
Highest Degree Attained					
Less Than HS	3%	2%	2%	2%	2%
High School	38%	35%	42%	34%	37%
A.A. Degree	10%	15%	14%	11%	12%
B.A. Degree	32%	32%	28%	34%	32%
Graduate Degree	17%	17%	14%	19%	17%
Sample Size	413	329	247	495	742

Additional sample statistics for the UWSF sample. Part-time is defined as reporting fewer than 35 usual hours per week in their primary job.



Suppose that, instead, the options were the following. Please select the option you would most prefer.

For the purposes of this exercise assume all other aspects of the listed jobs are identical. The unemployment benefit has no additional requirements and is not temporary.

Option 1:

HOURS:
Hours vary with business volume.
At least 10 hours per week
At most 30 hours per week
On average 20 hours per week

SCHEDULE POSTED:
1 week or less of advanced notice.

FLEXIBILITY:
Some. You can decide the time you start and finish work, within certain limits.

PRETAX MONTHLY PAY:
Varies with your productivity and hours worked.
At least $803
At most $2944
On average $1784

Option 2:

HOURS:
Hours vary with business volume.
At least 32 hours per week
At most 48 hours per week
On average 40 hours per week

SCHEDULE POSTED:
Attention: We want to make sure you are reading carefully. Please choose option three (the one to the right) to demonstrate you are paying attention.

FLEXIBILITY:
Some. You can decide the time you start and finish work, within certain limits.

PRETAX MONTHLY PAY:
Varies with your productivity and hours worked.
At least $1745
At most $3200
On average $2424

Option 3:

PRETAX MONTHLY BENEFIT:
$848 per month

Figure 12: The Attention Filter from the Understanding Work Schedule Forecastability survey. Every survey-taker saw the above as the 12th of 14 vignettes. In Option 2 the description for "Schedule Posted" instructs them to disregard the above instructions and choose Option 3. For reference, across vignettes the unemployment benefit is empirically the least likely option to be chosen. Filtering on whether they answered this question correctly leaves 40% of original respondents.

Table 13: Unweighted Estimated Preference Parameters

Parameterization

$$\frac{\left(C^{\gamma}(1-\ell)^{1-\gamma}\right)^{1-\rho_i}}{1-\rho_i} + \mathbb{1}_{ue}\overline{g} + \psi X \qquad \ln \rho_i \sim \ln N(m\rho, s\rho)$$

Estimates

	γ	$m\rho$	$s\rho$		$\overline{g}$
Estimate	0.86	-0.24	0.11		1.15
SE	(0.01)	(0.01)	(0.01)		(0.03)

	Advanced Notice		*Flexibility*		
ψ :	1–2 Weeks	3+ weeks	A little	Some	A lot
Estimate	0.07	0.14	0.13	0.34	0.80
SE	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
N=1026			Log-Likelihood: -11764.4		

Results for preference estimation without the re-weighting to match the NLSY97 sample.

