

# The Opportunity Cost(s) of Employment and Search Intensity\*

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## Abstract

The flow utility of unemployment plays a crucial role in labor search and matching models. Recent evidence by [Chodorow-Reich and Karabarbounis \(Forthcoming\)](#) suggests that the flow utility is high on average, volatile, and strongly procyclical. Taken together, these facts imply that labor search and matching models perform worse than prevailing conventional wisdom. In contrast, we build a model where unemployed workers choose between home production and job search. Procyclical job search implies that the effective unemployment benefit is countercyclical. Our results suggest that omitting endogenous search will upwardly bias the measured correlation between effective unemployment benefits and productivity.

**JEL Classification:** E13; E24; E32; J63; J64.

**Keywords:** Home Production; Search Intensity; Opportunity Cost of Employment; ATUS.

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# 1 Introduction

The Mortensen-Pissarides (Pissarides (1985), Mortensen and Pissarides (1994), and Pissarides (2000)) search and matching model (MP, henceforth), is frequently used in thinking about labor market fluctuations. Despite its ubiquity, the ability of the model to match key labor market facts over the business cycle crucially depends on the flow value of unemployment. Hagedorn and Manovskii (2008) show that if the flow value of unemployment is close to the equilibrium wage the model generates realistic dynamics. However, they assume that the flow value of unemployment is constant. In recent work Chodorow-Reich and Karabarbounis (Forthcoming) (CRK hereafter) measure this flow value over time. Their results suggest that the value of being unemployed is indeed high on average, but positively correlated with labor productivity. This positive correlation dampens the ability of the model to match labor market dynamics. However, CRK omit to consider that unemployed workers choose to allocate their time between searching for a new job and other activities such as home production.

We imbed such a choice in an otherwise standard MP model and show that under a standard calibration the model produces a countercyclical flow value of unemployment and matches labor market volatilities much better than the model without this endogenous trade-off. The mechanism is that when productivity is high, the value of search increases and, hence, unemployed workers devote more time to search and less time to home production. With lower home production, the flow value of unemployment falls, thus driving a negative correlation between the flow value and productivity and a positive correlation between search intensity and productivity. These results come part of the way in reconciling search models with constant outside options such as Hagedorn and Manovskii (2008) where unemployment benefits are uncorrelated with productivity and CRK who show the strong correlation between the two variables in the data.

The tradeoff between job search and other activities among unemployed workers lies at the heart of our model. Following Aguiar et al. (2013), we define “other activities” as activities commonly classified as home production. In the next section we show that unemployed individuals spend over 50 percent more time on home production than employed individuals giving us some justification for assuming that only unemployed workers can work from home. Additionally, our model implies that search intensity is procyclical. The empirical findings of the cyclicity of search intensity have been mixed. Using the number of methods one spends searching for a job as a proxy for search intensity, Shimer (2004) finds that intensity is countercyclical. With data from both the CPS and the American Time Use Survey (ATUS), Mukoyama et al. (2016) reach a similar conclusion. On the other hand, Krueger and Mueller

(2010) provide evidence that time spent on job search increases with a worker's expected wage. Since expected wages are higher in periods of high productivity, this is indirect evidence that search effort is procyclical. Most recently, [Gomme and Lkhagvasuren \(2015\)](#) find that *average* search intensity is subject to a compositional bias and therefore will not be representative of the search effort for a typical unemployed worker. Controlling for a variety of demographic characteristics and past wages and average hours of work of people unemployed for five months or less, they find that search intensity is procyclical and their estimates are statistically significant at standard confidence levels.<sup>1</sup> Since our theory deals with ex ante identical individuals, the search intensity of the typical unemployed worker is more relevant than the average search intensity. Therefore, the results in [Gomme and Lkhagvasuren \(2015\)](#) provide strong support for the implications of the cyclicity of search intensity in our model.

We calibrate the model to the usual macro aggregates but also bring in micro data from the American Time Use Survey to discipline the home production technology. The endogenous choice between job search and home production amplifies the response of labor market variables to technology shocks. This amplification is the product of a static and a dynamic effect. [Hagedorn and Manovskii \(2008\)](#) emphasize the static effect: home production raises the effective unemployment benefit in steady state so a given percent increase in productivity increases profit more in percent terms. Larger percent increases in profit cause firms to post more vacancies thereby amplifying the effects of productivity on labor market variables. However, there is also a dynamic effect. An increase in productivity increases worker search effort. Higher search effort raises firms' job filling rate which causes them to post more vacancies. Again, this amplifies labor market variables and induces a negative correlation between the flow value of unemployment and productivity; the opposite of what CRK find in the data. This, however, does not contradict their findings. Instead, our results show that there is more to consider when measuring the level and cyclicity of the flow benefit of unemployment.

In addition to complementing CRK, our paper is related to several strands of research. First, it is related to a long line of papers that seek to reconcile the MP model with the data. [Shimer \(2005\)](#) shows that a standard parametrization leads to counterfactual results. In addition to introducing additional calibration targets as in [Hagedorn and Manovskii \(2008\)](#), researchers have introduced a variety of modifications to the baseline model. [Hall \(2005\)](#), [Hall and Milgrom \(2008\)](#), and [Gertler and Trigari \(2009\)](#) show that changing the bargaining

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<sup>1</sup>[Gomme and Lkhagvasuren \(2015\)](#) also show that search intensity is countercyclical at a statistically insignificant level for workers unemployed more than five months. However, because of the limitations of the ATUS and CPS, they cannot control for past hours and wages.

process can bring the model closer to the data. The addition of on-the-job search, as in [Krause and Lubik \(2010\)](#), dampens the increase in wages following an increase in productivity, thereby inducing firms to post more vacancies. [Pries \(2008\)](#) includes worker heterogeneity as a way of increasing the volatility of labor market variables.<sup>2</sup> Finally, [Gomme and Lkhagvasuren \(2015\)](#) show that including endogenous search intensity (but no home production) significantly amplifies labor market variables. Their mechanism is similar to ours, but they do not have the “static effect” since their effective unemployment benefit is smaller than the statutory benefit due to positive search costs. Our work complements these explanations.

Second, our paper is related to an emerging line of research looking at individuals time allocation using the American Time Use Survey (ATUS). Prior to the inception of the ATUS in 2003, high frequency data on time use was unavailable. [Aguiar et al. \(2013\)](#) use variations across states to identify how time use changed during the Great Recession. They find that leisure absorbed roughly half of the time spent not working, whereas home production absorbed roughly a third. [Krueger and Mueller \(2010\)](#) use the same data in research described above. [Aguiar and Hurst \(2007\)](#) harmonizes earlier data from the PSID with the ATUS to construct longer trends of time use.

Our paper does not solve the Shimer puzzle. Nor does it prove that the flow utility of unemployment is negatively correlated with productivity. Instead, we take convincing evidence that search is procyclical and consider the implications of that in a quantitative framework. The results suggest that endogenous search has important implications for the time series properties of this flow utility and the behavior of labor market variables over the business cycle. We start by discussing the data.

## 2 Data

As is standard in the literature, we collect data on vacancies, unemployment, and productivity at a quarterly frequency from 1951–2004. The sources are described in detail in Appendix [B.1](#).

