A. Appendix

A.1. Data

A.1.1. CPS Data construction

We adopt the occupational classification system used in Jaimovich and Siu (2012) that affords ease of data access and replication. The classification is based on the categorization of occupations in the 2000 Standard Occupational Classification system. Non-routine cognitive workers are those employed in "management, business, and financial operations occupations" and "professional and related occupations". Routine cognitive workers are those in "sales and related occupations" and "office and administrative support occupations". Routine manual occupations are "production occupations", "transportation and material moving occupations", "construction and extraction occupations", and "installation, maintenance, and repair occupations". Non-routine manual occupations are "service occupations". Detailed information on 3-digit occupational codes are available from the authors upon request.

A.1.2. Classification errors

Our ML approach classifies each person (at each point in time) into one of the four "likely" occupational groups (NRC, RC, NRM, and RM). However we present our main results aggregating to two workers types – NRC and non-NRC, hence Tables A1 and A2 show the confusion matrices for those two categories, separately for men and women respectively. In each matrix we add the precision (share of correctly classified objects within a predicted category) and recall (share of observed that were picked up by the prediction within a category) values.

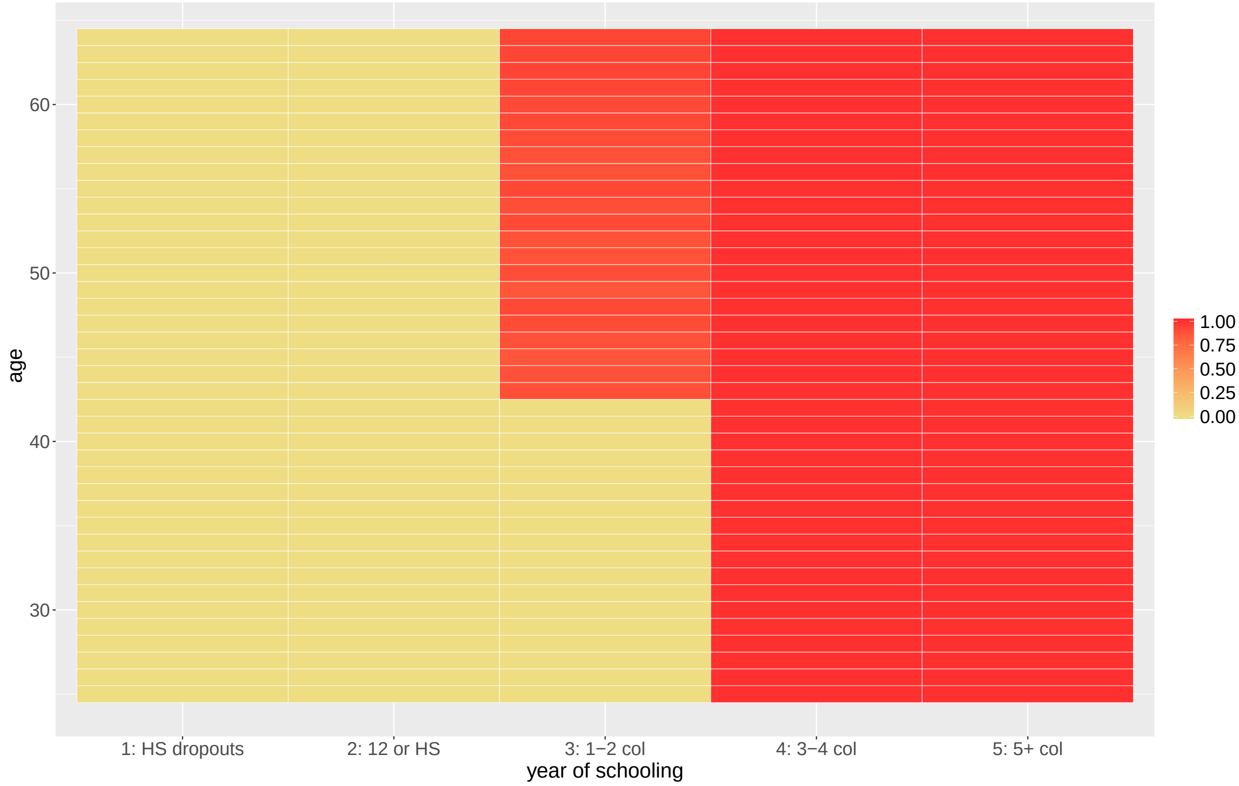
Table A1: Confusion Matrix - Men

		Classified		
		NRC	non-NRC	Precision
True	NRC	506,002	294,252	**63.23%**
	non-NRC	242,256	1,213,131	**83.35%**
	Recall	**67.62%**	**80.48%**	

Table A2: Confusion Matrix - Women

		Classified		
		NRC	non-NRC	Precision
True	NRC	342,362	150,507	**69.46%**
	non-NRC	241,376	1,167,622	**82.87%**
	Recall	**58.65%**	**88.58%**	

Figure A1: Probability of Non-Routine Cognitive by Cell



Notes: The probability of men in a specific education-age cell to be classified as non-NRC by the random forest algorithm.

