The 40-Hour Work Week*

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Abstract

Approximately half of U.S. employees adhere to the constraints of the traditional 40-hour work week. This study examines multifaceted implications of this standardized work schedule. To this end, a novel heterogeneous-agent model is developed, incorporating a wage penalty function faced by households when working fewer hours than a specific threshold. The calibrated model captures the salient features of the empirical distribution of hours worked, with a notable spike at the 40-hour mark. The study reveals the 40-hour work week as a critical determinant of both micro and macro labor supply elasticities. It yields a small micro elasticity with heterogeneity across households, while the macro elasticity is larger, making the extensive margin more influential. Moreover, the findings suggest that the conventional underlying primitive associated with elasticity plays a limited role. Ultimately, this paper uncovers the vulnerability of households constrained by this work schedule to the adverse effects of business cycle fluctuations.

Keywords: 40-hour work week, labor supply elasticity, wage penalty function, welfare effect of business cycles
JEL Codes: E24, E32, J21, J22

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1 Introduction

A considerable number of U.S. households are subject to the restrictions of the typical 40-hour work week (Bick, Blandin and Rogerson, 2022). This observation gains further support from Figure 1, illustrating the distribution of weekly hours worked among individual employees based on the Current Population Survey (CPS).[1] Evidently, more than half of those employed dedicate approximately 40 hours per week to their work.[2] The 40-hour work week schedule, coupled with its inherent friction holds the potential for multifaceted implications concerning labor dynamics and welfare, as it fundamentally restricts employees' ability to adapt their desired work hours in response to wage fluctuations (Altonji and Paxson, 1988; Labanca and Pozzoli, 2022*a*).

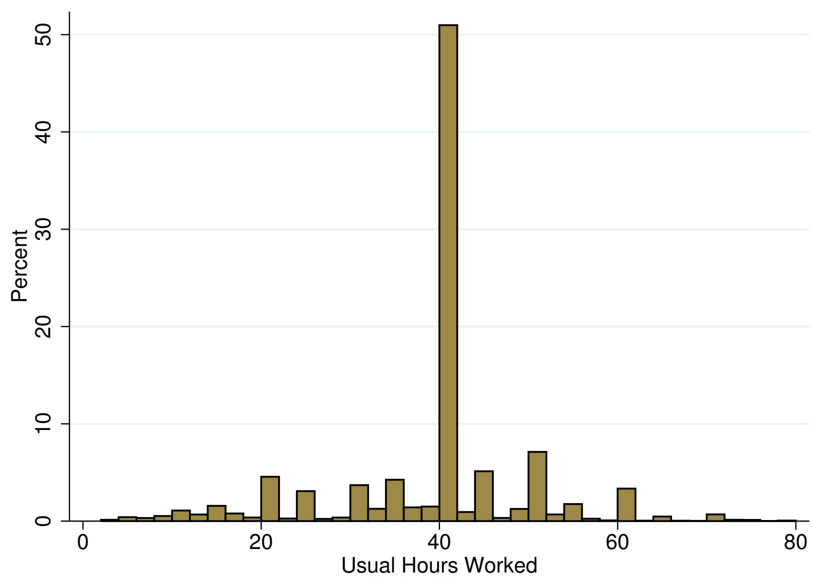

Figure 1: USUAL HOURS DISTRIBUTION

Note: Usual weekly hours for individual workers from the CPS over 1976-2019.

To begin with, the 40-hour work week may play a critical role in determining both micro and macro labor supply elasticities. On the micro level, individuals adhering to the standard 40-hour work schedule may exhibit a small elasticity due to limited variation

[1]Figure 1 presents the usual weekly hours of individual workers aged 16 and above, using a pooled sample from the CPS spanning 1976–2019. "Usual weekly hours" is defined as the number of hours per week that respondents usually worked if they worked during the previous calendar year. Refer to the Appendix for further details.

[2]This pattern is robust to across various sample specifications, including samples using heads only, last week hours, annual hours, and different years. It is also robust to using the usual hours in the Panel Study of Income Dynamics (PSID). See the Appendix for details.

in hours. On the macro level, the restriction affects the composition between intensive and extensive margins, as adjustment along the intensive margin is costly for households working less than 40 hours per week. Second, the presence of a 40-hour work schedule has important welfare implications for business cycle fluctuations. The central premise revolves around the idea that households adhering to traditional schedules may face heightened vulnerability to business cycle uncertainty due to limited flexibility in adjusting their working hours. Against this backdrop, this paper explores the complexity and various aspects of the implications arising from the standardized work schedule. The analysis includes its role in i) shaping labor supply elasticities across different dimensions (macro vs. micro and extensive vs. intensive margins perspectives), ii) understanding aggregate and disaggregate dynamics, and iii) assessing welfare implications.

In pursuit of these explorations, a heterogeneous-agent model that incorporates market incompleteness (as in Aiyagari, 1994) and operative intensive and extensive margins of labor supply (as in Chang et al., 2019) is developed here. Given the incomplete nature of asset markets, households encounter limitations in fully insuring themselves against idiosyncratic shocks. The extensive margin adjustment in the model is driven by the home production technology, which households use only when they are not employed (as in Castaneda, Díaz-Giménez and Ríos-Rull, 1998 and Krusell et al., 2009). Importantly, a unique aspect of this model is the inclusion of a wage penalty function that households encounter when they work fewer hours than a specific threshold, resulting in a notable spike in the distribution of hours at that threshold.[3] This assumption allows employed households to make both minor and substantial adjustments in their work hours.

The calibrated model yields the empirically realistic distribution of hours worked, evident through the pronounced peak at the 40-hour threshold. Furthermore, the benchmark model qualitatively replicates the nonmonotonic profile of hourly wages across the hours distribution and effectively reproduces the spike distribution across productivity and wealth groups. Leveraging this empirically realistic model, an exploration of the multifaceted implications and consequences intricately associated with the 40-hour work week is undertaken, which reveals three key findings.

[3]The wage penalty function is grounded in empirical findings from Bick, Blandin and Rogerson (2022) and Labanca and Pozzoli (2022*b*).

Firstly, the 40-hour work week acts as a critical determinant shaping both micro and macro labor supply elasticities. On the micro level, the 40-hour work week friction generates a resulting micro elasticity much smaller than the associated preference parameter value. For instance, in the benchmark model, where the curvature parameter is set to 1, the resulting micro elasticity is 0.58. Importantly, the standardized work schedule generates significant heterogeneity in micro elasticity among households, contingent upon likelihood of adherence to schedule. Notably, households constrained by the 40-hour work week exhibit an elasticity of around zero. On the macro level, the 40-hour work week and its associated friction impact the composition between adjustments along intensive and extensive margins, making the latter more influential. The benchmark model implies a macro elasticity of roughly 1.3 (more than twice the magnitude of the micro elasticity). This suggests that the 40-hour work week restriction helps reconcile the gap between micro and macro perspectives on labor supply elasticity—a longstanding divide that persists despite the consensus among microeconomists that labor supply elasticities tend to be small, in contrast to the macroeconomic viewpoint.

Secondly, both macro and micro labor supply elasticities exhibit a relatively muted response to changes in an underlying primitive—the curvature parameter for hours worked—under a 40-hour work schedule. This is mainly because the micro elasticity of households bound by the 40-hour work week friction remains unchanged regardless of the values of the preference parameter. To explore more deeply the nature and importance of this phenomenon, another crucial question is asked: How does examining the independent micro elasticity parameter enhance our understanding of labor elasticities in a 40-hour work week model? The analysis suggests that considering micro elasticity as an independent parameter tends to underestimate macro elasticities implied by the model with a 40-hour work week. This challenges the conventional assumption that both micro and macro elasticities can be considered as isolated components and underscores the interconnected nature of these variables within the context of the 40-hour work week.