Our second main data source in the paper comes from the American Time Use Survey (ATUS) which is conducted by the BLS at a monthly frequency. The ATUS began in 2003 and is affiliated with the Current Population Survey (CPS). Households participate in the CPS for eight months and at the end of the eighth month a fraction of households are asked to participate in the ATUS for which one member of the household, aged fifteen or over, is randomly selected to be the subject. Subjects schedule a day on which they are called by

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<sup>2</sup>[Rogerson et al. \(2009\)](#) show that the addition of fixed factors like home production can rationalize the muted differences in cross-country unemployment rates despite large differences in labor market policies.

the ATUS interviewers and are asked detailed questions about how they allocated their time the prior day. Subjects are interviewed only once and results are published monthly by the BLS. The data contains 124,517 observations from 2003–2011.<sup>3</sup>

Respondents are asked how many minutes they spend on each activity. Time allocation is broken down into 18 categories, distinguished by a two digit identification code.<sup>4</sup> Activities are further divided into a finer second level category (four digits) and a still finer third level category.<sup>5</sup> In addition to the amount of time households devote to each activity, the ATUS collects extensive demographic data. For instance, we know each participant’s age, gender, and labor force status. The labor force status is comprised of five categories: employed–at work, employed–absent, unemployed–on layoff, unemployed–searching, and not in the labor force (NLF). While we include weekends, all observations for which the day in reference is a holiday are removed from the sample.<sup>6</sup>

Following [Aguiar et al. \(2013\)](#), we separate home production into several categories. *Child care* measures all the time spent with children, including children outside the household. *Core home production* includes activities such as cleaning, laundry, and meal preparation. Examples of *home ownership* activities are lawn care and home repair. *Time spent obtaining goods and services* includes time spent shopping for goods, researching purchases, and consulting specialists like doctors and lawyers. Finally, *others care* includes time spent caring for non-children. [Aguiar et al. \(2013\)](#) include all these categories, with the exception of child care, in their preferred measure of non-market work. To control for life-cycle issues, we only include subjects between 18 and 65. Also, anyone who refused to participate, counted two activities during one time slot, had any missing data, or participated in a category that could not be classified is excluded. We are left with 83,758 observations. [Table 1](#) displays average hours per week conditional on employment status for the main categories. Total HP includes all the aforementioned categories. We present more detailed summary statistics in [Table 6](#) of [Appendix B.2](#).

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<sup>3</sup>It is important to distinguish between the multi-year file and the year specific files. The latter have variables and weightings that occasionally changed over the years. In particular, the BLS changed the method of weighting responses between 2003 and 2006; since 2006 the same weighting method has been used. The multi-year files compile all yearly data using the same weighting and variables for each year.

<sup>4</sup>The categories include: personal care activities; household activities; caring for and helping household members; caring for and helping non-household members; work and work related activities; education; consumer purchases; professional and personal care services; household services; government services and civic obligations; eating and drinking; socializing, relaxing, and leisure; sports, exercise and recreation; religious and spiritual activities; volunteer activities; telephone calls; and travel.

<sup>5</sup>For example, household activities has code 02. A subset of household activities is housework which has code 0201. A subset of housework is laundry and has code 020102.

<sup>6</sup>In the quantitative exercise, we think of the time endowment in the model as 168 hours per week. Hence, the model is consistent with the treatment in the data, accounting for weekends, but not holidays.

Table 1: Means for the Period 2003M01–2011M12

	Core HP	Core HP + Cons. Purchases	Total HP
Everyone	9.41	14.45	22.46
Employed–Full time	7.06	11.61	18.05
Unemployed–Searching	12.41	18.17	28.64
Total Unemployed	12.61	18.33	29.03

*Notes:* The figures in the table are average hours per week in selected activities conditional on an individual’s employment status. Total Unemployed includes those who are unemployed–searching and unemployed–on layoff. The means are calculated as a weighted average of individual observations where the weights are provided in the survey’s data files. Total HP includes core HP, consumer purchases, home ownership activities, caring for others, and caring for children. The activities comprising these subcategories are described in the Appendix B.1.

Our results are consistent with the averages reported by [Aguiar et al. \(2013\)](#) and [Burda and Hamermesh \(2010\)](#). There are several things to note. First, individuals who have full time jobs spend the least amount of time on home production activities. Second, whether we focus exclusively on people who are unemployed and actively searching, which is more consistent with the definition of unemployed in the model, or the total unemployment pool makes little difference for average home production. Finally, in percentage terms, the biggest difference in time spent on home production activities between employed and unemployed is in core home production and caring for others, with the unemployed spending 79% and 111% more time on the respective activities.<sup>7</sup>

### 3 Endogenous Home Production and Search Intensity

In this section, we follow [Pissarides \(2000\)](#) in building a model with endogenous search intensity. While employed workers simply work at the equilibrium wage, unemployed workers decide what proportion of time to devote to search and work from home. The main finding is that search intensity is procyclical, which implies the opportunity cost of employment is countercyclical.

#### 3.1 Model

The model is closely related to [Pissarides \(1985\)](#), [Pissarides \(2000\)](#), and [Shimer \(2005\)](#). Time is discrete and indexed by  $t$ . There is a measure one of infinitely lived workers and a continuum of infinitely lived firms. Workers can either be employed or unemployed and have lifetime utility  $\mathbb{E}_0 \sum_{t=0}^{\infty} \delta^t y_t$  where  $y_t$  is income in period  $t$  and  $\delta$  is the discount factor

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<sup>7</sup>Despite the significant change in market hours over the Great Recession, our point estimates barely change if we restrict our analysis to the pre-recession period, 2003-2006.

common to workers and firms. Firms produce output using a constant returns technology with labor as its only input. Each unit of labor produces  $p_t$  units of output at time  $t$ . Firms can post a vacancy at a flow cost of  $c$ . Free entry of firms implies that the value of posting a vacancy is zero in equilibrium. Mathematically, firms' preferences can be expressed as  $\mathbb{E}_0 \sum_{t=0}^{\infty} \delta^t (p_t - w_t - cv_t)$ .

We depart from the standard formalization by assuming unemployed workers can spend their time in home production or looking for a job. Normalizing the unemployed worker's time endowment to one, let  $n$  and  $x$  denote home production and search intensity respectively. The home production function,  $g(n)$ , is strictly increasing, strictly concave and  $\lim_{n \rightarrow 0} g_n = \infty$  and  $\lim_{n \rightarrow \infty} g_n = 0$ .<sup>8</sup> Clearly, under this framework the transition probabilities depend not only on the number of vacancies and the unemployment rate, but also on the amount of time individuals devote to job search. That is, if workers search more intensely, a given level of vacancies and unemployment will translate into a greater number of matches. Denoting the intensity of search by individual  $i$  in period  $t$  as  $x_{i,t}$ , we can express the efficiency of searching workers as  $x_t u_t$ . This implies that the matching function at time  $t$  will now be  $m(x_t u_t, v_t)$ . Define labor market tightness as  $\theta_t = v_t/u_t$ . The probability a firm fills a job is  $m(x_t u_t, v_t)/v_t = q(\theta_t, x_t)$  and the average job finding rate is  $m(x_t u_t, v_t)/u_t = f(\theta_t, x_t)$ .