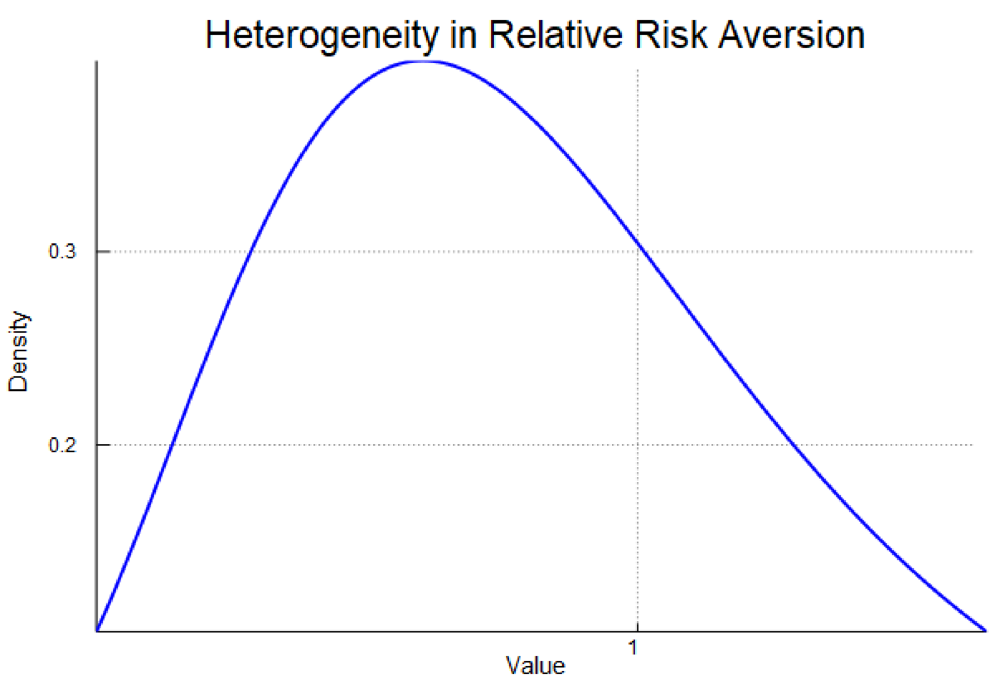


Figure 13: The estimated heterogeneity in relative risk aversion from the unweighted USWF sample. These values are directly related to the risk aversion parameter through $-\frac{cU_{cc}}{U_c} = \rho_i\gamma + 1 - \gamma$.

Table 14: Comparison of Simulated and Observed Moments

Aggregate Moments									
	UE Rate	θ	Job Openings	$\frac{\text{variable}}{\text{fixed}}$					
Data	0.06	0.42	0.03	1.18					
Simulated	0.09	0.41	0.08	1.01					
Fixed: Wages									
Data	7.68	8.25	9.00	10.00	11.07	13.00	14.72	16.50	20.00
Simulated	10.72	10.77	10.84	10.91	11.01	11.27	11.48	11.76	12.17
Fixed: Hours									
Data	20.00	30.00	37.00	40.00	40.00	40.00	40.00	40.00	40.00
Simulated	26.39	29.22	31.36	33.02	35.43	36.33	37.08	37.72	38.27
Fixed: Wages / Hours									
Data	0.22	0.24	0.28	0.30	0.34	0.38	0.41	0.47	0.76
Simulated	0.28	0.29	0.29	0.30	0.31	0.34	0.37	0.40	0.46
Variable: Wages									
Data	8.00	8.69	10.00	11.00	12.00	14.00	15.47	18.87	24.00
Simulated	10.45	10.48	10.51	10.54	10.57	10.61	10.64	10.67	10.76
Variable: Hours									
Data	23.87	27.67	32.67	36.40	38.33	40.00	41.67	43.47	48.33
Simulated	37.98	38.75	39.16	39.51	39.83	40.22	40.49	40.84	41.22
Variable: Var(Hours)									
Data	0.50	1.06	2.00	3.56	4.67	5.56	7.72	11.53	22.26
Simulated	0.44	0.91	0.99	1.70	2.65	3.96	4.57	9.05	14.89
Variable: Wages / Hours									
Data	0.24	0.27	0.29	0.32	0.35	0.39	0.43	0.48	0.72
Simulated	0.25	0.26	0.26	0.26	0.27	0.27	0.27	0.28	0.28
Variable: Var(Hours) / Hours									
Data	0.01	0.03	0.06	0.10	0.13	0.16	0.21	0.31	0.68
Simulated	0.01	0.02	0.02	0.04	0.07	0.10	0.11	0.24	0.39

The observed and simulated moments outlined in Table 6.

Table 15: Regression of Demographic Characteristics on 10× Coefficient of Relative Risk Aversion

	β	*s.e.*	t-stat	p-value
Household				
Cohabitating	-0.33	(0.14)	-2.31	0.02
Mother	0.22	(0.21)	1.07	0.29
Child $<$ 3	-0.73	(0.24)	-3.09	0.00
Mother*(Child $<$3)	1.09	(0.35)	3.15	0.00
Race and Ethnicity				
Black	0.03	(0.29)	0.12	0.91
Hispanic	-0.22	(0.24)	-0.90	0.37
White	-0.40	(0.33)	-1.21	0.23
White Male	-0.01	(0.20)	-0.07	0.94
Non-White Female	-0.49	(0.37)	-1.32	0.19
Education (Highest Degree Completed)				
College Degree	-0.79	(0.38)	-2.08	0.04
Graduate Degree	-0.62	(0.41)	-1.52	0.13
HS	-0.77	(0.38)	-2.04	0.04
Currently a Student	0.35	(0.24)	1.43	0.15
r^2: 0.03			Sample size 1026	

A regression of demographic characteristics on the values of the coefficient of relative risk aversion for median ρ values as outline in Figure 11. The relationship between ρ_i and the coefficient of relative risk aversion is RRA = $-\frac{cU_{cc}}{U_c} = \rho_i\gamma + 1 - \gamma$.