The last notable finding is that households encumbered by the standardized work schedule are subject to heightened vulnerability to business cycles. Specifically, households constrained by the 40-hour work week are willing to pay as much as 0.02 percentage of their lifetime consumption to eliminate business cycle volatility, whereas non-constrained households experience a negligible welfare cost. This disparity is primarily attributed to the absence of a labor supply channel for the former group, as the friction curtails their ability to freely adjust hours worked in response to wage fluctuations (e.g., Lester, Pries and Sims, 2014; Cho, Cooley and Kim, 2015).

This paper makes noteworthy contributions to several domains within the fields of labor and macroeconomics. Firstly, it addresses the challenge of reconciling micro and macro evidence on labor supply—a topic that has garnered attention due to the differing perspectives between microeconomists and macroeconomists regarding the magnitude of labor supply elasticities. While the view that labor supply elasticities are small is clearly the majority position among microeconomists, it is less well accepted among macroeconomists. Leading explanations for this divergence include extensive margin (Hansen, 1985; Chang and Kim, 2006),[4] adjustment costs (Chetty et al., 2011), nonlinearities (Rogerson and Wallenius, 2009), liquidity constraints (Domeij and Floden, 2006), and human capital accumulation (Imai and Keane, 2004). In this context, this study introduces the concept of the 40-hour work week as a novel avenue for reconciling the divergence between micro and macro labor supply elasticities.

The present study also aligns with the existing literature investigating how optimization frictions shape labor supply. Previous research in this domain has explored hours constraints (Altonji and Paxson, 1988; Chetty et al., 2011; Lachowska et al., 2023). While most studies assume that hours constraints are imposed by firms, this paper focuses more directly on the household optimization problem, introducing the concept of households choosing a specific threshold of hours due to the associated wage penalties below it. This concept is related to the model of Bick, Blandin and Rogerson (2022), which explores the cross-sectional distribution of weekly hours and hourly wages, with a focus on labor supply modeling to account for a concentration of usual work week. Labanca and Pozzoli (2022*a*) is another relevant study to consider. They explore how constraints on working hours shape labor supply decisions using linked employer-employee data on hours worked and the variation in tax rates derived from the 2010 Danish tax reform. As one of the initial investigations into how the 40-hour work week serves as a critical determinant, the present work provides a comprehensive exploration, shedding light on its role

[4]Micro studies based on quasi-experiments, such as tax holidays in Iceland and Switzerland, suggest that Frisch elasticities at both the extensive and intensive margins are small (Chetty et al., 2013). However, a recent study by Mui and Schoefer (2021) reports an asymmetry in the extensive margin elasticity of labor supply, suggesting that small elasticities found in tax holiday studies do not necessarily reject the use of sizable aggregate Frisch elasticities for business cycle analysis.

in shaping labor supply elasticities across various dimensions, including macro vs. micro perspectives and extensive vs. intensive margins.

Finally, this paper is linked to a large body of quantitative work studying welfare implications over business cycles. Schulhofer-Wohl (2008) observes that trading insurance reduces business cycle costs. Storesletten, Telmer and Yaron (2001) and De Santis (2007) show that market incompleteness magnifies welfare costs, while Krebs (2007) highlights costs from uninsurable job risks. Krusell et al. (2009) deviate from a representative-agent assumption and uncover greater costs, especially for unemployed and low-wealth households. The present study introduces another source of welfare costs associated with business cycle fluctuations. Some research suggests that business cycle fluctuations might not always harm households' welfare. For instance, Lester, Pries and Sims (2014) and Cho, Cooley and Kim (2015) find a positive link between volatility and welfare, provided factor supply is sufficiently flexible. This balances benefits against consumption volatility downsides highlighted by Lucas (1987) and others. Building upon these insights, the present paper elucidates the underlying mechanisms of the welfare implications through a decomposition analysis, distinguishing between labor supply and asset channels.

The paper is organized as follows. Section 2 develops a heterogeneous-agent model incorporating the 40-hour work week. In Section 3, the calibration strategy for the model's parameters is explicated. Section 4 presents the model fits, examining how well the model replicates the data. Section 5 explores the implications of the 40-hour work week on labor supply elasticity and its welfare implications over business cycle fluctuations. Finally, Section 6 provides concluding remarks.

2 Model

The model economy is populated by a continuum (measure one) of households with identical preferences. Households face idiosyncratic productivity shocks but are unable to completely insure themselves against the shocks, which implies that asset markets are incomplete, as in Aiyagari (1994). This market incompleteness, combined with borrowing constraints, leads to substantial ex-post heterogeneity in a household's wealth, income, and consumption. Additionally, the model features operative intensive and extensive margins of labor supply. The key novel feature of the model is that employed households should pay a wage penalty when working less than a particular threshold of hours, resulting in a spike in the distribution of hours at that threshold. The second building block of the model is a representative firm that utilizes both labor and capital to produce goods in a competitive market.

2.1 Households

The model economy is populated by a continuum of infinitely-lived households. Households maximize their expected lifetime utility by choosing streams of consumption, c_t, and the time devoted to work, $h_t \in [0, 1]$:

$$\max \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{c_t^{1-\sigma} - 1}{1-\sigma} - \psi \frac{h_t^{1+1/\gamma}}{1+1/\gamma} \right) \right]$$

subject to

$$c_t + a_{t+1} = w_t z_t g(h_t) + (1 + r_t) a_t + \xi_t, \tag{1}$$

and

$$a_{t+1} \geq \underline{a},$$

where β is the subjective time discount factor, $1/\sigma$ is the intertemporal elasticity of substitution, $\psi > 0$ captures disutility from working, and γ is the curvature parameter for hours worked. Households face idiosyncratic productivity shocks z, which follow a finite-state Markov chain, $z \in \{z_1, ..., z_{n_z}\}$, where $\Pr(z' = z_j | z = z_i) = \mathbf{Q}^{\mathbf{z}}(i, j) \geq 0$ and $\sum_{j=1}^{n_z} \mathbf{Q}^{\mathbf{z}}(i, j) = 1$ for all i. Households trade claims for physical capital, a_t, which yields the rate of real return r_t. Households are also subject to a borrowing constraint: their assets holding a_{t+1} cannot go below $\underline{a}$ at any time. In each period, each household is given one unit of time that can be allocated between hours worked and leisure time. When a household with labor productivity of z_t dedicates h_t units of time, the resulting wage earnings are $w_t z_t g(h_t)$, where w_t is the real wage rate for the efficiency unit of labor, and $g(\cdot)$ is the mapping from time devoted to work into units of labor services. ξ_t is the home-produced good, which depends on employment status.

There is a home production technology to which each household has access. With the use of this technology, households are able to produce $\overline{\xi}$ units of the current period's consumption good without requiring any capital input.[5] This technology serves as the driving force behind the extensive margin adjustment: households employ this technology solely during periods when they are non-employed. It is also worth noting that, in line with Castaneda, Díaz-Giménez and Ríos-Rull (1998) and Krusell et al. (2009), the home-produced good is included directly in the budget constraint, allowing households to allocate it between consumption, c_t, and savings, a_{t+1}.

In order to generate a spike at a particular threshold in the distribution of hours, it is assumed that households face a wage penalty function, $g(\cdot)$, which is a nonlinear schedule for labor services as a function of hours worked. Specifically, following the spirit of Bick, Blandin and Rogerson (2022), a non-linearity that takes the form with time costs is considered:

$$g(h) = h - \kappa \max(\overline{h} - h, 0),$$

where κ is a wage penalty parameter.[6] The wage penalty function, $g(\cdot)$, is the key novel feature of the model and has several advantages. First, this functional form provides a flexible and clear mapping from hours worked to the marginal effect on labor services or resulting wages. For $h \in [\underline{h}, \overline{h}]$,[7] hourly earnings are $wz\left\{1 - \kappa\left(\frac{\overline{h}-h}{h}\right)\right\} < wz$, where wz is hourly earnings in the linear function, $g(h) = h$ (or $\kappa = 0$). This implies that employed households should pay a wage penalty, $wz\kappa\left(\frac{\overline{h}-h}{h}\right)$, when they work below $\overline{h}$.[8] Second, the wage penalty function helps explain the properties of the cross-sectional distribution of hours that the linear function ($\kappa = 0$) could not capture. Specifically, the nonlinear function generates bunching around $\overline{h}$ in the distribution of hours worked, which has a notable impact on the elasticity of labor supply at the individual level. With

[5]It is assumed that fixed hours are dedicated to home production, and these hours do not influence household utility.