The value functions for a firm matched with a worker, a firm with a vacancy, an employed worker and an unemployed worker are given respectively by

$$\mathbb{J}_t = p_t - w_t + \delta \mathbb{E}_t [s \mathbb{V}_{t+1} + (1-s) \mathbb{J}_{t+1}] \quad (1)$$

$$\mathbb{V}_t = -c + \delta \mathbb{E}_t \{q(\theta_t, x_t) \mathbb{J}_{t+1} + [(1-q(\theta_t, x_t))] \mathbb{V}_{t+1}\} \quad (2)$$

$$\mathbb{W}_t = w_t + \delta \mathbb{E}_t [s \mathbb{U}_{t+1} + \delta(1-s) \mathbb{W}_{t+1}] \quad (3)$$

$$\mathbb{U}_t = \max_{\{x_{i,t}\}} z_g + g(1-x_{i,t}) + \delta \mathbb{E}_t \left\{ \frac{x_{i,t}}{x_t} f(\theta_t, x_t) \mathbb{W}_{t+1} + \left[ 1 - \frac{x_{i,t}}{x_t} f(\theta_t, x_t) \right] \mathbb{U}_{t+1} \right\}. \quad (4)$$

The opportunity cost of employment is the sum of government unemployment benefits,  $z_g$ , and home production,  $g(1-x_{i,t})$ . When deciding the time to devote to search, a worker takes aggregate probabilities and the search intensity of other workers as given. Workers are now moving from unemployment to employment at a rate  $m(x_t, u_t)/(x_t u_t)$ . Worker  $i$ , however, can affect the probability of obtaining a match by modifying her individual effort and so her individual probability is given by  $x_{i,t} m(x_t, u_t)/(x_t u_t)$ . In a symmetric Nash equilibrium, which is the equilibrium we focus on, all workers will choose the same level of

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<sup>8</sup>We closely follow the approach of [Pissarides \(2000\)](#) to model the worker's decision of how much time to devote to search.

search intensity,  $x_i = x_{-i} = x$ . Therefore, the optimality condition can be expressed as:

$$g_n(1-x) = \delta \frac{f(\theta_t, x_t)}{x_t} \mathbb{E}_t (\mathbb{W}_{t+1} - \mathbb{U}_{t+1}) \quad (5)$$

where the notation  $h_z$  denotes the derivative of function  $h$  with respect to variable  $z$ . Note that  $g_n(1-x) = -g_x(1-x)$ . The free-entry condition implies that in equilibrium  $\mathbb{V} = 0$ . Hence, the surplus of a match,  $\mathbb{S}$ , can be expressed as:

$$\begin{aligned} \mathbb{S}_t &= \mathbb{J}_t + (\mathbb{W}_t - \mathbb{U}_t) \\ &= p_t - z_g - g(1-x) + \delta [(1-s) - \beta f(\theta_t, x_t)] \mathbb{E}_t \mathbb{S}_{t+1}. \end{aligned} \quad (6)$$

Note that after taking into account the free-entry condition, Equation (2) can be written as:

$$c = \delta q(\theta_t, x_t) \mathbb{E}_t \mathbb{J}_{t+1}. \quad (7)$$

Wages are determined by generalized Nash bargaining. That is,  $w_t$  solves:

$$\operatorname{argmax}_{w_t} (\mathbb{W}_t - \mathbb{U}_t)^\beta (\mathbb{J}_t - \mathbb{V}_t)^{1-\beta}. \quad (8)$$

The solution to this optimization problem is

$$w_t = \beta p_t + (1-\beta) [z_g + g(1-x)] + \delta \beta f(\theta_t, x_t) \frac{c}{\delta q(\theta_t, x_t)}. \quad (9)$$

Finally, the flow equation for unemployment is

$$u_{t+1} = s(1-u_t) + [1-f(\theta_t, x_t)] u_t. \quad (10)$$

## 3.2 Comparative Statics

Combining the steady state of Equation (7) and Equation (6), we can write the first equilibrium condition:

$$\frac{c}{\delta q(\theta, x)} = \frac{(1-\beta) [p - z_g - g(1-x)] - \beta \theta c}{1 - \delta(1-s)}. \quad (11)$$

The second equilibrium equation comes from the first order condition in the problem faced by unemployed workers, equation (5). From the Nash bargaining we have  $\beta/(1-\beta)\mathbb{J} = \mathbb{W} - \mathbb{U}$ ; hence, we can solve Equation (7) for  $\mathbb{J}$  and substitute its steady-state value for  $\mathbb{W} - \mathbb{U}$  into

(5). This gives us

$$g_n(1-x) = \frac{\beta\theta c}{x(1-\beta)}. \quad (12)$$

**Proposition 1** *Under our assumptions about the home production technology, search intensity and labor market tightness are increasing in market productivity and so  $x_p > 0$  and  $\theta_p > 0$ .*

**Proof** See Appendix A.1.

Perhaps a better way of understanding the intuition underlying the steady-state comparative static results is to replace Equation (11), with the firm's job creation equation, which is simply Equation (1) evaluated in the steady-state equilibrium. Using the equilibrium wage and the firm's share of the surplus implies:

$$[1 - \delta(1-s)] \frac{c}{\delta q(\theta, x)} = (1-\beta)[p - z_g - g(1-x)] - \beta c \theta. \quad (13)$$

One can graph  $\theta$  as a function of  $x$  in  $(\theta, x)$  space. The function, labeled  $JC$ , is plotted in Figure 1. The positive slope of the  $JC$  curve follows from taking the total differential of (13) and solving for  $d\theta/dx$ :

$$\frac{d\theta}{dx} = \frac{[(1-\beta)g_n(1-x) + q_x\gamma]}{\beta c - q_\theta\gamma} > 0 \quad (14)$$

where  $\gamma = c[1 - \delta(1-s)]/\delta q^2(\theta, x)$ . Similarly, using Equation (12) one can graph  $\theta$  as a function of  $x$ . The function, labeled  $HP_{var}$ , is also plotted in Figure 1 which provides intuition behind the amplification due to the presence of endogenous home production. Taking the total differential of (12) and solving for  $d\theta/dx$  gives us:

$$\frac{d\theta}{dx} = \frac{g_n(1-x) - xg_{nn}(1-x)}{c\beta} > 0 \quad (15)$$

where the sign follows from  $g_n > 0$  and  $g_{nn} < 0$ . The final curve in Figure 1, labeled  $HP_{fix}$ , depicts the case of exogenous search intensity. When search intensity is fixed,  $x$  cannot respond to changes in  $\theta$ . Finally, we have the following propositions regarding the equilibrium:

**Proposition 2 (Existence)** *Under our assumptions of the home production technology, there is a steady-state equilibrium provided that government provided unemployment benefits are not too large.*