A.1.3. Recovering true series from series with errors

The classification errors discussed in A.1.2 imply that we do not have "clean" series for the dynamics of NRC and non-NRC type persons. However, we show now that while we cannot recover correct the classification a the individual level, it is possible to correct the aggregate series of interest. Suppose that we are interested in recovering the share or persons of NRC and non-NRC types in specific labor force status, and call these x_{NRC}, and x_{NNRC}. Define our observed values from the classifier as $\hat{x}_{NRC}$, and $\hat{x}_{NNRC}$, and define the classification outcomes in terms of the following shares (with the convention $S_{True|Classified}$) as in Table A3:

Table A3: Classification Definitions

		Classified	
		NRC	non-NRC
True	NRC	$S_{NRC\|NRC}$	$S_{NRC\|NNRC}$
	non-NRC	$S_{NNRC\|NRC}$	$S_{NNRC\|NNRC}$

We can then write the observed values as a function of the true values and the share as follows

$$\begin{aligned}\hat{x}_{NRC} &= S_{NRC|NRC}x_{NRC} + S_{NNRC|NRC}x_{NNRC} \\ \hat{x}_{NNRC} &= S_{NRC|NNRC}x_{NRC} + S_{NNRC|NNRC}x_{NNRC}\end{aligned}$$

Thus if we know the shares in A3, we are left with a simple two-equation two-unknown linear system that will allow us to recover x_{NRC} and x_{NNRC}. The first way to recover the shares in A3 is to use the classification errors from the training, reported in section A.1.2. The second approach is to use the restrictions implied by nature by some of the series. For example, the series or true values of employment share in R occupations for the NRC type *during the training period*, should be roughly zero. While the second approach is appealing, it can only be applied to the occupation series, and not to the NLF series, for which we apply the first approach. It is important to note that both approaches require the assumption that the classification errors are not correlated with the labor market status and occupation choice in the post-training period.

A.1.4. Labor market status: Women

Table A4: Labor market status and occupation composition changes 1989-2017 by type: Women

	non-NRC		NRC	
	(1)	(2)	(3)	(4)
	1989	2017	1989	2017
Population Weight	0.76	0.57	0.24	0.43
Fraction in R	0.41	0.30	0.12	0.12
Fraction in NRM	0.15	0.20	~0	0.01
Fraction in NRC	0.02	0.05	0.74	0.72
Fraction in NLF	0.39	0.41	0.13	0.14
Fraction in Unemployment	0.03	0.04	0.01	0.02
Unemployment rate	0.06	0.07	0.01	0.01

Notes: The first row of the table reports the share of the population in the non-NRC and NRC groups for women aged 25-64 in 1989 and 2017. Rows 2-6 report the fraction of women in 5 labor market states: Employed in routine occupation (R); Employed in non-routine manual occupation (NRM); Employed in non-routine cognitive occupation (NRC); Not in the labor force (NLF); and unemployed. The last row reports the unemployment rate. The categorization into non-NRC and NRC groups was done using a random forest algorithm (see text for more details). CPS weights are applied in all calculations.

A.2. Model Derivations

A.2.1. Wage functions

Taking the first order condition with respect to wages we have

$$\tau\left(\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}\right)\left[U'\left(C_{e,R,\varepsilon}\right)\left(1-T_{e,R,\varepsilon}\right)-U'\left(C_{u,R,\varepsilon}\right)\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}\right]=\left(1-\tau\right)\left(\tilde{V}_{R,\varepsilon}\left(\Lambda\right)\right)\left(1-T_{\pi}\right)$$

or

$$\begin{aligned}\tilde{V}_{R,\varepsilon}\left(\Lambda\right) &= \left[U'\left(C_{e,R,\varepsilon}\right)\left(1-T_{e,R,\varepsilon}\right)-U'\left(C_{u,R,\varepsilon}\right)\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}\right]\frac{\tau}{1-\tau}\frac{1}{1-T_{\pi}}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}\\ &= \xi\frac{\tau}{1-\tau}\frac{1}{1-T_{\pi}}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}\end{aligned}$$

Where $\xi\equiv\left[U'\left(C_{e,R,\varepsilon}\right)\left(1-T_{e,R,\varepsilon}\right)-U'\left(C_{u,R,\varepsilon}\right)\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}\right]$. Substituting for the marginal value of workers, and using the first order condition one period ahead, we can right the left hand side as

$$\begin{aligned}\tilde{V}_{R,\varepsilon}\left(\Lambda\right) &= U\left(\omega_{R,\varepsilon}\left(1-T_{e,R,\varepsilon}\right)\right)-U\left(b_{R,\varepsilon}\omega_{R,\varepsilon}\left(1-T_{u,R,\varepsilon}\right)\right)+\beta\left(1-\delta-\mu\left(\theta_{R,\varepsilon_R}\right)\right)\tilde{V}_{R,\varepsilon}\left(\Lambda'\right)=\\ &= U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)+\beta\left(1-\delta-\mu\left(\theta_{R,\varepsilon_R}\right)\right)\xi\frac{\tau}{1-\tau}\frac{1}{1-T_{\pi}}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}\end{aligned}$$

Substitute for the marginal value of the firm we can write the right hand side as follows:

$$\begin{aligned}&\xi\frac{\tau}{1-\tau}\frac{1}{1-T_{\pi}}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}=\\ &\xi\frac{\tau}{1-\tau}\frac{1}{1-T_{\pi}}\left[\left(1-T_{\pi}\right)\left(f_R\varepsilon_R P_R-\omega_{R,\varepsilon_R}\right)+\left(1-\delta\right)\beta\frac{\partial J\left(x'_{R,\varepsilon_R},\Lambda'\right)}{\partial x'_{R,\varepsilon_R}}\right]\end{aligned}$$