[6]Bick, Blandin and Rogerson (2022) use a step function with two kinks at 40 and 50 hours to replicate the observation that mean wages increase up to 50 hours. In contrast, this paper examines the impact of the 40-hour work week on elasticities and therefore only considers one kink point.

[7]$\underline{h}$ is minimum hours guaranteeing that $\kappa\left(\frac{\overline{h}-h}{h}\right) < 1$, i.e., $\underline{h} = \frac{\kappa}{1+\kappa}\overline{h}$.

[8]The wage penalty function is empirically supported by Bick, Blandin and Rogerson (2022) and Labanca and Pozzoli (2022*b*).

this framework, this study seeks to evaluate the role of the wage penalty function in accounting for the observed hours patterns in the data and to determine its implications for both macro and micro labor supply elasticities.

The state variables for a household are the vector $x \equiv (a, z)$ and the economy-wide state, X, is described by the type distribution of households, μ, and an aggregate productivity shock, λ, i.e., $X \equiv (\mu, \lambda)$. The value function for a non-employed household, denoted by $V^N(x, X)$, is defined as follows:

$$V^N(x, X) = \max_{c,a'} \left\{ \tfrac{c^{1-\sigma}-1}{1-\sigma} + \beta \mathbb{E}\left[V(x', X'|z, \lambda)\right] \right\} \; s.t.$$

$$c + a' = (1 + r(X))a + \overline{\xi},$$

$$a' \geq \underline{a}, \;\; \mu' = \mathbb{T}(\mu, \lambda), \text{ and } \lambda' = \Xi(\lambda), \tag{2}$$

where $\mathbb{T}$ and Ξ denote a transition operator for μ and the law of motion for the aggregate shocks, respectively. For simplicity of notation, subscripts representing time are omitted, and variables in the following period are indicated with prime. Given the wage penalty function, $g(\cdot)$, the value function for an employed household, denoted by $V^E(x, X)$, is defined as follows:

$$V^E(x, X) = \max_{c,a',h} \left\{ \tfrac{c^{1-\sigma}-1}{1-\sigma} - \psi \tfrac{h^{1+1/\gamma}}{1+1/\gamma} + \beta \mathbb{E}\left[V(x', X'|z, \lambda)\right] \right\} \; s.t.$$

$$c + a' = w(X) z g(h) + (1 + r(X))a, \text{ and Eq. (2).}$$

Given the state variables, a household's employment decision will be made by the following:

$$V(x, X) = \max \left\{ V^E(x, X), V^N(x, X) \right\}. \tag{3}$$

2.2 The Representative Firm

There is a representative firm in a competitive market. The production technology for the representative firms is represented by a constant-returns-to-scale Cobb-Douglas production function, given by:

$$Y_t = F(K_t, L_t, \lambda_t) \equiv \lambda_t K_t^{\alpha} L_t^{1-\alpha},$$

where λ_t is aggregate productivity, K_t is aggregate capital, L_t is aggregate effective labor, and α denotes the capital income share. The representative firm demands labor and capital in order to maximize current profits:

$$\Pi_t = \max_{K_t, L_t} \left\{ \lambda_t K_t^{\alpha} L_t^{1-\alpha} - w_t L_t - (r_t + \delta) K_t \right\},$$

where δ is the depreciation rate of capital. It is assumed that λ_t follows a AR(1) process:[9]

$$\lambda' = (1 - \rho_\lambda) + \rho_\lambda \lambda + \varepsilon_\lambda \qquad \text{with} \qquad \varepsilon_\lambda \overset{iid}{\sim} \mathcal{N}(0, {\sigma_\lambda}^2).$$

2.3 Definition of Equilibrium

A recursive competitive equilibrium consists of a law of motion for the distribution, $\mathbb{T}(X)$, a set of value functions, $\{V^E(x,X), V^N(x,X), V(x,X)\}$, a set of decision rules for households, $\{c(x,X), a'(x,X), h(x,X)\}$, aggregate capital and labor inputs, $\{K(X), L(X)\}$, and a set of factor prices, $\{r(X), w(X)\}$, the law of motion for the aggregate shocks, $\Xi(\lambda)$, such that:

1. Individual households optimize:

   Given $r(X)$ and $w(X)$, optimal decision rules $c(x,X)$, $a'(x,X)$, and $h(x,X)$ solve $V^N(x,X)$, $V^N(x,X)$, and $V(x,X)$.

2. The representative firm maximizes profits as follows:

$$r(X) = F_1(K(X), L(X), \lambda) - \delta$$

$$w(X) = F_2(K(X), L(X), \lambda)$$

   for all X.

3. The goods market clears as follows:

$$\int \{c(x,X) + a'(x,X) - \xi(x,X)\}\, d\mu = F(K(X), L(X), \lambda) + (1 - \delta) K(X)$$

[9] I discretize the continuous AR(1) processes of aggregate productivity shocks as Markov chains, using the algorithm developed in Tauchen (1986).

for all X.

4. Factor markets clear as follows:

$$L(X) = \int xg\left\{h(x, X)\right\} d\mu$$

$$K'(X) = \int a'(x, X) d\mu$$

for all X.

5. The law of motion for the aggregate shocks as follows:

$$\lambda' = \Xi(\lambda).$$

6. Individual and aggregate behaviors are consistent: for all $A^0 \subset \mathcal{A}$, and $Z^0 \subset \mathcal{Z}$,

$$\mu'(A^0, Z^0) = \int_{A^0, Z^0} \left\{ \int_{\mathcal{A}, \mathcal{Z}} \mathbf{1}_{a'=a'(x,X)} \mathbf{Q}^{\mathbf{z}}(z, z') d\mu \right\} da' dz'.$$

3 Calibration

This section explicates the calibration of the parameters used in the model economy. A simulation period corresponds to a quarter. Table 1 summarizes the parameter values employed in the benchmark model.

3.1 Preference

A value for the risk aversion parameter, σ, is chosen to be 1. Time discount factor, β, is set such that the quarterly return to capital is 1 percent (4 percent annualized) in the steady state. The value for the curvature parameter, γ, is set to 1. By choosing this value, the contribution of the intensive margin to the volatility of total hours aligns with the observed data. Moreover, the resulting micro elasticity derived from this choice falls within the range of empirically estimated values. In Section 5.1.2, different values of γ are explored to analyze how this parameter influences both micro and macro labor supply elasticities in the presence of the 40-hour work week friction.

Table 1: PARAMETERS OF THE MODEL ECONOMY

Parameter	Value	Description	Source/Target Moments
β	0.97703	Time discount factor	Return to capital
σ	1.0	Risk aversion	Standard
γ	1.0	Curvature parameter	See text
ψ	21.1	Disutility parameter	Average hours worked
$\overline{h}$	0.24	Constrained hours	40 hours per week
$\overline{\xi}$	0.09	Home production parameter	Employment rate
κ	0.25	Wage penalty parameter	40-hour spike share
ρ_x	0.975	Persistence of z shocks	Floden and Linde (2001)
σ_x	0.201	Standard deviation of z shocks	Earnings Gini
$\underline{a}$	-0.5	Borrowing limit	Kaplan, Moll and Violante (2018)
α	0.33	Capital income share	Standard
δ	0.025	Capital depreciation rate	Standard
ρ_λ	0.95	Persistence of λ shocks	Standard
σ_λ	0.01	Standard deviation of λ shocks	Output volatility

3.2 Labor Supply

As mentioned above, a significant proportion of households allocate approximately 40 hours per week to work out of their available discretionary time (168 hours per week). Hence, the social norm of hours worked, $\overline{h}$, is chosen to be 0.24 (approximately 40/168). The wage penalty parameter, κ, is set to match the observation that roughly 50 percent of employed households adhere to the 40-hour work week. Given the value of γ, the disutility parameter of working, ψ, is chosen so that the average hours conditional on working are 0.23 (around 38 hours per week in the CPS). The home production parameter, $\overline{\xi}$, is set so that the employment rate is 70 percent in the steady state.