**Proof** See Appendix A.2.

**Proposition 3 (Uniqueness)** *Provided a steady-state equilibrium exists, it is unique.*

**Proof** See Appendix A.3.

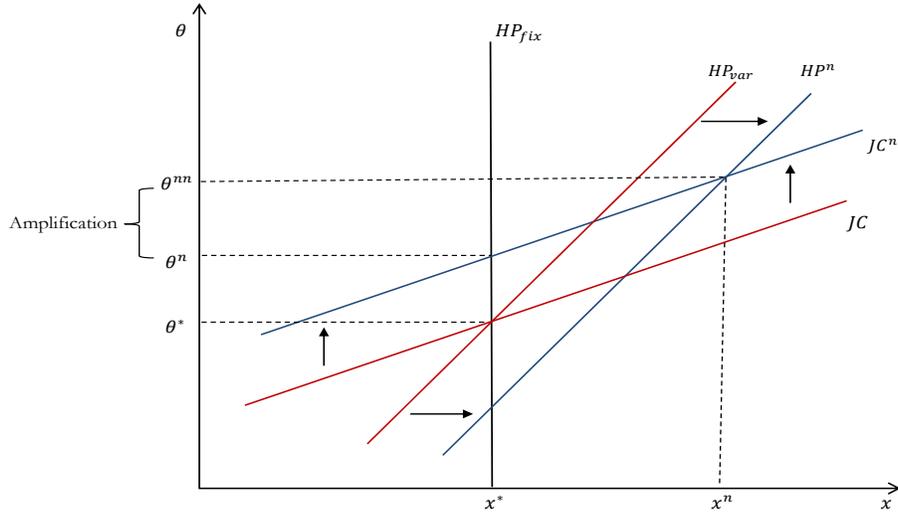


Figure 1: Amplification Effect of Endogenous Home Production

In Appendix A.3, we prove  $HP_{var}$  is everywhere steeper than  $JC$  implying that the curves cross no more than once. What is the intuition behind both  $JC$  and  $HP_{var}$  curves having a positive slope? When  $\theta$  is high, the chances of finding a job for a given search intensity increase so workers devote less time to home production and more time to search. However, since workers devote more time to search, firms find that posting vacancies is increasingly profitable, which leads to more vacancies, and therefore, a higher  $\theta$ . In other words, there is a complementarity between workers' search decisions and firms' job creation decisions.

When there is a permanent increase in productivity, as depicted in Figure 1, the  $HP_{var}$  curve shifts right and the  $JC$  curve shifts left implying a move to a new equilibrium  $(x^n, \theta^n)$ . Higher steady-state productivity increases the match surplus which simultaneously induces unemployed workers to search more intensely and firms to post more vacancies. However, if search intensity is exogenous, as with  $HP_{fix}$ , the new equilibrium is  $(x^*, \theta^n)$ . The fact that workers cannot increase search intensity significantly dampens the response of labor market variables, which follow from movements in  $\theta$ .

### 3.3 Calibration

One period in our model corresponds to one week in the data. We choose parameter values that are either consistent with empirical estimates or are calibrated so the steady

state in the model matches features in the data. The values for the parameters used in the baseline calibration are shown in Table 2.

We set  $\delta = 0.999$  to match an annual risk free interest rate return of four percent and  $s = 0.008$  so that jobs last two and a half years on average. As it is standard, we adopt a constant returns to scale Cobb-Douglas matching function,  $m(xu, v) = \nu(xu)^\alpha v^{1-\alpha}$ , where the novelty here is the appearance of the worker's search intensity term.

We choose the worker's steady-state search intensity,  $x$ , so that the amount of time spent working at home,  $1 - x$ , equals the difference in home hours by employed and unemployed people normalized by the average length of a work week for an employed worker. Using the ATUS data, this implies

$$1 - x = \frac{29.03 - 18.05}{47.00} = 0.23.$$

While it might seem implausible that unemployed workers spend 77% percent of their time endowment on search activities, we do not take this interpretation too literally.<sup>9</sup> Indeed, in the standard framework, unemployed workers implicitly devote all of their time to search activity. In our framework, we think of time spent on home production as time workers are not eligible to bump into a job.

We follow [Hagedorn and Manovskii \(2008\)](#) who match a monthly job finding rate,  $f(\theta)$ , of 0.45 and normalize  $\theta$  to equal one in steady state. As in [Shimer \(2005\)](#), we take  $z_g = 0.4$ ,  $\alpha = 0.72$ , and choose the worker's bargaining power so that the steady-state solution satisfies the Hosios condition ([Hosios \(1990\)](#)).<sup>10</sup> The latter requires  $\beta = \alpha$ . The match efficiency parameter is pinned down by  $\nu = f(\theta, x)/x^\alpha = 0.192$ .

The home production function is given by  $g(1 - x) = A_h(1 - x)^\phi$ , with  $A_h > 0$  and  $0 < \phi < 1$ .<sup>11</sup> We are not aware of estimates on the home production technology and therefore take  $\phi = 0.5$  in the baseline and consider a variety of robustness exercises later in the paper. The remaining two parameters,  $c$  and  $A_h$ , are jointly calibrated by evaluating the free entry condition and the unemployed worker's optimization condition in steady state.

$$c = \delta q(1 - \beta) \frac{p - z_g - A_h(1 - x)^\phi}{1 - \delta(1 - s - \beta f)}$$

$$A_h \phi (1 - x)^{\phi-1} = \frac{\theta c \beta}{x(1 - \beta)}.$$

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<sup>9</sup>Additionally, there are very few nonzero observations of search time in the data, therefore finding a precise estimate is problematic. In Appendix B.2, Table 6 shows that less than 20 percent of unemployed workers spend time searching for a job on a given day.

<sup>10</sup>As shown in [Rogerson et al. \(2005\)](#), the Hosios condition generalizes to an environment of endogenous search intensity that we consider here.

<sup>11</sup>Strict concavity of the production function is necessary for the existence of a solution.

These two equations pin down  $A_h$  and  $c$  whose respective values are 0.439 and 0.352.

Table 2: Value of Parameters

Parameter	Description	Value
$\delta$	Household's discount factor	0.999
$s$	Exogenous separation	0.008
$c$	Cost of posting a vacancy	0.352
$\alpha$	Elasticity of matches w.r.t. unemployment	0.720
$\beta$	Worker's bargaining power	0.720
$\nu$	Efficiency of the match	0.192
$z_g$	Government provided unemployment benefits	0.400
$A_h$	Home productivity	0.439
$x$	Search intensity	0.770
$\phi$	Curvature of the home production function	0.500
$\rho_p$	Persistence of productivity process	0.994
$\sigma_p$	Standard deviation of productivity process	0.003

Finally, we assume that log labor productivity has a mean of zero and follows the autoregressive process:  $\ln p_t = \rho_p \ln p_{t-1} + \epsilon_{p,t}$  with  $\epsilon_{p,t} \sim \mathcal{N}(0, \sigma_p^2)$ . We discretize the continuous process using the Rouwenhorst method.<sup>12</sup> We select  $\rho_p$  and  $\sigma_p$  to simultaneously match the autocorrelation and volatility of HP filtered log output per worker with a smoothing parameter of  $10^5$ . From 1951-2014 the quarterly standard deviation and autocorrelation of output per worker in the nonfarm business sector was 0.019 and 0.896 respectively. This requires  $\sigma_p = 0.0030$  and  $\rho_p = 0.994$ . After simulating the model, we aggregate the weekly results into quarters and present the quarterly results in all the tables that follow.

### 3.4 Results

Panel A of Table 3 shows the second moments of the labor market variables in the data. As is well known, the standard deviations of unemployment, vacancies, and labor market tightness are an order of magnitude larger than the standard deviation of productivity. The correlation between unemployment and vacancies, i.e. the Beveridge curve, is also strongly negative.

How well does the model without home production do in matching these facts? As Panel B shows, the model performs quite poorly. The standard deviation of unemployment is more than 20 times smaller than in the data and the standard deviations of vacancies and

<sup>12</sup>Kopeccky and Suen (2010) show that the Rouwenhorst method has more desirable properties than the more commonly used Tauchen and Hussey (1991) method, in particular for highly persistent autoregressive processes.

labor market tightness are also quite low. However, the model produces a strong negative correlation between unemployment and vacancies.