Therefore we have

$$U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)+\beta\left(1-\delta-\mu\left(\theta_{R,\varepsilon_R}\right)\right)\xi\frac{\tau}{1-\tau}\frac{1}{1-T_\pi}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}=$$
$$\xi\frac{\tau}{1-\tau}\frac{1}{1-T_\pi}\left[\left(1-T_\pi\right)\left(f_R\varepsilon_R P_R-\omega_{R,\varepsilon_R}\right)+\left(1-\delta\right)\beta\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}\right]$$
$$\Rightarrow$$
$$U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)-\beta\mu\left(\theta_{R,\varepsilon_R}\right)\xi\frac{\tau}{1-\tau}\frac{1}{1-T_\pi}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}=$$
$$\xi\frac{\tau}{1-\tau}\left(f_R\varepsilon_R P_R-\omega_{R,\varepsilon_R}\right)$$
$$\Rightarrow$$
$$\frac{1-\tau}{\tau}\frac{1}{\xi}\left(U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)\right)-\beta\mu\left(\theta_{R,\varepsilon_R}\right)\frac{1}{1-T_\pi}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}=$$
$$f_R\varepsilon_R P_R-\omega_{R,\varepsilon_R}$$
$$\Rightarrow$$
$$\omega_{R,\varepsilon_R}=f_R\varepsilon_R P_R-\frac{1-\tau}{\tau}\frac{1}{\xi}\left(U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)\right)+\beta\theta_{R,\varepsilon_R}q\left(\theta_{R,\varepsilon_R}\right)\frac{1}{1-T_\pi}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}$$

where we substitute the relationship $\mu\left(\theta_{R,\varepsilon_R}\right)=\theta_{R,\varepsilon_R}q\left(\theta_{R,\varepsilon_R}\right)$. Finally, we can use the steady state version of the first order condition for vacancies $\left(1-T_\pi\right)\kappa_{R,\varepsilon_R}=E\left[\beta q\left(\theta_{R,\varepsilon_R}\right)\frac{\partial J\left(x'_{R,\varepsilon_R},\Lambda'\right)}{\partial x'_{R,\varepsilon_R}}\right]$. This yields the general wage function

$$\omega_{R,\varepsilon_R}=f_R\varepsilon_R P_R-\frac{1-\tau}{\tau}\frac{1}{\xi}\left(U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)\right)+\theta_{R,\varepsilon_R}\kappa_{R,\varepsilon_R}=$$
$$f_R\varepsilon_R P_R-\frac{1-\tau}{\tau}\frac{U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)}{U'\left(C_{e,R,\varepsilon}\right)\left(1-T_{e,R,\varepsilon}\right)-U'\left(C_{u,R,\varepsilon}\right)\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}}+\theta_{R,\varepsilon_R}\kappa_{R,\varepsilon_R}$$

When we assume a CRRA utility function $U\left(C\right)=\frac{C^{1-\sigma}}{1-\sigma}$ and that there are no lump sum transfers to workers who are in the labor force then we can simplify further:

$$
\begin{aligned}
&\frac{U\left(C_{e,R,\varepsilon}\right)-U\left(C_{u,R,\varepsilon}\right)}{U'\left(C_{e,R,\varepsilon}\right)\left(1-T_{e,R,\varepsilon}\right)-U'\left(C_{u,R,\varepsilon}\right)\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}}=\\
&\frac{\frac{\left(C_{e,R,\varepsilon}\right)^{1-\sigma}}{1-\sigma}-\frac{\left(C_{u,R,\varepsilon}\right)^{1-\sigma}}{1-\sigma}}{\left(C_{e,R,\varepsilon}\right)^{-\sigma}\left(1-T_{e,R,\varepsilon}\right)-\left(C_{e,R,\varepsilon}\right)^{-\sigma}\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}}=\\
&\frac{1}{1-\sigma}\frac{\left(\omega_{R,\varepsilon_R}\left(1-T_{e,R,\varepsilon}\right)\right)^{1-\sigma}-\left(b_{R,\varepsilon}\omega_{R,\varepsilon_R}\left(1-T_{u,R,\varepsilon}\right)\right)^{1-\sigma}}{\left(\omega_{R,\varepsilon_R}\left(1-T_{e,R,\varepsilon}\right)\right)^{-\sigma}\left(1-T_{e,R,\varepsilon}\right)-\left(b_{R,\varepsilon}\omega_{R,\varepsilon_R}\left(1-T_{u,R,\varepsilon}\right)\right)^{-\sigma}\left(1-T_{u,R,\varepsilon}\right)b_{R,\varepsilon}}=\\
&\frac{1}{1-\sigma}\frac{\left(\omega_{R,\varepsilon_R}\right)^{1-\sigma}\left(1-T_{e,R,\varepsilon}\right)^{1-\sigma}-\left(\omega_{R,\varepsilon_R}\right)^{1-\sigma}\left(1-T_{u,R,\varepsilon}\right)^{1-\sigma}b_{R,\varepsilon}^{1-\sigma}}{\left(\omega_{R,\varepsilon_R}\right)^{-\sigma}\left(1-T_{e,R,\varepsilon}\right)^{1-\sigma}-\left(\omega_{R,\varepsilon_R}\right)^{-\sigma}\left(1-T_{u,R,\varepsilon}\right)^{1-\sigma}b_{R,\varepsilon}^{1-\sigma}}=\\
&\frac{1}{1-\sigma}\frac{\left(\omega_{R,\varepsilon_R}\right)^{1-\sigma}\left[\left(1-T_{e,R,\varepsilon}\right)^{1-\sigma}-\left(1-T_{u,R,\varepsilon}\right)^{1-\sigma}b_{R,\varepsilon}^{1-\sigma}\right]}{\left(\omega_{R,\varepsilon_R}\right)^{-\sigma}\left[\left(1-T_{e,R,\varepsilon}\right)^{1-\sigma}-\left(1-T_{u,R,\varepsilon}\right)^{1-\sigma}b_{R,\varepsilon}^{1-\sigma}\right]}=\\
&\frac{1}{1-\sigma}\omega_{R,\varepsilon_R}
\end{aligned}
$$