3.3 Borrowing Constraint and Labor Productivity

Following Kaplan, Moll and Violante (2018), the borrowing limit, $\underline{a}$, is set to match the quarterly average earnings in the model economy. Parameters related to labor productivity, z, are selected as follow. Individual labor productivity and the transition matrix are determined by discretizing a log-normal process, $\ln z' = \rho_z \ln z + \varepsilon_z'$, $\varepsilon_z \overset{iid}{\sim} \mathcal{N}(0, {\sigma_z}^2)$. The transition probability matrices, $\mathbf{Q^z}$, is discretized, using the algorithm developed in Tauchen (1986), with 21 values of labor productivity ($n_z = 21$). Following Floden and Linde (2001), ρ_z is set to 0.975, which is estimated with the AR(1) wage process using the

Table 2: SUMMARY OF KEY MOMENTS: DATA AND MODEL

Moment	Data	Model
Targeted		
Employment rate	0.70	0.70
Gini coefficient for earnings	0.63	0.63
Share of weekly hours at $\bar{h}$	0.52	0.52
Untargeted		
Gini coefficient for wealth	0.78	0.74
Gini coefficient for income	0.57	0.59
CV of annual hours	0.43	0.30

Note: The Gini coefficients are from PSID 1994, and the statistics related to hours are from the CPS 1976–2019.

PSID. The standard deviation of individual productivity shocks, σ_z, is closely related to earnings inequality. Accordingly, σ_z is chosen to be 0.201, by ensuring that the steady-state earnings Gini coefficient matches the 0.63 in the PSID 1994.[10] Given the choice of the standard deviation of individual earnings risks, it is also important to see if the model matches the earnings distribution among employed households in the data. The earnings Gini coefficient conditional on working in the model is 0.44, comparable to the 0.43 in PSID 1994.

3.4 Production Technology

Parameter values for production are standard. The capital income share, α, and quarterly depreciation rate, δ, are chosen to be 0.33 and 2.5 percent, respectively. Regarding the parameters for aggregate productivity shocks, the following are used: $\rho_\lambda = 0.95$ and $\sigma_\lambda = 0.01$.

4 Model Fits

This section assesses the model's ability to represent the distribution of individuals from various perspectives. This assessment includes examining the empirical distribution of hours worked, highlighted by the distinct peak at the 40-hour threshold. Additionally, it investigates whether the benchmark model qualitatively reproduces the nonmonotonic

[10]Using the 1994 survey year is justified as it falls in the midpoint of the CPS sample period.

profile of hourly wages across the hours distribution and effectively captures the spike distribution across productivity or wealth groups.

4.1 Key Steady-state Moments

This subsection provides an overview of the aggregate moments of distributions in the benchmark model economy. Table 2 presents a summary of both the data and the model counterparts of the targeted (upper panel) and untargeted moments (bottom panel). The targeting efforts yield successful results, as effectively targeting three three aggregate moments of distribution: the employment rate, the share of households working 40 hours per week, and the Gini coefficient for earnings. Additionally, the model economy provides a reasonably good fit for the untargeted moments. Specifically, the income and wealth Gini coefficients are reasonably reproduced, with the wealth Gini coefficient in the benchmark model being slightly lower (0.74) than that in the U.S. data (0.78), while the income Gini coefficient in the model (0.57) is close to the data. Moreover, the distribution of hours worked in the model economy is broadly consistent with the data, with the coefficient of variation of annual hours in the benchmark model being 0.30, compared to 0.43 in the CPS.

4.2 Steady-state Hours Distributions

The following analysis assesses the role of the wage penalty function in accounting for the observed distribution of hours worked. The focus here is on the significance of the peak at 40 hours, crucial for determining the implications of both macro and micro labor supply elasticities. Therefore, the model's ability to explain the distribution of hours worked by households is investigated here, emphasizing the pivotal role played by the wage penalty function in generating this distribution.

The left panel of Figure 2 illustrates the distribution of weekly hours worked for employed households generated by the benchmark model.[11] The figure shows that the benchmark model is able to replicate the distribution of hours worked to some degree.[12]

[11] To ensure consistency with the CPS sample size, I simulate 60,000 households over a period of 20 quarters for the figure.

[12] Given that a simulation period in the model corresponds to a quarter, the weekly hours are equivalent to the quarterly labor supply amount. This can be interpreted as households consistently providing the same number of weekly hours throughout each quarter.

(A) WEEKLY HOURS (B) ANNUAL HOURS

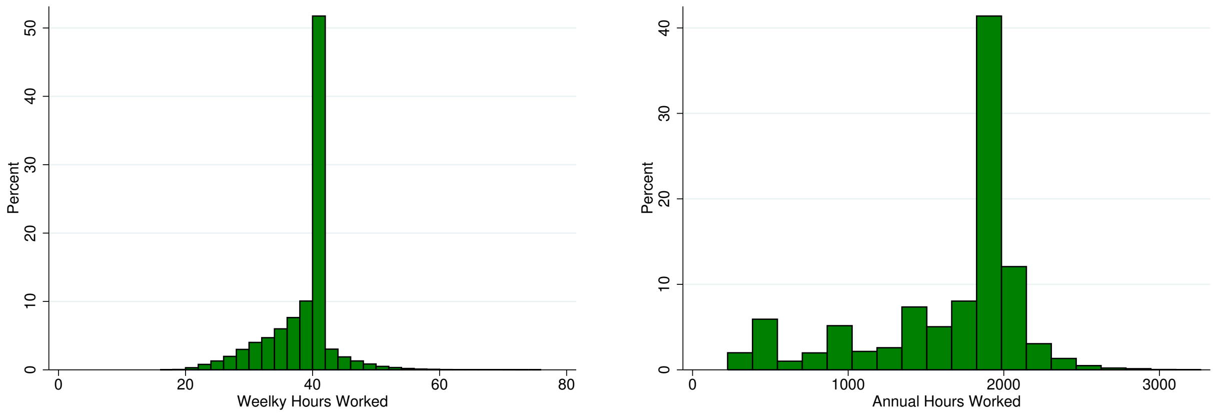

Figure 2: WEEKLY AND ANNUAL HOURS DISTRIBUTION: BENCHMARK MODEL

Note: Weekly and annual hours for individual workers in the benchmark model economy.

Notably, the benchmark model generates a dispersed distribution with a prominent spike at 40 hours, consistent with the data. It is also instructive to see how well the model can account for the distribution of annual hours worked for employed households.[13] The right panel of Figure 2 depicts the distribution of annual working hours for corresponding households. The model does an excellent job of explaining the distribution of annual working hours, producing a distribution that is similar to the data and more dispersed than the distribution of weekly working hours. Notably, the model also replicates the spike at 2000 working hours, consistent with the fact that over 40 percent of households work around 2000 hours per year, as found in the data (See Figure A.1 in the Appendix).

In light of the assumed wage penalty function, it is crucial to assess the extent to which the wage penalty faced by households in the model aligns with the data. To this end, the relationship between wages and hours is explored in both the model and the data. Figure 3 describes how average hourly wages vary across the hours bins in the model and the CPS. As discussed earlier, in the model, given individual productivity z, hourly wages for households working fewer than 40 hours, relative to those working exactly 40 hours, are calculated using the wage penalty term, $\left\{1 - \kappa\left(\frac{\bar{h}-h}{h}\right)\right\}$. In the data, this wage penalty is effectively captured when computing hourly wages across different hour bins, while controlling for various heterogeneity across individuals. Consequently, the

[13] Annual hours are calculated by aggregating individual quarterly hours over the course of a year.