Table 16: Regression of Demographic Characteristics on 10× the Frisch Elasticity

	β	*s.e.*	t-stat	p-value
Household				
Cohabitating	0.09	(0.05)	1.94	0.05
Mother	-0.05	(0.07)	-0.75	0.46
Child < 3	0.23	(0.08)	2.70	0.01
Mother*(Child $<$3)	-0.35	(0.12)	-3.01	0.00
Race and Ethnicity				
Black	-0.09	(0.09)	-0.96	0.34
Hispanic	0.09	(0.08)	1.13	0.26
White	0.07	(0.10)	0.70	0.48
White Male	0.02	(0.06)	0.27	0.79
Non-White Female	0.13	(0.11)	1.15	0.25
Education (Highest Degree Completed)				
College Degree	0.20	(0.12)	1.68	0.09
Graduate Degree	0.16	(0.13)	1.25	0.21
HS	0.22	(0.12)	1.85	0.07
Currently a Student	-0.09	(0.07)	-1.23	0.22
r^2: 0.03			Sample size 1026	

A regression of demographic characteristics on the values of the Frisch for median ρ values as outline in Figure 11 for someone working thirty-five hours per week out of a possible eighty-four. The relationship between ρ_i and the Frisch elasticity is $\frac{1-\gamma(1-\rho_i)}{\rho_i}\frac{1-L}{L}$ for $L = 0.42$.

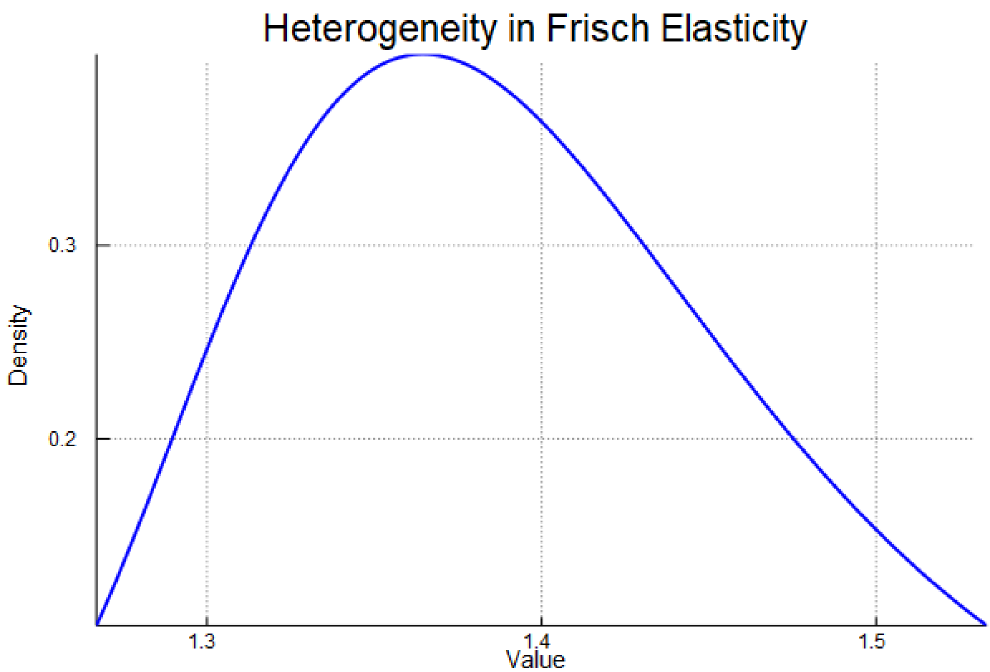


Figure 14: The estimated heterogeneity in the Frisch elasticity from the unweighted UWSF sample. The calculations here assume a labor supply of thirty-five out a possible eighty-four hours per week. These values relate to the worker primitives through the following identity: $\frac{1-\gamma(1-\rho_i)}{\rho_i}\frac{1-\ell}{\ell}$ where here $\ell = 0.42$.