and as a result the wage function simplifies to

$$
\begin{aligned}
&\omega_{R,\varepsilon_R}=f_R\varepsilon_R P_R+\theta_{R,\varepsilon_R}\kappa_{R,\varepsilon_R}-\frac{1-\tau}{\tau}\frac{1}{1-\sigma}\omega_{R,\varepsilon_R}\\
&\Rightarrow\\
&\omega_{R,\varepsilon_R}=\frac{1}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[f_R\varepsilon_R P_R+\theta_{R,\varepsilon_R}\kappa_{R,\varepsilon_R}\right]
\end{aligned}
$$

Armed with this wage function we move to the optimality condition for vacancies

$$
\frac{\kappa_{R,\varepsilon_R}}{q\left(\theta_{R,\varepsilon_R}\right)}=\beta\left[f_R\varepsilon_R P_R-\omega_{R,\varepsilon_R}+\left(1-\delta\right)\frac{\kappa_{R,\varepsilon_R}}{q\left(\theta_{R,\varepsilon_R}\right)}\right]
$$

Substituting the wage function we have

$$
\frac{\kappa_{R,\varepsilon_R}}{q\left(\theta_{R,\varepsilon_R}\right)}=\beta\left[f_R\varepsilon_R P_R-\frac{1}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[f_R\varepsilon_R P_R+\theta_{R,\varepsilon_R}\kappa_{R,\varepsilon_R}\right]+\left(1-\delta\right)\frac{\kappa_{R,\varepsilon_R}}{q\left(\theta_{R,\varepsilon_R}\right)}\right]
$$

and once we add the assumption that hiring cost if proportional to productivity we get

$$\frac{\kappa_0}{q\left(\theta_{R,\varepsilon_R}\right)} = \beta\left[1 - \frac{1}{1 + \frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1 + \theta_{R,\varepsilon_R}\kappa_0\right] + (1-\delta)\frac{\kappa_0}{q\left(\theta_{R,\varepsilon_R}\right)}\right]$$

$$\frac{\kappa_0}{q\left(\theta_{R,\varepsilon_R}\right)}(1 - \beta(1-\delta)) = \beta\frac{\frac{1-\tau}{\tau}\frac{1}{1-\sigma} - \theta_{R,\varepsilon_R}\kappa_0}{1 + \frac{1-\tau}{\tau}\frac{1}{1-\sigma}}$$

$$\kappa_0\left[\frac{1 - \beta(1-\delta)}{q\left(\theta_{R,\varepsilon_R}\right)} + \beta\frac{\theta_{R,\varepsilon_R}}{1 + \frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\right] = \beta\frac{\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}{1 + \frac{1-\tau}{\tau}\frac{1}{1-\sigma}}$$

$$\kappa_0 = \frac{\beta\frac{\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}}{\frac{1-\beta(1-\delta)}{q\left(\theta_{R,\varepsilon_R}\right)} + \beta\frac{\theta_{R,\varepsilon_R}}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}}$$

A.3. Productivity cutoffs

Denote the value of staying out of the labor force by $V_{o,\varepsilon}$, a constant number in steady state.

The value of employment in occupation R with idiosyncratic productivity ε_R is

$$V_{e,R,\varepsilon} = \frac{\left(\omega_{R,\varepsilon_R}\left(1-T_{e,R,\varepsilon_R}\right)\right)^{1-\sigma}}{1-\sigma} + \beta\left(1-\delta\right)V_{e,R,\varepsilon} + \beta\delta V_{u,R,\varepsilon}$$

$$V_{e,R,\varepsilon} = \frac{1}{1-\beta\left(1-\delta\right)}\left[\frac{\left(\frac{f_R\varepsilon_R P_R}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1+\theta_{R,\varepsilon_R}\kappa_0\right]\left(1-T_{e,R,\varepsilon_R}\right)\right)^{1-\sigma}}{1-\sigma}\right] + \frac{\beta\delta}{1-\beta\left(1-\delta\right)}V_{u,R,\varepsilon}$$

where we substituted the explicit wage function under the assumption of proportional hiring costs.