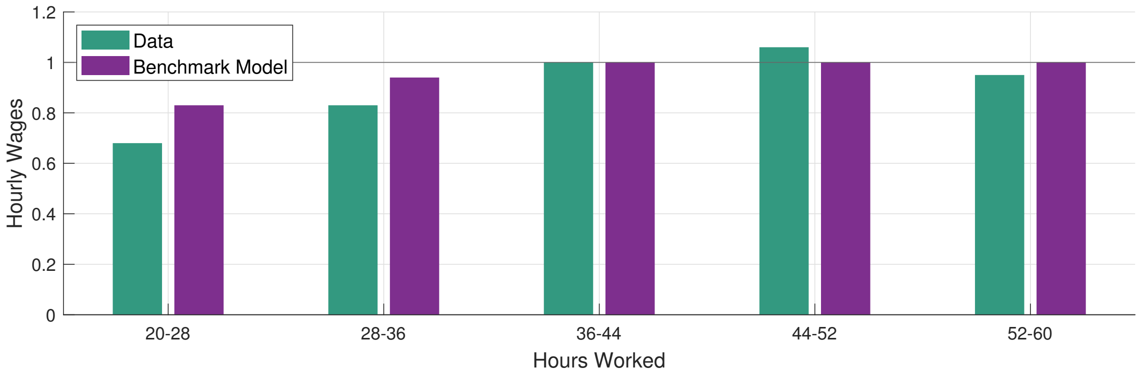

Figure 3: WAGE-HOURS PROFILE

Note: Average hourly wages across the hours bins in the benchmark model and the CPS. The hourly wage for the 36–44 hours bin is normalized to 1 for reference in both model and data. In this figure, to be consistent with the penalty term in the model, $\left\{1 - \kappa\left(\frac{\bar{h}-h}{h}\right)\right\}$, hourly wages in the data are controlled for various individual characteristics.

empirical hourly wages in Figure 3 are controlled for numerous individual characteristics to maintain consistency with the penalty term in the model.[14]

The range of weekly hours, spanning 20 to 60, is divided into eight-hour bins. The hourly wage for the 36–44 hours bin is normalized to one for reference. In the CPS, hourly wages increase as we move from the 20–28 hours bin to the 36–44 hours bin: hourly wages in the latter are approximately 30 percent higher. There is a slight variation after the 36–44 hours bin (a minor increase in the 44–52 hours bin and a slight decrease in the 52–60 hours bin). This observed pattern aligns with the findings presented in the work by Bick, Blandin and Rogerson (2022).[15]

The nonmonotonic profile of hourly wages across the hours distribution is qualitatively well-replicated by the benchmark model. Hourly wages in the model also experience an increase up to the 36–40 hours bin. Specifically, hourly wages in the 20–28 hours bin are approximately 20 percent lower than those in the 36–44 hours bin. It is important

[14]The wage-hours profile is computed based on the code and data provided by Bick, Blandin and Rogerson (2022). They employ a regression analysis to determine hourly wages across various hour bins, using the CPS outgoing rotation group (ORG) surveys from September 1995 through August 2007. Their regression model includes a set of individual hourly dummy variables, each set to 1 if an individual's typical weekly working hours fall within a specific range. To address individual heterogeneity, they include a control vector featuring a quadratic term for age and dummy variables for various demographic factors, such as education, marital status, race/ethnicity, sector of employment, union membership, metropolitan area status, state of residence, and so forth. See Bick, Blandin and Rogerson (2022) for further details.

[15]As a robustness check, I also compute the nonmonotonic profile, without controlling for individual characteristics. This observed pattern remains robust in this case. Refer to Figure A.3 in the Appendix for further details.

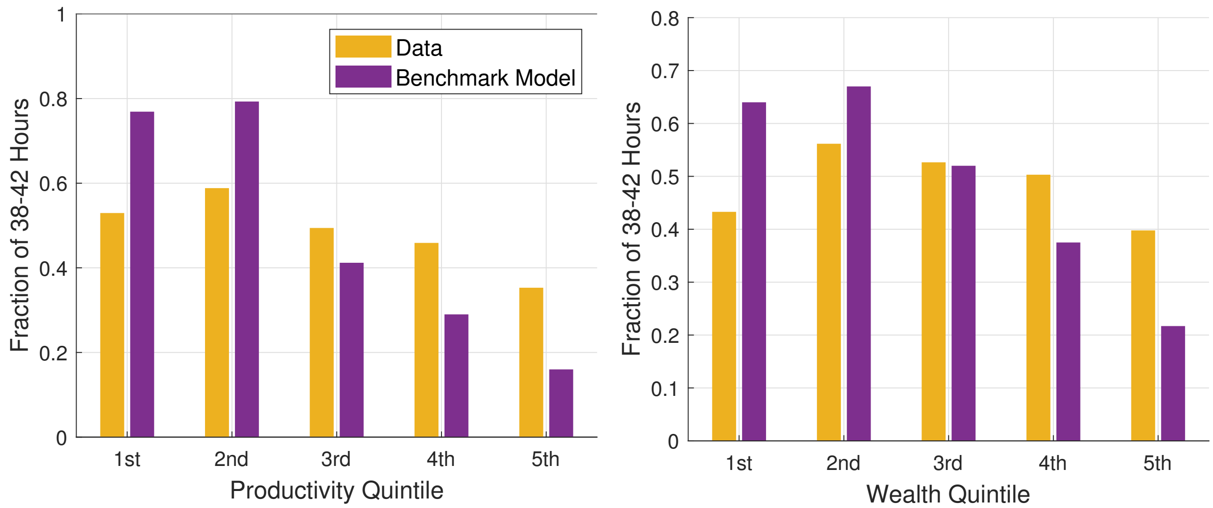

Figure 4: DISTRIBUTIONS OF 40-HOUR WORK WEEK OVER PRODUCTIVITY AND WEALTH

Note: Productivity is defined as hourly wages in both the data and the model. The data are from PSID 1994.

to note that, by design, hourly wages remain constant after the 36-44 hours bin in the model, in contrast to the slight variation observed in the CPS.

Having assessed the model's ability to account for the distribution of hours worked, particularly focusing on the spike at 40 hours, as well as the distribution of hourly wages among employed workers, a detailed investigation into the spike distribution follows. Figure 4 illustrates the proportion of households adhering to the 40-hour work week based on their productivity (or hourly wages) and wealth distribution. The spike distribution in the benchmark model takes on a hump-shaped form in both dimensions, aligning with the data findings.[16] For instance, the majority of households with the lowest or highest productivity do not work around 40 hours (they work fewer or more). Notably, the second productivity quintile contains a relatively high number of households working around 40 hours. This trend holds true in the wealth dimension as well. Thus, the benchmark model effectively reproduces the spike distribution across productivity or wealth groups.

To elucidate the impact of the wage penalty function on the creation of a spike distribution at 40 hours, the benchmark model is compared to a model without a wage penalty,

[16] As the CPS lacks wealth information, the PSID 1994 is employed in this figure. The spike at 40 hours in the PSID is smaller than in the CPS. Therefore, the numbers are proportionally adjusted to maintain the same average in both the data and the model.