Table 3: Business Cycle Statistics

<b>Panel A: U.S. Data: 1951Q1 - 2014Q4</b>						
	$u$	$v$	$v/u$	$f$	$p$	
$\sigma$	0.1953	0.2066	0.3456	0.1322	0.0198	
$\rho$	0.9450	0.9500	0.9431	0.9194	0.8968	
	$u$	1	-0.8970	-0.9615	-0.9432	-0.3320
	$v$		1	0.9389	0.8662	0.3915
Correlation	$v/u$			1	0.8997	0.4193
Matrix	$f$				1	0.3229
	$p$					1
<b>Panel B: Standard Model</b>						
	$u$	$v$	$v/u$	$f$	$p$	
$\sigma$	0.0082	0.0237	0.0316	0.0088	0.0192	
$\rho$	0.9276	0.0874	0.8987	0.8987	0.8987	
	$u$	1	-0.9518	-0.9731	-0.9731	-0.9730
	$v$		1	0.996p	0.9969	0.9968
Correlation	$v/u$			1	1	0.9999
Matrix	$f$				1	0.9999
	$p$					1
<b>Panel C: Variable Home Production</b>						
	$u$	$v$	$v/u$	$f$	$p$	
$\sigma$	0.0434	0.0426	0.0837	0.0471	0.0198	
$\rho$	0.9237	0.8068	0.8958	0.8947	0.8971	
	$u$	1	-0.8939	-0.9734	-0.9738	-0.9615
	$v$		1	0.9728	0.9702	0.9691
Correlation	$v/u$			1	0.9989	0.9919
Matrix	$f$				1	0.9848
	$p$					1

*Notes:* The data used to construct Panel A were obtained from the BLS, as described in Appendix B.1. For both Panel B and Panel C, the moments reported were obtained using our baseline calibration. We generate the equivalent to 20,000 data sets ( $N$ ) with 256 observations each ( $T$ ) – which corresponds to the number of quarterly observations for the period 1951Q1–2014Q4 – employing a “burn-in” period of 1,000 observations and present the averages across these data sets. Panel B presents the unconditional moments obtained from the baseline search model without home production. Moments in Panel C correspond to the model with endogenous home production. In both panels,  $\sigma$  represents standard deviation and  $\rho$  quarterly autocorrelation. Values for the variables are reported as log-deviations from an HP trend with smoothing parameter of  $10^5$ .

Panel C shows the results with endogenous home production and search intensity. The standard deviation of unemployment increases by a factor of five and the standard deviation of labor market tightness more than doubles. At the same time, the Beveridge curve relationship is not only preserved, but almost exactly hits the exact correlation in the data. All of these are improvements to the baseline model.

Since search intensity is procyclical, the flow utility of unemployment is countercyclical

and has about the same standard deviation as productivity. In contrast, CRK find that the opportunity cost of employment is quite volatile and procyclical regardless of its level. While we do not include most of the numerous items CRK account for, our results suggest that the tradeoff between home production and search intensity significantly affects labor market volatilities. Put differently, our results indicate that if CRK had formalized this tradeoff in their model, the flow utility of unemployment would certainly be less procyclical.

### 3.5 Decomposing the Effects of Home Production

As [Hagedorn and Manovskii \(2008\)](#) show, labor market volatilities increase as the steady-state level of unemployment benefits increase. To decompose the steady-state effect from the endogenous search intensity effect, we solve and simulate the model with exogenous search intensity, but keep the steady-state value of the flow utility of unemployment equal to what it is in our model with endogenous search intensity. [Table 4](#) displays the results.

Table 4: Fixed Home Production

	$u$	$v$	$v/u$	$f$	$p$
$\sigma$	0.0131	0.0377	0.0504	0.0141	0.0197
$\rho$	0.9240	0.8735	0.8968	0.8968	0.8969
	$u$	1	-0.9561	-0.9755	-0.9751
	$v$		1	0.9971	0.9965
Correlation	$v/u$		1	1	0.9994
Matrix	$f$			1	0.9994
	$p$				1

*Notes:* The moments reported are averages across 20,000 data sets ( $N$ ) with 256 observations each ( $T$ ) – which corresponds to the number of quarterly observations for the period 1951Q1–2014Q4 – employing a “burn-in” period of 1,000 observations, from the model in which the value of home production is exogenously set to its steady-state value. The parameters are set to their baseline values or are calibrated as described in the text. In the table,  $\sigma$  represents standard deviation and  $\rho$  quarterly autocorrelation. Values for the variables are reported as log-deviations from an HP trend with smoothing parameter of  $10^5$ .

The standard deviations of the labor market variables are much closer to those of [Panel B](#) than [Panel C](#) of [Table 3](#), implying that most of the improvement to the baseline model comes from the endogenous search intensity rather than the increase in the level of unemployment benefits. This is further demonstrated through the impulse response function of labor market tightness in response to a productivity shock. [Figure 2](#) shows the how labor market tightness changes in response to a one standard deviation increase in productivity. Labor market tightness increases by much more in the model with endogenous home production and stays higher over the entire time horizon. Consequently, the endogenous tradeoff between search intensity and home production amplifies labor market variables more than an increase in the steady-state flow value of unemployment.

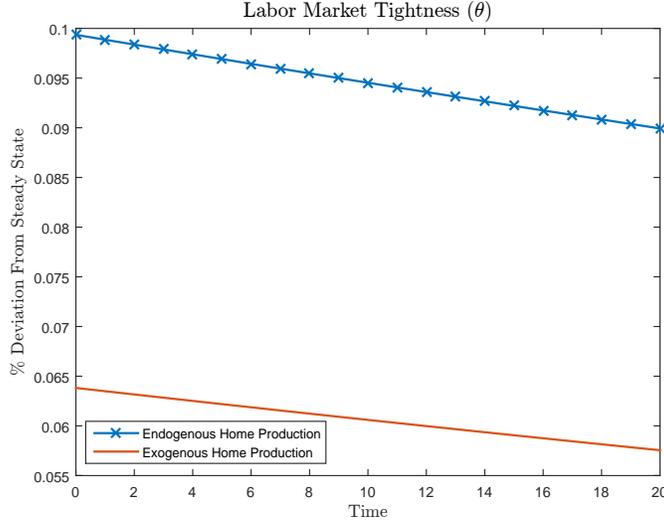


Figure 2: Labor Market Tightness Impulse Response

### 3.6 Robustness Exercises

The primary concern with the results in the last section is the extent to which they are driven by our choice of parameters in the home production function. The other parameters are relatively standard. Table 7 in the Appendix C shows the results for  $\phi = 0.3$  and  $\phi = 0.7$ . For each choice of  $\phi$  we recalibrate  $c$  and  $A_h$  to match the steady-state targets from our original calibration. In Panel A we set  $\phi = 0.3$  and fix the value of home production, whereas home production is endogenous in Panel B. The second moments in Panel A are very similar to Table 4, while the results in Panel B are similar to the results in Panel C of Table 3. Alternatively, raising the value of  $\phi$  to 0.7, as in Panels C and D, increases the volatilities in the endogenous home production case. Also, in the endogenous case, the correlation between vacancies and unemployment increases as  $\phi$  increases. Taken together these results suggest that the curvature parameter starts to significantly affect the results for some value greater than 0.5.