The value of unemployment in occupation R with idiosyncratic productivity ε_R is

$$V_{u,R,\varepsilon} = \frac{\left(b_{R,\varepsilon_R}\omega_{R,\varepsilon_R}\left(1-T_{u,R,\varepsilon_R}\right)\right)^{1-\sigma}}{1-\sigma} + \beta\left(1-\mu\left(\theta_{R,\varepsilon_R}\right)\right)V_{u,R,\varepsilon} + \beta\mu\left(\theta_{R,\varepsilon_R}\right)V_{e,R,\varepsilon}$$

$$V_{u,R,\varepsilon}\left(1-\beta\right) = \left[\frac{\left(b_{R,\varepsilon_R}\frac{f_R\varepsilon_R P_R}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1+\theta_{R,\varepsilon_R}\kappa_0\right]\left(1-T_{u,R,\varepsilon_R}\right)\right)^{1-\sigma}}{1-\sigma}\right] + \beta\mu\left(\theta_{R,\varepsilon_R}\right)\left[V_{e,R,\varepsilon}-V_{u,R,\varepsilon}\right]$$

Note that the first order condition of the bargaining problem implies that

$$V_{e,R,\varepsilon} - V_{u,R,\varepsilon} = \xi\frac{\tau}{1-\tau}\frac{1}{1-T_\pi}\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}}$$

and the first order condition with respect to vacancies implies that

$$\frac{\partial J\left(x_{R,\varepsilon_R},\Lambda\right)}{\partial x_{R,\varepsilon_R}} = \frac{\left(1-T_\pi\right)\kappa_0 P_R f_R\varepsilon_R}{\beta q\left(\theta_{R,\varepsilon_R}\right)}$$

Substituting, we have

$$V_{u,R,\varepsilon}\left(1-\beta\right) = \left[\frac{\left(b_{R,\varepsilon_R}\frac{f_R\varepsilon_R P_R}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1+\theta_{R,\varepsilon_R}\kappa_0\right]\left(1-T_{u,R,\varepsilon_R}\right)\right)^{1-\sigma}}{1-\sigma}\right]$$
$$+\theta_{R,\varepsilon_R}\xi\frac{\tau}{1-\tau}\kappa_0 P_R f_R\varepsilon_R$$

Now we can substitute for ξ, taking into account the CRRA assumption

$$\begin{aligned}\xi &= U'(C_{e,R,\varepsilon})(1-T_{e,R,\varepsilon}) - U'(C_{u,R,\varepsilon})(1-T_{u,R,\varepsilon})\, b_{R,\varepsilon} \\ &= (\omega_{R,\varepsilon_R})^{-\sigma}\left[(1-T_{e,R,\varepsilon})^{1-\sigma} - (1-T_{u,R,\varepsilon})^{1-\sigma} b_{R,\varepsilon}^{1-\sigma}\right] \\ &= \left(\frac{f_R\varepsilon_R P_R}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1+\theta_{R,\varepsilon_R}\kappa_0\right]\right)^{-\sigma}\left[(1-T_{e,R,\varepsilon})^{1-\sigma} - (1-T_{u,R,\varepsilon})^{1-\sigma} b_{R,\varepsilon}^{1-\sigma}\right]\end{aligned}$$

Therefore

$$\begin{aligned}V_{u,R,\varepsilon}(1-\beta) &= \left[\frac{\left(b_{R,\varepsilon_R}\frac{f_R\varepsilon_R P_R}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1+\theta_{R,\varepsilon_R}\kappa_0\right](1-T_{u,R,\varepsilon_R})\right)^{1-\sigma}}{1-\sigma}\right] \\ &+ \left(\frac{f_R\varepsilon_R P_R}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\left[1+\theta_{R,\varepsilon_R}\kappa_0\right]\right)^{-\sigma}\left[(1-T_{e,R,\varepsilon})^{1-\sigma} - (1-T_{u,R,\varepsilon})^{1-\sigma} b_{R,\varepsilon}^{1-\sigma}\right]\theta_{R,\varepsilon_R}\frac{\tau}{1-\tau}\kappa_0 P_R f_R \varepsilon_R \\ &= (f_R P_R \varepsilon_R)^{1-\sigma}\left[\begin{array}{l}\frac{\left(b_{R,\varepsilon_R}\frac{1+\theta_{R,\varepsilon_R}\kappa_0}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}(1-T_{u,R,\varepsilon_R})\right)^{1-\sigma}}{1-\sigma} + \\ \left(\frac{1+\theta_{R,\varepsilon_R}\kappa_0}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\right)^{-\sigma}\left[(1-T_{e,R,\varepsilon})^{1-\sigma} - (1-T_{u,R,\varepsilon})^{1-\sigma} b_{R,\varepsilon}^{1-\sigma}\right]\theta_{R,\varepsilon_R}\frac{\tau}{1-\tau}\kappa_0\end{array}\right]\end{aligned}$$

or

$$V_{u,R,\varepsilon} = \frac{(f_R P_R \varepsilon_R)^{1-\sigma}}{1-\beta}\left[\begin{array}{l}\frac{\left(b_{R,\varepsilon_R}\frac{1+\theta_{R,\varepsilon_R}\kappa_0}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}(1-T_{u,R,\varepsilon_R})\right)^{1-\sigma}}{1-\sigma} + \\ \left(\frac{1+\theta_{R,\varepsilon_R}\kappa_0}{1+\frac{1-\tau}{\tau}\frac{1}{1-\sigma}}\right)^{-\sigma}\left[(1-T_{e,R,\varepsilon})^{1-\sigma} - (1-T_{u,R,\varepsilon})^{1-\sigma} b_{R,\varepsilon}^{1-\sigma}\right]\theta_{R,\varepsilon_R}\frac{\tau}{1-\tau}\kappa_0\end{array}\right]$$