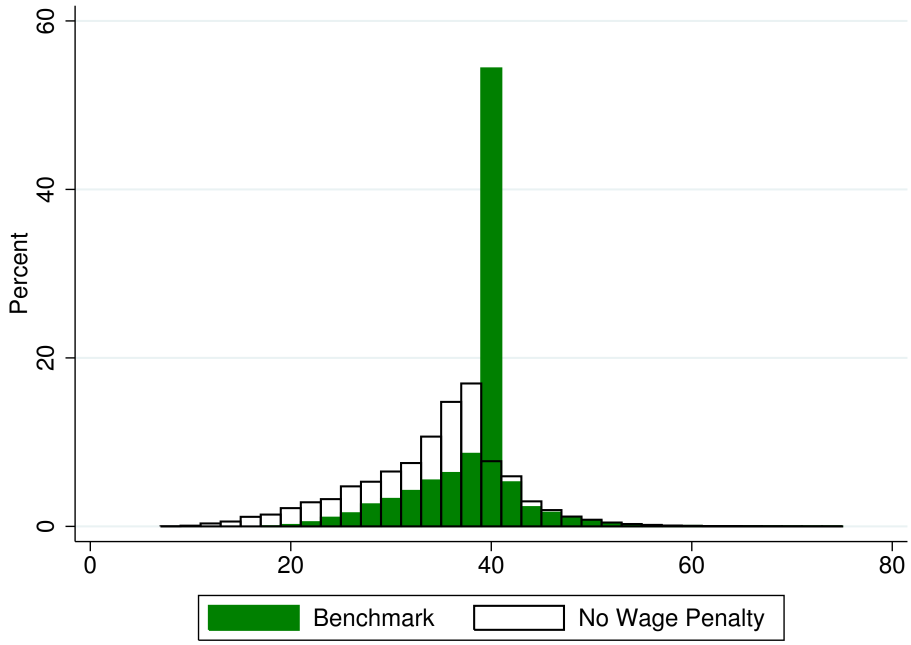

Figure 5: WEEKLY HOURS DISTRIBUTION: BENCHMARK VS. NO WAGE PENALTY

Note: Weekly hours distributions in the benchmark model and the model without wage penalty ($\kappa = 0$).

i.e., $\kappa = 0$.[17] Figure 5 illustrates the hours worked distribution in both model economies: the benchmark economy and the model with no wage penalty. Qualitatively, the figure demonstrates the critical role played by the wage penalty function in generating the spike distribution at 40 hours. In the model with no wage penalty, only 8 percent of households adhere to the 40-hour work week, compared to approximately 50 percent in the benchmark economy. It is worth noting that the distribution of households working overtime in the no wage penalty model is nearly indistinguishable from that in the benchmark model.[18] This suggests that if households were not subject to the wage penalty, most of those currently adhering to the 40-hour work week would choose to work fewer hours.

Quantitatively, the elimination of the wage penalty has a substantial impact. The employment rate rises to 76.4 percent without the wage penalty, indicating increased employment. However, workers, on average, put in fewer hours, leading to an approximate 11 percent reduction in hours per worker. As a result, output and consumption decrease

[17]In this analysis, instead of recalibrating the model to align with targeted moments, factor prices are allowed to fluctuate under the condition of $\kappa = 0$ to capture the general equilibrium effect. This approach provides insights into how households would adjust their hours worked were the friction associated with the 40-hour work week removed.

[18]They are not perfectly identical due to the general equilibrium effect.

Table 3: VOLATILITIES AND COMOVEMENTS OF AGGREGATE VARIABLES

	σ_Y	σ_C/σ_Y	σ_I/σ_Y	σ_H/σ_Y	σ_E/σ_Y	$\sigma_{H/E}/\sigma_Y$	σ_G/σ_Y
Data	1.77	0.56	3.48	0.83	0.70	0.21	0.36
Model	1.90	0.35	3.17	0.61	0.51	0.10	0.19

	$\rho(Y,Y)$	$\rho(C,Y)$	$\rho(I,Y)$	$\rho(E,Y)$	$\rho(H,Y)$	$\rho(\frac{H}{E},Y)$	$\rho(G,Y)$
Data	1.00	0.79	0.94	0.90	0.82	0.77	-0.48
Model	1.00	0.92	0.98	0.96	0.95	0.92	-0.96

Note: σ_x and $\rho(x,Y)$ are the standard deviation of variable x, and the cross correlation of x with output (Y), respectively. C, I, H, E, and G denote consumption, investment, total hours, employment, and the income Gini coefficient, respectively. All variables are logged and detrended by the HP filter.

by around 2 percent in the no wage penalty scenario, compared to the benchmark model. Notably, the welfare cost of the wage penalty is significant, with households willing to pay approximately 1 percent of their lifetime consumption to eliminate this friction.

4.3 Business Cycle Properties

This subsection examines the business cycle properties of the model economy. The equilibrium of the model is solved using the method proposed by Krusell and Smith (1998). Following the standard procedure, logarithms are used and the HP filter (with a smoothing parameter of 1,600) is applied to the simulated series before calculating summary statistics. Table 3 presents the conventional set of business cycle statistics for the model economy, alongside the cyclical behavior of U.S. aggregate quarterly data from 1976:I to 2019:IV (aligned with the CPS period). The focus is on the (relative) volatilities and cross-correlations with output of key aggregate variables. The model effectively captures the volatility of output observed in the data, with a cyclical variation of 1.90, comparable to the U.S. data (1.77). Consumption and investment exhibit standard real business cycle behavior, with being about half and about three times as volatile as output, respectively.

Given the primary focus on labor market variables, the nature of labor market fluctuations is explored in more detail here. Traditional business cycle models often struggle to replicate observed hours fluctuations. For example, Chang et al. (2019)'s model, incorporating both intensive and extensive margins, only accounts for 30-60 percent of the actual cyclical variations in total hours relative to output. In contrast, the benchmark model reasonably matches the volatility of total hours worked relative to output, explaining around three-quarters of the variation, with a value of 0.61, equivalent to approximately 73 per-

Table 4: VOLATILITIES OF LABOR VARIABLES

	σ_H/σ_Y	σ_E/σ_Y	$\sigma_{H/E}/\sigma_Y$
Benchmark	0.61	0.50	0.10
No Wage Penalty (Not Recalibrated)	0.57	0.38	0.21
No Wage Penalty (Recalibrated)	0.59	0.43	0.19

Note: See the note in Table 3.

cent variation in the data. Breaking down the total margin of labor supply (denoted by H), the extensive margin (employment, denoted by E) contributes 84 percent of the total margin variation, while the intensive margin (hours per worker, denoted by H/E) makes up the remaining 16 percent. These compositional variations are also comparable to the data.

The income distribution, as measured by Gini coefficient, is countercyclical over the business cycle in the data.[19] As shown in Table 3, the income Gini is negatively correlated with output, with a correlation coefficient of -0.48. The model economy successfully reproduces the countercyclicality of the income Gini, displaying a negative cross-correlation with output of -0.96. The countercyclical nature of the benchmark model's income Gini is primarily attributed to changes in the extensive margin of labor supply for income-poor households over the business cycles, as documented in Castaneda, Díaz-Giménez and Ríos-Rull (1998) and Kwark and Ma (2021).

To investigate the impact of the 40-hour work week and the associated friction, represented by the wage penalty function, on the business cycle dynamics of the model economy, a comparative analysis between the benchmark model and a counterfactual model where the wage penalty is absent ($\kappa = 0$) follows. This analysis considers both recalibrated and not-recalibrated counterfactual economies. Table 4 presents a comparison of the cyclicality observed in key labor-related variables across these two types of economies.

The presence of the wage penalty function does not significantly affect the cyclical variation in total hours; instead, it predominantly influences the composition of labor adjustments between the extensive and intensive margins. To be more specific, in the absence of the wage penalty, the variation in total hours closely resembles that of the benchmark model, recalibrated or not. However, the importance of the intensive margin

[19] Due to the delayed nature of the income distribution in the data, the table presents the cross-correlation between current output and the Gini coefficient with a two-year lag.

becomes more pronounced, as households can now adjust their working hours without incurring any associated costs. For instance, the contribution rate of the intensive margin to total variation is around 30 percent, almost double the 16 percent in the model with the wage penalty.[20] This analysis sheds light on the distinct role of the wage penalty in shaping the labor market dynamics, emphasizing the differential impact on extensive and intensive margin adjustments.

5 Results

This section, after assessment of the model's ability to represent the distributions of individual labor supply from various perspectives, presents a comprehensive exploration of the implications and consequences associated with the 40-hour work week. Firstly, how the 40-hour work week serves as a critical determinant, influencing both micro and macro labor supply elasticities, is investigated. Secondly, the examination explores the sensitivity of both micro and macro elasticities to variations in an underlying primitive. Lastly, whether households affected by the friction of the 40-hour work week are more susceptible to business cycles is examined, seeking to uncover the underlying mechanism.