To investigate this question more thoroughly, Figure 3 presents some results over a range of  $\phi$ . We plot two lines on each figure. One of them keeps  $c$  and  $A_h$  fixed at their baseline value while the other recalibrates them to match the steady-state targets. The top two panels show that the volatilities of labor market tightness and the worker's outside option increase at an accelerating rate around  $\phi = 0.6$ . Similarly, as  $\phi$  rises above 0.6, the correlation between the worker's outside option and productivity starts to rapidly rise. Fixing  $c$  and  $A_h$  to their baseline values, on the other hand, dampens this increase in volatilities. These results suggests that any choice of  $\phi$  below 0.6 does not significantly affect the results.

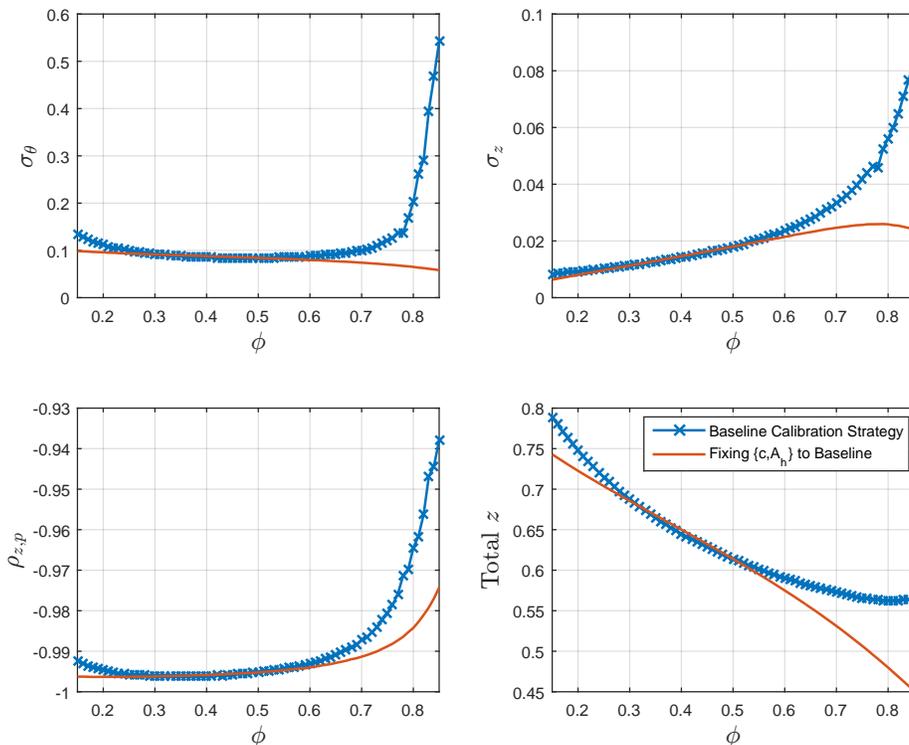


Figure 3: Quantitative Effects of Different Calibration Strategies

*Notes:* Each moment described in the vertical axis, is obtained as an average across 10,000 data sets of 256 quarters each – corresponding to the number of quarterly observations for the period 1951Q1-2014Q4 – employing a “burn-in” period of 1,000. With the exception of the parameter that disciplines the curvature of the home production function,  $\phi$ , the remaining parameters are set to their baseline values or are calibrated as described in the text.  $\sigma_y$ ,  $\rho_y$ , and  $\rho_{y,\omega}$  represent, respectively, the standard deviation of variable  $y$ , the quarterly autocorrelations of variable  $y$ , and the quarterly cross correlation of variables  $y$  and  $\omega$ . Except for Total  $z$ , which represents the total unfiltered outside option in the model  $(z_g + A_h(1-x)^\phi)$ , the moments are reported as log-deviations from an HP trend with smoothing parameter of  $10^5$ .

Next, we investigate how sensitive the results are to a change in the matching function parameter,  $\alpha$ . Following Shimer, we take  $\alpha = 0.72$  in the baseline. However, [Mortensen and Nagypal \(2007\)](#) contend that this is outside the plausible range of estimates for the parameter. Citing [Petrongolo and Pissarides \(2001\)](#), they claim that an upper bound is around 0.7 and the lower bound is around 0.5. We simulate the model for  $\alpha = 0.5$  while preserving the Hosios condition implying  $\beta = 0.5$ . The results, displayed in Table 5, show that this change tends to amplify labor market variables and raise the correlation between unemployment and vacancies. In any case, our results are not qualitatively different for lower values of  $\alpha$  that are reasonable.

As a final exercise, we consider how much we need to adjust other parameters in the model with exogenous home production to match the volatility of labor market tightness in the model with endogenous home production. First, we ask what value of  $z_g$  in the exogenous home production case matches the volatility in the endogenous home production case. It

turns out  $z_g$  must be raised by 59 percent to 0.6375 for the results to be identical. Also, as [Mortensen and Nagypal \(2007\)](#) show, the volatility of labor market tightness is decreasing in the elasticity of matches with respect to unemployment. We therefore lower the value of  $\alpha$  until the volatility of labor market tightness with exogenous home production matches the volatility with endogenous home production. We move the worker’s bargaining power in tandem with  $\alpha$  so the Hosios condition is preserved. In this case we need  $\alpha = \beta = 0.0543$  to match the volatilities, which is clearly outside the plausible range. The conclusion of all these robustness exercises is that the endogenous tradeoff between home production and search intensity continues to be a powerful amplification mechanism of labor market variables over a wide range of parameter values.

Table 5: Endogenous Home Production with  $\alpha = \beta = 0.5$

	$u$	$v$	$v/u$	$f$	$p$
$\sigma$	0.0549	0.0344	0.0856	0.0596	0.0197
$\rho$	0.9239	0.7309	0.8953	0.8947	0.8967
	$u$	1	-0.8265	-0.9737	-0.9736
	$v$		1	0.9273	0.9269
Correlation	$v/u$			1	0.9996
Matrix	$f$				1
	$p$				

*Notes:* The moments reported are averages across 20,000 data sets ( $N$ ) with 256 observations each ( $T$ ) – which corresponds to the number of quarterly observations for the period 1951Q1–2014Q4 – employing a “burn-in” period of 1,000 observations, from the model with endogenous home production. Except for  $\alpha$  and  $\beta$ , the parameters are set to their baseline values or are calibrated as described in the text. In the table,  $\sigma$  represents standard deviation and  $\rho$  quarterly autocorrelation. Values for the variables are reported as log-deviations from an HP trend with smoothing parameter of  $10^5$ .

## 4 Conclusion

This paper introduces home production into an otherwise standard labor search model. By incorporating information from the American Time Use Survey we identify parameters in the home production function. There is convincing evidence that unemployed workers devote more time to home production than employed workers, regardless of how narrowly home production is defined or how the population is partitioned into employment status. We are the first ones to exploit this information in the context of a search and matching model.

The main result is that including endogenous search intensity causes the opportunity cost of employment to move countercyclically. An increase in productivity encourages unemployed workers to spend more time looking for a job and less time working on home

production activities. This amplifies labor market variables and generally improves the quantitative performance of standard search and matching models.

Although our findings contrast with [Chodorow-Reich and Karabarbounis \(Forthcoming\)](#), who find that the opportunity cost of employment is procyclical, we view our work as complementary. The opportunity cost is the product of many endogenous choices and public policies, some of which are subtle and hard to measure. As [Chodorow-Reich and Karabarbounis \(Forthcoming\)](#) emphasize, however, understanding the properties of this opportunity cost is critical to how we think about unemployment over the business cycle. In that regard, we have demonstrated that endogenous search intensity should not be ignored.