Note that the term in brackets is constant in steady state because it is a combination of exogenous parameters and the tightness ratio, which we have shown to be independent of the productivity parameters. Defining the term in brackets by $\daleth_R$ and the analogue for NRM by $\daleth_{NRM}$ we can express the values of unemployment in both occupations as

$$V_{u,R,\varepsilon} = \frac{(f_R P_R \varepsilon_R)^{1-\sigma}}{1-\beta} \daleth_R$$

$$V_{u,R,\varepsilon} = \frac{(f_{NRM} P_{NRM} \varepsilon_{NRM})^{1-\sigma}}{1-\beta} \daleth_{NRM}$$

A.4. Derivation of Change in Welfare by Group

The welfare change due to automation for those who switched form R to NRM is given by

$$\Delta_{R^{OLD}\rightarrow NRM^{NEW}} = \frac{\begin{bmatrix} \frac{UN_{\varepsilon_{NRM}}}{EMP_{\varepsilon_{NRM}}+UN_{\varepsilon_{NRM}}} \frac{\urcorner_{NRM}}{1-\beta} + \\ \frac{EMP_{\varepsilon_{NRM}}}{EMP_{\varepsilon_{NRM}}+UN_{\varepsilon_{NRM}}} \left(\frac{\frac{\left(1-\beta(1-\mu(\theta_{\varepsilon_{NRM}}))\right)}{1-\beta}\urcorner_R - \frac{b_{\varepsilon_{NRM}}^{1-\sigma}\left(1-T_{u,\varepsilon_{NRM}}\right)^{1-\sigma}}{1-\sigma}}{\beta\mu(\theta_{\varepsilon,NRM})} \right) \end{bmatrix}^{\frac{1}{1-\sigma}} f_{NRM} P_{NRM}^{NEW} E\left(\varepsilon_{NRm}\right)^{R^{OLD}\rightarrow NRM^{NEW}}}{\begin{bmatrix} \frac{UN_{\varepsilon_R}}{EMP_{\varepsilon_R}+UN_{\varepsilon_R}} \frac{\urcorner_R}{1-\beta} + \\ \frac{EMP_{\varepsilon_R}}{EMP_{\varepsilon_R}+UN_{\varepsilon_R}} \left(\frac{\frac{\left(1-\beta(1-\mu(\theta_{\varepsilon_R}))\right)}{1-\beta}\urcorner_R - \frac{b_{\varepsilon_R}^{1-\sigma}\left(1-T_{u,\varepsilon_R}\right)^{1-\sigma}}{1-\sigma}}{\beta\mu(\theta_{\varepsilon,R})} \right) \end{bmatrix}^{\frac{1}{1-\sigma}} f_R P_R^{OLD} E\left(\varepsilon_R\right)^{R^{OLD}\rightarrow NRM^{NEW}}}$$

which given our calibration targets can be simplified to

$$\Delta_{R^{OLD}\rightarrow NRM^{NEW}} = \frac{f_{NRM} P_{NRM}^{NEW} E\left(\varepsilon_{NRm}\right)^{R^{OLD}\rightarrow NRM^{NEW}}}{f_R P_R^{OLD} E\left(\varepsilon_R\right)^{R^{OLD}\rightarrow NRM^{NEW}}}$$

where we note that in the numerator we draw the ε_{NRM} abilities for these individuals that transitions to NRM.

The average change in welfare for R workers who leave the labor force is given by

$$\Delta_{R^{OLD}\rightarrow NLF^{NEW}} = \frac{\frac{1}{1-\beta}\frac{1}{1-\sigma}\left(b_O\right)^{\frac{1}{1-\sigma}}}{\begin{bmatrix} \frac{UN_{\varepsilon_R}}{EMP_{\varepsilon_R}+UN_{\varepsilon_R}} \frac{\urcorner_R}{1-\beta} + \\ \frac{EMP_{\varepsilon_R}}{EMP_{\varepsilon_R}+UN_{\varepsilon_R}} \left(\frac{\frac{\left(1-\beta(1-\mu(\theta_{\varepsilon_R}))\right)}{1-\beta}\urcorner_R - \frac{b_{\varepsilon_R}^{1-\sigma}\left(1-T_{u,\varepsilon_R}\right)^{1-\sigma}}{1-\sigma}}{\beta\mu(\theta_{\varepsilon,R})} \right) \end{bmatrix}^{\frac{1}{1-\sigma}} f_R P_R^{OLD} E\left(\varepsilon_R\right)^{R^{OLD}\rightarrow NLF^{NEW}}}$$

Note that by definition, there is an individual who is indifferent between participating in the labor force and not. Then, since the value of being outside of the labor force does not change in this analysis, we can rewrite the above expression as

$$\Delta_{R^{OLD}\rightarrow NLF^{NEW}} = \frac{\varepsilon_R^{*,OLD}}{E\left(\varepsilon_R\right)^{R^{OLD}\rightarrow NLF^{NEW}}}$$