5.1 Implications for Labor Supply Elasticity

In principle, the 40-hour work week has the potential to serve as a critical determinant shaping both micro and macro labor supply elasticities. On the micro level, the 40-hour work week may play a crucial role in shaping individual labor supply decisions, introducing significant heterogeneity in labor supply elasticity among households based on the likelihood of adherence to this tradition. On the macro level, the standardized schedule impacts the composition between adjustments along intensive and extensive margins, with a particular emphasis on the extensive margin, making it more influential and thereby affecting macro elasticity.

[20] On the flip side, households are less inclined to make substantial changes to their extensive margin in the absence of the wage penalty, with the contribution rate of the extensive margin decreasing to approximately 70 percent from the benchmark model's 84 percent.

5.1.1 Implied Micro and Macro Labor Supply Elasticities

The model-implied Frisch elasticities derived from individual panel data are compared to those obtained from aggregate time-series data. To estimate the elasticity of micro labor supply, most empirical studies rely on individual panel data. Therefore, this convention is followed by generating panel data for 60,000 households over a period of 120 quarters. Using this artificial panel data, the model-implied elasticity is estimated by running a standard labor supply regression. As is customary in the empirical labor supply literature, the regression includes variables such as labor supply, consumption, and wages and is represented by the following equation:

$$\log h_{it} = b_0 + b_1 \log w_{it} + b_2 \log c_{it} + \alpha_i + \varepsilon_{it}. \tag{4}$$

where h_{it}, w_{it}, and c_{it} represent quarterly hours worked, hourly wages, and consumption for individual i at quarter t, respectively, and α_i is the individual fixed effect. The estimated parameter b_1 signifies the micro Frisch labor supply elasticity. When there is no wage penalty in the economy, and employed households make divisible labor supply decisions, the household's first-order condition implies that b_1 is equal to the preference parameter, γ. However, modifying the standard labor supply model to include the wage penalty function breaks the previously established connection between the preference parameter and the implied labor supply elasticity.[21] Also, it is crucial to acknowledge that this regression model is inherently unable to account for the micro elasticity of the extensive margin. This limitation arises from the implicit assumption that (reservation) wages of households are not observable when they are non-employed.[22]

Regarding the macro labor supply elasticity, the Frisch elasticity is estimated using a comparable equation based on quarterly aggregate time series data. The following regression equation is used to estimate the macro labor supply elasticity:

[21] As outlined in Rogerson and Wallenius (2009) and Chang and Kim (2006), introducing a non-linear budget constraint into the standard labor supply model results in a modification that breaks the tightened link between the preference parameter and implied labor supply elasticity.

[22] While converting the data into an annual format for estimation would capture the extensive margin, it would introduce a downward bias, primarily due to the inclusion of non-employed individuals' consumption within a year in the annual dataset.

Table 5: IMPLIED MACRO AND MICRO ELASTICITIES

		Benchmark	No Wage Penalty
Macro	Total	1.30	1.33
	Extensive	1.02	0.80
	Intensive	0.29	0.53
Micro	All Households	0.58	1.00
	38–42 Hours Bin	0.16	1.00
	39–41 Hours Bin	0.05	1.00

Note: The table displays the computed macro and micro elasticities for both the benchmark model and the model without the 40-hour work week friction. Micro elasticity is estimated using Equation (4), while macro elasticity is derived from the regression model in Equation (5). "All Households" refers to the micro elasticity calculated using the entire sample, whereas "38–42 Hours Bin" and "39–41 Hours Bin" represent micro elasticity computed for households within the specified hours bin.

$$\log H_t = d_0 + d_1 \log W_t + d_2 \log C_t + v_t, \tag{5}$$

where W_t is the market wage, and d_1 is the macro Frisch labor supply elasticity.

Table 5 reports the resulting macro and micro elasticities in the benchmark model and the model without the 40-hour work week friction.[23] When examining the macro labor supply elasticity, there are two key points to consider.[24] Firstly, in the benchmark model, the implied macro labor supply elasticity (1.3) falls within the range of values typically used in standard business cycle models. The macro elasticity in this economy is jointly determined by underlying primitives such as a wage penalty parameter, a degree of heterogeneity and curvature in preferences over hours. Specifically, the extensive margin elasticity is substantial, at around 1, while the intensive margin elasticity is relatively small, at approximately 0.3. These values align with empirical estimates found in the literature, including Fiorito and Zanella (2012).[25] Second, interestingly, the wage penalty function affects the composition between extensive and intensive margins of elasticities. In the presence of a wage penalty, the significance of the intensive margin diminishes, as a substantial number of employed households incur wage penalties when adjusting their hours. Consequently, they adjust the intensive margin to a lesser extent, opting in-

[23]In this analysis, with $\kappa = 0$, I recalibrate the model to align with the targeted moments, keeping the parameter for the extent of heterogeneity, σ_z, fixed at the same value as in the benchmark model. The overall distributions of wealth and income in the model without the wage penalty are not different from those in the benchmark model, as demonstrated in Table A.2 of the Appendix.

[24]The macro intensive margin elasticity, by definition, captures changes in the composition of hours worked among households over the business cycle.

[25]Using the PSID, Fiorito and Zanella (2012) report intensive margin elasticity estimates in the range of 0.3–0.4 and extensive margin elasticity estimates in the range of 0.8–1.4.

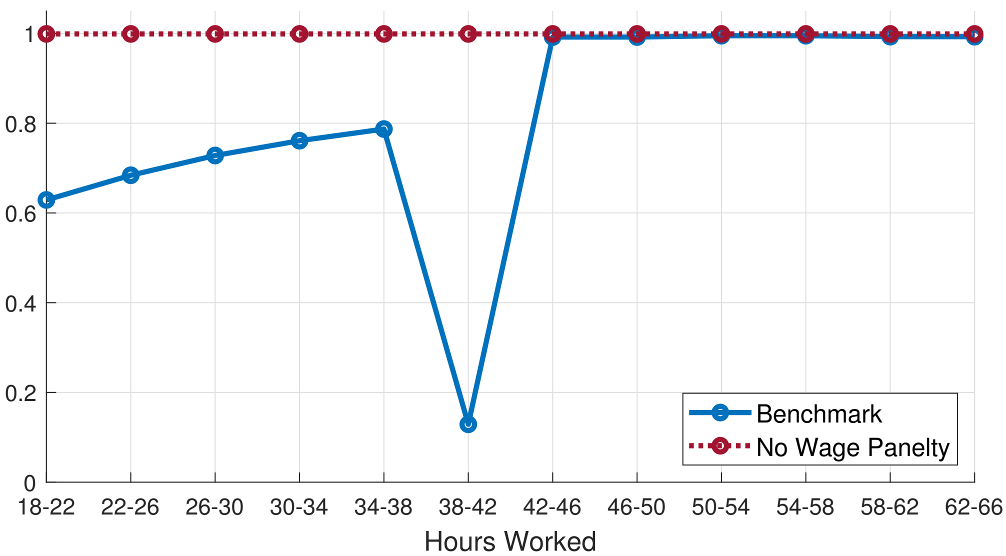

Figure 6: MICRO ELASTICITIES ACROSS HOURS DISTRIBUTION

Note: The y-axis shows the estimate of the Frisch elasticities based on Equation (4) while the x-axis is hours worked.

stead for more frequent adjustments along the extensive margin. For instance, when the friction related to the 40-hour work week is eliminated, the intensive margin contributes approximately 40 percent to the total margin elasticity, notably higher than the 22 percent observed in the benchmark model.[26] Accordingly, the model without a wage penalty generates a slightly larger macro elasticity, reaching 1.33.[27]

The most significant finding from Table 5 is that the 40-hour work week generates considerably small micro elasticity. In the benchmark model, the micro elasticity is 0.58, which is much smaller than the macro elasticity and is consistent with empirical estimates in the literature, such as Chetty et al. (2013). Conversely, in the absence of the wage penalty function, the micro elasticity is exclusively determined by the curvature parameter γ: the micro-level elasticity equals unity, mirroring the value of the curvature parameter. These findings provide compelling support for the notion that a small micro elasticity is fully compatible with a scenario in which aggregate labor supply elasticities are actually large.