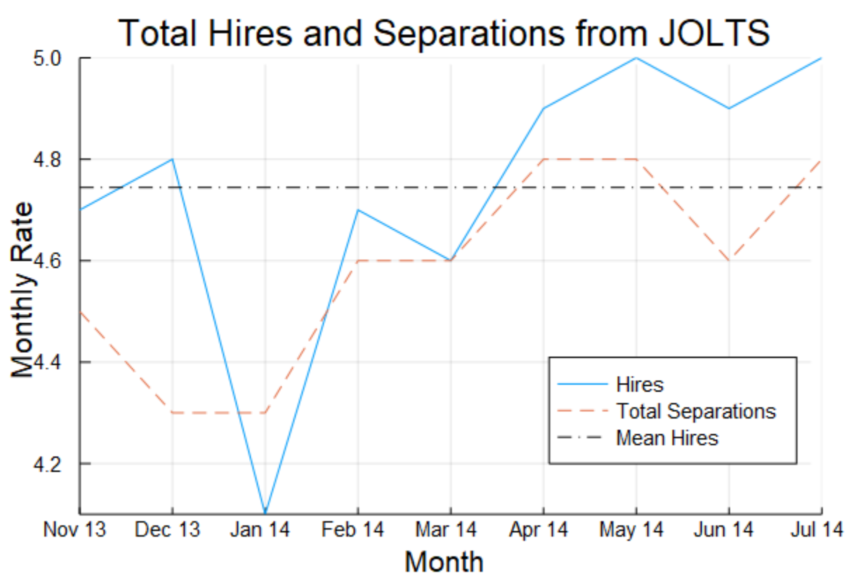


Figure 15: The Hires and Total Separations series for November 2013 through July 2014 from the JOLTS database. Rates are seasonally-adjusted.

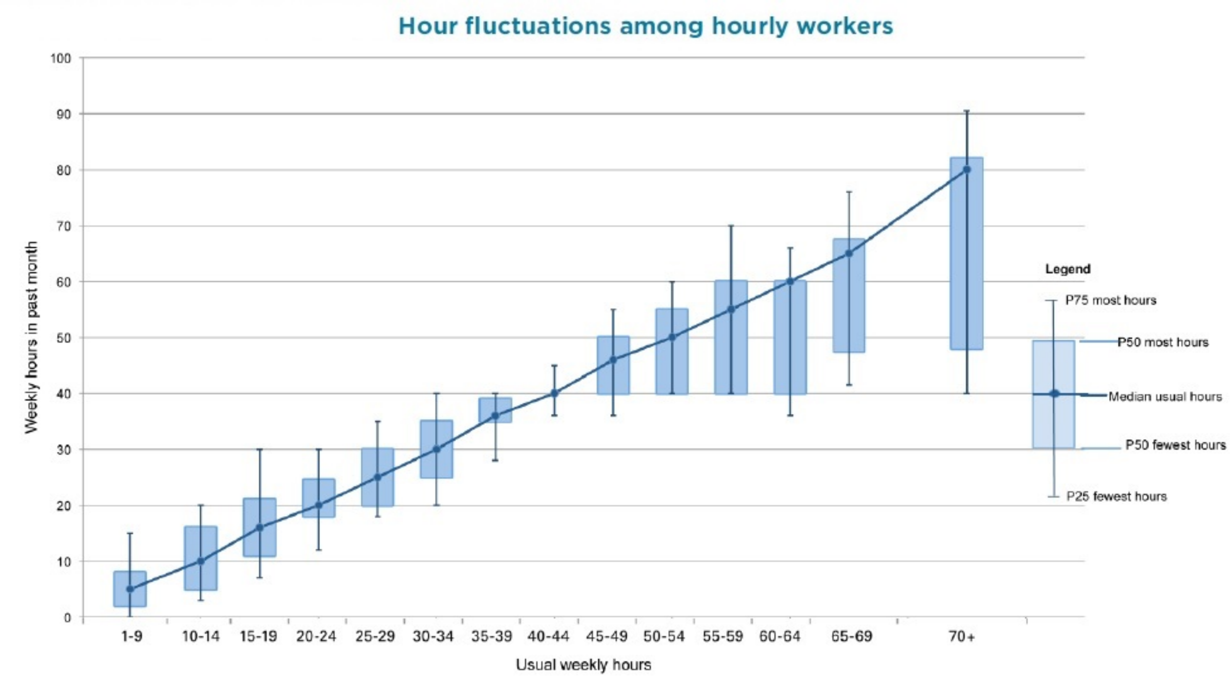


Figure 16: The distribution of actual hours worked in a week conditional on usual hours for employees in their early 30s. Taken from Lambert et al. (2014) who use information from the 2011 round of the National Longitudinal Survey of Youth 1997.