The average change in the consumption equivalence for those who worked in Non-Routine Manual occupations, and continued working in Non-Routine Manual occupations is given by

$$\Delta_{NRM^{OLD}\rightarrow NRM^{NEW}} = \frac{P_{NRM}^{NEW}}{P_{NRM}^{OLD}}$$

The average change in consumption equivalent welfare for those who were outside the labor force and started working in Non-Routine-Manual occupations post-automation is given by

$$\Delta_{NLF^{OLD}\rightarrow NRM^{NEW}} = \left[\begin{array}{l} \frac{UN_{\varepsilon_{NRM}}}{EMP_{\varepsilon_{NRM}} + UN_{\varepsilon_{NRM}}} \frac{\daleth_{NRM}}{1-\beta} + \\ \frac{EMP_{\varepsilon_{NRM}}}{EMP_{\varepsilon_{NRM}} + UN_{\varepsilon_{NRM}}} \left(\frac{\frac{\left(1-\beta(1-\mu(\theta_{\varepsilon_{NRM}}))\right)}{1-\beta} \daleth_{NRM} - \frac{b_{\varepsilon_{NRM}}^{1-\sigma}\left(1-T_{u,\varepsilon_{NRM}}\right)^{1-\sigma}}{1-\sigma}}{\beta\mu(\theta_{\varepsilon,NRM})} \right) \end{array} \right]^{\frac{1}{1-\sigma}} \quad \frac{f_{NRM} P_{NRM}^{NEW} E\left(\varepsilon_{NRM}\right)^{NLF^{OLD}\rightarrow NRM^{NEW}}}{\frac{1}{1-\beta}\frac{1}{1-\sigma}\left(b_O\right)^{\frac{1}{1-\sigma}}}$$

As above, given the cutoff value of those individuals who are outside the labor force we can rewrite this expression as

$$\Delta_{NLF^{OLD}\rightarrow NRM^{NEW}} = \frac{P_{NRM}^{NEW} E\left(\varepsilon_{NRM}\right)^{NLF^{OLD}\rightarrow NRM^{NEW}}}{P_{NRM}^{OLD} \varepsilon_{NRM}^{*,OLD}}$$

A.5. Alternative calibration of ρ

Table A5: Alternative calibration with $\rho = 0.5$

	ICT Change	Retraining	UI	UBI	NLF Benefits	Taxation
Labor states						
ΦNLF	2.091	-2.149	-2.133	5.751	14.743	-5.013
ΦR	-3.896	0.526	1.584	-4.673	-11.279	3.709
ΦNRM	1.805	1.623	0.550	-1.078	-3.464	1.304
Emp Rate: R	0.950	0.000	0.945	0.945	0.950	0.950
Emp Rate: NRM	0.950	0.000	0.944	0.944	0.950	0.950
ΔY_{NRC}	1.200	0.379	0.119	-14.439	-7.858	-2.163
ΔY_{R}	-4.155	1.316	0.302	-4.648	-11.965	2.973
ΔY_{NRM}	9.664	4.144	-0.438	-3.548	-12.495	3.784
GDP						
ΔGDP	12.140	1.327	0.282	-9.920	-9.748	0.195
NRC Labor Tax						
ΦLabor NRC Tax	0.000	-1.524	-0.449	35.500	24.587	10.355
Labor Share						
Φ Agg Labor Share	-2.591	0.521	-2.617	0.000	-0.405	0.528
Wages						
$\Delta\omega_{R}$	-6.154	-0.093	0.516	-7.142	3.240	-4.112
$\Delta\omega_{NRM}$	2.149	-3.129	0.730	-6.139	2.747	-3.590
$\Delta\omega_{NRC}$	23.373	0.901	0.001	8.108	-3.587	4.451
$\Delta\omega_{NRC}$: After Tax	23.373	0.766	0.157	-11.240	-9.151	-2.606
Welfare: Consumption Equivalence						
Δ: R^{Old} -> R^{New}	-6.60	0.80	1.96	6.18	3.29	10.20
Δ: R^{Old} -> NRM^{New}	-1.70	NA	2.34	9.09	NA	10.50
Δ: R^{Old} -> NLF^{New}	-3.60	0.20	NA	26.50	16.50	NA
Δ: NRM^{Old} -> R^{New}	NA	-1.00	NA	NA	3.04	NA
Δ: NRM^{Old} -> NRM^{New}	2.50	-2.50	2.15	6.77	2.78	10.80
Δ: NRM^{Old} -> NLF^{New}	NA	-1.60	NA	27.08	16.27	NA
Δ: NLF^{Old} -> R^{New}	NA	NA	2.28	NA	NA	5.83
Δ: NLF^{Old} -> NRM^{New}	1.90	10.44	2.39	NA	NA	6.10
Δ: NLF^{Old} -> NLF^{New}	0.00	0.00	0.00	34.60	34.66	0.00
Δ: NRC^{Old} -> NRC^{New}	23.30	20.70	0.72	-21.70	-22.50	-5.30