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# A Proofs

## A.1 Proposition 1

Start by differentiating the two equilibrium conditions, (11) and (12), with respect to productivity to obtain

$$-\frac{c}{\delta q(\theta, x)^2} (q_\theta \theta_p + q_x x_p) = \frac{(1-\beta)(1+g_n x_p) - \beta c \theta_p}{1-\delta(1-s)} \quad (16)$$

and

$$(g_n - g_{nn}x) x_p = \frac{c\beta}{1-\beta} \theta_p \quad (17)$$

where the notation  $y_z$  represents the partial derivative of the function  $y$  with respect to variable  $z$ . After arranging terms we can express equations (16) and (17) in matrix form,

$$\begin{bmatrix} g_n - g_{nn}x & -\frac{\beta c}{(1-\beta)} \\ (1-\beta)g_n + [1-\delta(1-s)]\frac{cq_x}{\delta q(\theta, x)^2} & [1-\delta(1-s)]\frac{cq_\theta}{\delta q(\theta, x)^2} - \beta c \end{bmatrix} \begin{bmatrix} x_p \\ \theta_p \end{bmatrix} = \begin{bmatrix} 0 \\ -(1-\beta) \end{bmatrix}. \quad (18)$$

Using Cramer's rule we have that

$$x_p = -\frac{\beta c}{|H|} \quad (19)$$

and

$$\theta_p = -\frac{(1-\beta)(g_n - g_{nn}x)}{|H|}. \quad (20)$$

Since  $g_{nn} < 0$ , in both expressions the numerators are positive. The determinant of the Hessian is given by,

$$|H| = (g_n - g_{nn}x) [1-\delta(1-s)] \frac{cq_\theta}{\delta q(\theta, x)^2} + g_{nn}x\beta c \frac{c\beta}{1-\beta} [1-\delta(1-s)] \frac{cq_x}{\delta q(\theta, x)^2}.$$

Since  $q_\theta = -q_x(x/\theta)$ , this expression can be further simplified:

$$|H| = g_{nn}x\beta c + [1-\delta(1-s)] \frac{cq_x}{\delta q(\theta, x)^2} \left[ \frac{c\beta}{(1-\beta)} - (g_n - g_{nn}x) \frac{x}{\theta} \right]. \quad (21)$$

Finally, using the equilibrium condition for search intensity, given by equation (12) the Hessian can be written as

$$|H| = g_{nn}x\beta c + [1-\delta(1-s)] \frac{cx^2 q_x g_{nn}}{\delta \theta q(\theta, x)^2}. \quad (22)$$

Since  $g_{nn} < 0$  and  $q_x > 0$  the former expression is negative. This implies that both comparative statics, (19) and (20), are positive. ■

## A.2 Proposition 2: Existence

The  $HP_{var}$  and  $JC$  curves are given, respectively, by:

$$g_n(1-x) = \theta \frac{\beta c}{(1-\beta)x}$$

$$\frac{c[1-\delta(1-s)]}{\delta q(\theta, x)} = (1-\beta)[p - z_g - g(1-x)] - \beta c \theta.$$

Solving explicitly for  $\theta$  in the first equation and substituting it into the second and exploiting the functional form of the matching function yields:

$$\frac{c[1-\delta(1-s)]}{\delta} \left( \frac{\beta c}{1-\beta} \right)^\alpha [g_n(1-x)]^\alpha - (1-\beta)[p - z_g - g(1-x)] + x(1-\beta)g_n(1-x) = 0.$$

To prove a steady state equilibrium exists, we need to show there is some  $x^*$  that solves the above equation. Let

$$\mathbb{F}(x) = \frac{c[1-\delta(1-s)]}{\delta} \left( \frac{\beta c}{1-\beta} \right)^\alpha [g_n(1-x)]^\alpha$$

$$- (1-\beta)[p - z_g - g(1-x)] + x(1-\beta)g_n(1-x).$$

$\mathbb{F}(x)$  is continuous on  $[0, 1)$ . Note also that on  $[0, 1)$ ,

$$\mathbb{F}'(x) = -\alpha \frac{c[1-\delta(1-s)]}{\delta} \left( \frac{\beta c}{1-\beta} \right)^\alpha [g_n(1-x)]^{(\alpha-1)} g_{nn}(1-x) - x(1-\beta)g_{nn}(1-x)$$

$$> 0$$

since  $g_{nn}(1-x) < 0$ . Then it follows that

$$\mathbb{F}(0) = A_1 (g_n|_{x=1})^\alpha - (1-\beta)[p - z_g - g(1)]$$

and by the Inada condition,

$$\lim_{x \rightarrow 1} \mathbb{F}(x) = A_1 \lim_{x \rightarrow 1} [g_n(1-x)]^\alpha - (1-\beta)[p - z_g - g(1)] + (1-\beta) \lim_{x \rightarrow 1} x g_n(1-x)$$

$$= \infty$$

where  $A_1$  is a positive constant. Hence, provided that

$$z_g < \frac{-A_1}{(1-\beta)} [g_n(1)]^\alpha + p - g(1)$$

$\mathbb{F}(0) < 0$  and there exists a  $x^*$  such that  $\mathbb{F}(x^*) = 0$ . ■

### A.3 Proposition 3: Uniqueness

If the worker's outside option is not too high, the curves cross at least once. Therefore, we need to show that the curves cross no more than once. This amounts to showing that the  $HP_{var}$  curve, (12), is everywhere steeper than the  $JC$  curve, (13). The two slopes are given respectively by (14) and (15), repeated here for convenience:

$$HP_{var} : \frac{d\theta}{dx} = \frac{g_n(1-x) - xg_{nn}(1-x)}{c\beta} \quad (23)$$

$$JC : \frac{d\theta}{dx} = \frac{(1-\beta)g_n(1-x) + q_x(\theta, x)\gamma}{\beta c - q_\theta(\theta, x)\gamma} \quad (24)$$

where  $\gamma$  is a positive constant. As shown in the text, both of these slopes are positive. Subtracting equation (24) from (23) and multiplying through by the denominators (which are both positive) yields:

$$[\beta c - q_\theta(\theta, x)][g_n(1-x) - xg_{nn}(1-x)] - c\beta [(1-\beta)g_n(1-x) + q_x(\theta, x)]. \quad (25)$$

Since  $m(xu, v)$  is homogenous of degree one,  $q(\theta, x)$  is homogenous of degree zero; therefore  $q_\theta(\theta, x)\theta = -q_x(\theta, x)x$ . Substituting this into (25),

$$\begin{aligned} & \left[ \beta c + \gamma \frac{x}{\theta} q_x(\theta, x) \right] [g_n(1-x) - xg_{nn}(1-x)] - c\beta [(1-\beta)g_n(1-x) + \gamma q_x(\theta, x)] \\ &= g_x(1-x) \left[ \beta c - \beta c(1-\beta) + \gamma \frac{x}{\theta} q_x(\theta, x) \right] - xg_{xx}(1-x) \left[ \beta c + \gamma \frac{x}{\theta} q_x \right] - c\beta \gamma q_x(\theta, x) \\ &= \gamma q_x(\theta, x) \left[ \frac{x}{\theta} g_n(1-x) - c\beta \right] - xg_{nn}(1-x) \left[ \beta c + \gamma \frac{x}{\theta} q_x \right] + \beta^2 c g_n(1-x) \\ &= \gamma q_x(\theta, x) \beta c \left[ \frac{\beta}{1-\beta} \right] - xg_{nn}(1-x) \left[ \beta c + \gamma q_x(\theta, x) \frac{x}{\theta} \right] + \beta^2 c g_n(1-x) \\ &> 0 \end{aligned}$$

where the first term in the last expression follows from (12). Since  $g(\cdot)$  is strictly increasing and strictly concave and  $q(\theta, x)$  is increasing in  $x$ , the inequality follows. ■