Notes

Φ= Percentage Points change

Δ = Percenrate change

Table A6: Alternative calibration with $\rho = -0.5$

	ICT Change	Retraining	UI	UBI	NLF Benefits	Taxation
Labor states						
ΦNLF	2.258	-2.186	-2.356	6.202	15.624	-5.626
ΦR	-3.742	0.373	1.628	-4.897	-11.877	4.089
ΦNRM	1.484	1.733	0.723	-1.308	-3.837	1.533
Emp Rate: R	0.950	0.000	0.000	0.946	0.950	0.950
Emp Rate: NRM	0.950	0.000	0.000	0.946	0.950	0.950
ΔY_{NRC}	1.232	0.237	0.179	-13.886	-8.249	-1.882
ΔY_{R}	-3.335	0.053	-0.291	-5.671	-13.349	2.942
ΔY_{NRM}	5.458	6.160	-0.666	-4.868	-14.480	4.457
GDP						
ΔGDP	11.894	0.733	-0.256	-10.422	-10.900	-0.095
NRC Labor Tax						
ΦLabor NRC Tax	0.000	-1.281	-0.650	35.290	25.816	9.664
Labor Share						
Φ Agg Labor Share	-2.441	0.008	-2.547	-1.764	-0.438	0.108
Wages						
$\Delta\omega_{R}$	-7.231	0.091	-0.303	-7.447	2.917	-4.788
$\Delta\omega_{NRM}$	6.434	-5.453	0.443	-5.604	3.529	-4.406
$\Delta\omega_{NRC}$	23.224	0.696	-0.435	6.972	-4.443	4.241
$\Delta\omega_{NRC}$: After Tax	23.224	0.796	0.145	-14.375	-12.314	-3.051
Welfare: Consumption Equivalence						
Δ: R^{Old} -> R^{New}	-7.00	1.42	1.78	6.24	3.65	10.00
Δ: R^{Old} -> NRM^{New}	-0.40	NA	3.00	15.04	3.87	10.21
Δ: R^{Old} -> NLF^{New}	-4.30	NA	NA	25.70	16.30	NA
Δ: NRM^{Old} -> R^{New}	NA	-1.62	NA	NA	NA	NA
Δ: NRM^{Old} -> NRM^{New}	6.64	-4.35	2.50	7.99	4.10	10.43
Δ: NRM^{Old} -> NLF^{New}	NA	-2.55	NA	26.82	16.90	NA
Δ: NLF^{Old} -> R^{New}	NA	0.90	2.16	NA	NA	5.71
Δ: NLF^{Old} -> NRM^{New}	4.00	9.96	2.51	NA	NA	5.98
Δ: NLF^{Old} -> NLF^{New}	0.00	0.00	0.00	33.60	33.60	0.00
Δ: NRC^{Old} -> NRC^{New}	22.46	20.60	0.00	-22.50	-24.00	-5.30
Notes						
Φ= Percentage Points change						
Δ = Percenrate change						

A.6. Elasticity of unemployment duration to unemployment benefits

In the context of the UI and UBI experiment, a key channel through which these policies operate is via the bargaining problem and its impact on the wage and vacancies positing by firms. To discipline our analysis we required the model to match the elasticity of unemployment duration to unemployment benefits; different values of this elasticity have vastly different implications for the impact of different policy reforms. As such we require our model to match an elasticity value of 1, which is within the range of the empirical counterpart (see for example Meyer (1990) and Chetty (2008)).

What is the resulting elasticity in our current calibration? To evaluate this elasticity in the model we solve for the labor market equilibrium for different individuals and for different values of unemployment transfers. We then estimate the aggregate resulting tightness ratio and job finding rates, from which we calculate the elasticity of unemployment duration to unemployment transfers. We then find that the resulting elasticity is about 10, which is too high given empirical estimates. In bargaining models with curvature in the utility it is known that the higher the degree of risk aversion in the economy, the more sensitive is the bargained wage, and hence vacancy creation and job finding rates to change in unemployment benefits.

As such, we follow the approach in Yedid-Levi (2016) that allows us to match the elasticity of unemployment duration to unemployment benefits, while also allowing calibrate the utility with log preferences. In this modification we introduce an additional parameter that links the bargaining power of the worker with labor market tightness, in a way that tames the response of wages to changes in UI benefits. Formally, the bargaining power τ is now expressed as $\tau(\theta) = \frac{\tau_0}{\tau_0 + (1-\tau_0)\left(\frac{\theta^{ss}}{\theta}\right)^{\zeta}}$. Note that when $\zeta = 0$ then the model converges to the benchmark case with constant bargaining power. Importantly, this implies that this alternative parametrization of the model does not affect any of the results presented until Section 6 since the value of τ is not changed as long as the tightness ratio does not deviate from its steady state value. Indeed in Section 5 following the ICT price change the tightness ratio is not altered.

To identify ζ we repeat the discussed above analysis and reestimate the elasticity of unemployment duration to unemployment benefits until the model matches the micro elasticity, converging on a value of $\zeta = 20$. An alternative approach to lowering the duration elasticity is to choose a CRRA parameter that is substantially lower than 1. This is because in bargaining models with curvature in the utility function, higher risk aversion generates more sensitivity of wages and therefore vacancy creation and job finding rate. Importantly, adopting a lower value of σ does not alter any of the results until Section 6.

Thus to summarize, until section 6, given that the unemployment rate is constant, the elasticity of unemployment duration to unemployment benefits is quantitatively an irrelevant moment. In Section 6 where unemployment reacts to the changes in UI and UBI, we verify that the model matches the observed micro elasticity of unemployment duration to unemployment benefits.