## B Data

### B.1 Description and Sources

In addition to making use of the ATUS data described in the main text, we construct vacancies,  $v$ , by using the method proposed by [Barnichon \(2010\)](#). To do so, we combine job openings from the [JOLTS](#) data set (Series JTS00000000JOL), the Help-Wanted Online Advertisement Index published by the [Conference Board](#) (Series HWOL), and the Help-Wanted Print Advertising Index that was discontinued in October 2008 and was also constructed by the [Conference Board](#). Unemployment,  $u$ , is the quarterly average of the monthly seasonally adjusted unemployment rate reported by the [BLS](#) (Series LNU04000000). Finally, productivity,  $p$ , is defined as output per job in the Nonfarm Business Sector also from the [BLS](#) (Series PRS85006163).

The data on time use comes from the multi-year microdata files obtained from the American Time Use Survey ([ATUS](#)) conducted by the [BLS](#). Multi-year microdata files apply the same definitions and weighting system to all observations across years.

The ATUS breaks activities into three tier categories, each of which is classified with two digits. The first tier is the most general and the third tier is the most specific. As an example, Laundry has the code 020102. It falls under the Housework category, 0201, and the Housework category falls under the Household Activities category, 02. So Laundry is a three tiered activity, Housework a two tiered category, and Household Activities a one tiered category. We follow [Aguiar et al. \(2013\)](#) as closely as possible in our time use classifications. There are some small differences because they use the 2010 lexicon to classify categories. Where we report only a two (four) digit category it means all the (four) six digit categories are included.

As mentioned in the text, we exclude all individuals younger than 18 and older than 65 and any day that is a holiday. We also exclude observations where the respondent reported insufficient detail, missing travel, recorder simultaneous activities, refused to provide information, or couldn't remember an activity. The time use figures are reported in minutes per day; we convert it to hours per week by multiplying by 7/60. All aggregate statistics we report weight all individual observations by the variable, `tufnwgtp`.

Table 6 reports means for various activities by employment status. We also report the percent of people within an employment status cell participating in that activity in any given day.

## B.2 Summary Statistics

Table 6: Summary Statistics 2003M01-2011M12

	(1) Market Work	(2) Job Search	(3) Home Production	(4) Care for Child	(5) Care for Others	(3)+(4)+(5) Total Home Production	Size Sample Size
Employed Full Time	47.00	0.04 (0.3%)	13.61 (82.1%)	3.48 (34.0%)	0.96 (11.9%)	18.05	50,356
Employed Part Time	26.23	0.20 (1.2%)	17.16 (86.9%)	5.38 (41.0%)	1.32 (15.1%)	23.86	10,446
Employed Absent	—	0.12 (1.0%)	23.79 (87.3%)	7.10 (38.0%)	1.38 (13.6%)	32.27	2,589
Out of the Labor Force	—	0.09 (0.6%)	23.54 (87.3%)	7.10 (37.8%)	1.61(13.5%)	32.24	16,223
Unemployed and Searching	—	3.56 (19.1%)	20.85 (86.9%)	5.80 (38.3%)	1.99 (16.1%)	28.64	3,623
Unemployed on Layoff	—	1.37 (6.0%)	24.44 (87.1%)	5.16 (35.7%)	2.31 (15.4%)	31.91	521
Total	31.90	0.26 (1.4%)	16.63 (84.1%)	4.63 (35.9%)	1.20 (12.9%)	22.46	83,758

*Notes:* With each  $x$ -digit corresponding to the categories used for the construction of each column, the table was constructed as follows: Market Work: 0501, 0502, 180501, 180502, and 180589; Job Search: 0504; Core Home Production: 0201, 0202, 020302, 020303, 020399, 020701, 020799, 020801, 020899, 020901, 020902, 020905, 020999, 029999, and 180280; Care for Child: 0301, 0302, 0303, 0401, 0402, 0403, 180381, and 180481; Care for Others: 0304, 0305, 039999, 0404, 0405, 049999, 180382, and 180382; Home production refers to the sum of core home production, home ownership activities, and consumer purchases.

## C Importance of Curvature Parameter

Table 7: Effects of Curvature of Home Production

<b>High Curvature: <math>\phi = 0.3</math></b>						<b>Low Curvature: <math>\phi = 0.7</math></b>						
<b>Panel A: Fixed Home Production</b>						<b>Panel C: Fixed Home Production</b>						
	$u$	$v$	$v/u$	$f$	$p$		$u$	$v$	$v/u$	$f$	$p$	
$\sigma$	0.0162	0.0467	0.0624	0.0175	0.0197	$\sigma$	0.0117	0.0339	0.0452	0.0127	0.0197	
$\rho$	0.9240	0.8732	0.8966	0.8966	0.8968	$\rho$	0.9241	0.8737	0.8970	0.8970	0.8970	
	$u$	1	-0.9559	-0.9754	-0.9754	-0.9746	$u$	1	-0.9561	-0.9756	-0.9756	-0.9753
	$v$		1	0.9971	0.9971	0.9960	$v$		1	0.9971	0.9971	0.9967
Correlation	$v/u$			1	1	0.9989	$v/u$			1	1	0.9996
Matrix	$f$				1	0.9989	$f$				1	0.9996
	$p$					1	$p$					1
<b>Panel B: Variable Home Production</b>						<b>Panel D: Variable Home Production</b>						
	$u$	$v$	$v/u$	$f$	$p$		$u$	$v$	$v/u$	$f$	$p$	
$\sigma$	0.0428	0.0510	0.0918	0.0464	0.0197	$\sigma$	0.0621	0.0439	0.1013	0.0686	0.0196	
$\rho$	0.9236	0.8266	0.8958	0.8949	0.8970	$\rho$	0.9220	0.7430	0.8917	0.8887	0.8967	
	$u$	1	-0.9128	-0.9737	-0.9740	-0.9635	$u$	1	-0.8263	-0.9695	-0.9697	-0.9386
	$v$		1	0.9818	0.9799	0.9776	$v$		1	0.9386	0.9335	0.9261
Correlation	$v/u$			1	0.9991	0.9929	$v/u$			1	0.9979	0.9751
Matrix	$f$				1	0.9871	$f$				1	0.9590
	$p$					1	$p$					1

*Notes:* The moments reported are averages across 20,000 data sets ( $N$ ) with 256 observations each ( $T$ ) – which corresponds to the number of quarterly observations for the period 1951Q1–2014Q4 – employing a “burn-in” period of 1,000 observations. Panels A and B simulate the model with a value of  $\phi = 0.3$  and fix all other parameters at their baseline values or are calibrated as described in the text. Home production is exogenous in Panel A, but endogenous in Panel B. Panels C and D simulate the model with a value of  $\phi = 0.7$  and fix all other parameters at their baseline values or are calibrated as described in the text. Home production is exogenous in Panel C, but endogenous in Panel D. In the table,  $\sigma$  represents standard deviation and  $\rho$  quarterly autocorrelation. Values for the variables are reported as log-deviations from an HP trend with smoothing parameter of  $10^5$ .