[26]This finding remains robust when the no wage penalty model is not recalibrated. In this specification, the macro elasticity is 1.31, where the intensive margin elasticity is 0.47 and the extensive margin elasticity is 0.84. Thus, the extensive margin is less significant in this specification as well.

[27]One might argue that comparing macro elasticity between the two economies is inherently unfair since they feature different values of micro elasticity. In Section 5.1.3, I will rigorously address this concern, demonstrating that a model with an equivalent average micro elasticity but without the traditional 40-hour work week tends to underestimate macro elasticity compared to its counterpart economy subject to the 40-hour work week friction.

The rationale behind the small micro elasticity in the presence of a wage penalty is straightforward. In the benchmark model, approximately 50 percent of employed households are constrained by the standard 40-hour work schedule. This results in little variation in their individual hours, entailing a small micro labor supply elasticity. As shown in Table 5, the micro elasticity for households in the 38–42 hours bin is 0.16, and it diminishes further when the impact of the 40-hour work week friction is stronger, revealing that households in the 39–41 hours bin have nearly zero elasticity (0.05).[28] This is corroborated by Figure 6, which illustrates the resulting Frisch elasticities across the hours distribution in the benchmark model. Micro-level elasticities exhibitsignificant heterogeneity across hours worked bins. As depicted in the figure, the estimates reveal a V-shaped pattern, with the lowest value observed for those binding to the friction. The micro elasticity for households working less than 40 hours per week is approximately 0.7, while the figure for households in the upper range of the hours distribution is approximately 1, as they are not bound by the wage penalty. This pattern overall aligns with empirical findings in existing literature such as Bick, Blandin and Rogerson (2022). Unsurprisingly, in the absence of the wage penalty function, the micro-level elasticity is uniformly distributed across the hours distributions.

5.1.2 Preference Parameter and Labor Supply Elasticities

In the current economic context, individual and aggregate elasticities are influenced collectively by underlying primitives. Given the wage penalty parameter, an essential parameter in this regard is the curvature parameter, γ. In principle, with a larger γ, the adverse effect from fluctuating hours worked over the business cycle is smaller, enabling households to increase their working hours by making adjustments along both the intensive and extensive margins. The following analysis demonstrates that in the presence of a 40-hour work schedule, the curvature parameter plays a limited role in shaping both macro and micro labor supply elasticities.

Table 6 presents a range of elasticities for three γ values: 0.5, 1, and 1.5. There are two key features observed in the model when there is no wage penalty. Firstly, in the absence of the 40-hour week friction, the macro elasticity of labor supply demonstrates

[28] This is in line with the results of Labanca and Pozzoli (2022*a*), which also found that stricter hours constraints lead to a significant decrease in the labor supply response to tax changes.

Table 6: IMPLIED MACRO AND MICRO ELASTICITIES: DIFFERENT γ

		With Wage Penalty			Without Wage Penalty		
		$\gamma = 1.5$	$\gamma = 1.0$	$\gamma = 0.5$	$\gamma = 1.5$	$\gamma = 1.0$	$\gamma = 0.5$
Macro	Total	1.51	1.30	0.97	1.80	1.33	0.84
	Extensive	1.19	1.02	0.77	1.06	0.80	0.54
	Intensive	0.32	0.29	0.20	0.74	0.53	0.30
Micro	All HHs	0.79	0.58	0.36	1.50	1.00	0.50
	39–41 hrs.	0.05	0.05	0.06	1.50	1.00	0.50

Note: The table displays the computed macro and micro elasticities for both the benchmark model and the model without the 40-hour work week friction. Micro elasticity is estimated using Equation (4), while macro elasticity is derived from the regression model in Equation (5). The term "All HHs" refers to the micro elasticity calculated using the entire sample, whereas "39-41 hrs." represents micro elasticity computed exclusively for households within the specified hours bin.

an increase as the preference parameter, γ, rises. Moving from $\gamma = 1$ to $\gamma = 1.5$ results in an approximately 40 percent increase in macro elasticity magnitude. This is attributed to the rise in both intensive and extensive margin elasticities. Secondly, micro elasticities are exclusively determined by γ, as previously discussed.[29]

In the model with the 40-hour work week, while macro elasticity increases alongside the preference parameter, it is crucial to note that the influence of γ on macro elasticity is considerably diminished compared to the model without a wage penalty. Specifically, the shift from $\gamma = 1$ to $\gamma = 1.5$ leads to a mere 16 percent rise in total elasticity when a wage penalty is imposed, in stark contrast to the substantial increase observed in without such penalty. This is primarily due to restricted adjustments along both extensive and intensive margins for households bound by the 40-hour work standard. Regarding extensive margin decisions, binding households exhibit behavior analogous to that observed in facing indivisibility, as outlined in the indivisible labor supply model by Chang and Kim (2006). In the framework of indivisible labor, labor supply dynamics is independent of the curvature parameter, as it is intricately tied to the configuration of the marginal worker distribution. Consequently, in this model economy, changes in the preference parameter leave the employment dynamics of the binding households almost unaltered.[30] Furthermore, the impact of a change in γ on intensive margin elasticity is also limited, since the binding households have zero micro elasticity regardless of γ values.[31]

[29]This implies that in the absence of a wage penalty, a relatively higher value of γ in the model can lead to a greater micro elasticity compared to macro elasticity.

[30]The extensive margin elasticity increases to some extent with a larger γ since the employment decisions for other non-binding households are influenced.

[31]This will be further discussed later in this subsection.

Table 7: Resulting Macro Elasticities

	With Wage Penalty				Without Wage Penalty			
Micro Elasticity	γ	Total	Ext.	Int.	γ	Total	Ext.	Int.
0.79	1.5	1.51	1.19	0.32	0.79	1.31	0.84	0.47
0.58	1.0	1.30	1.02	0.29	0.58	0.97	0.61	0.36
0.36	0.5	0.97	0.77	0.20	0.36	0.81	0.58	0.23

Note: The table displays the implied macro elasticities in both models, with and without the wage penalty, while maintaining consistent average micro elasticities. Fixing a row, both economies exhibit the same average level of micro elasticity.

Another noteworthy observation is that the composition of macro elasticity between extensive and intensive margins remains unaffected in the presence of a wage penalty, with the contribution rate of intensive elasticity to macro elasticity hovering at approximately 20 percent. However, absent of a wage penalty, the composition of macro elasticity changes along γ as the curvature parameter directly affects the intensive margin of labor supply for households. For example, when $\gamma = 0.5$, the contribution rate of the intensive elasticity to macro elasticity is 0.36, smaller than the 0.41 when $\gamma = 1.5$

The curvature parameter plays a limited role in shaping micro labor supply elasticity in the presence of a wage penalty. As shown in the bottom panel of Table 6, a change in micro elasticity is less pronounced than the magnitude of the change in γ. Moving from $\gamma = 0.5$ to 1, where γ is doubled, micro elasticity increases only by 60 percent. This is mainly attributed to the micro elasticity of households constrained by the 40-hour work week friction remaining unchanged as the preference parameter changes. Regardless of the values of γ, the micro elasticity of households constrained by the 40-hour work week (those falling within the 39–41 hours bin) remains consistently at approximately zero.

Consequently, the 40-hour work week acts as a mitigating factor, dampening the impact of a change in the curvature parameter, γ, on both macro and micro elasticities.

5.1.3 Micro Elasticity as an Independent Parameter

A potential challenge in comparing the macro elasticities of the two economies, as detailed in Table 5, stems from the inherent differences in their micro elasticities. Accordingly, the extent to which considering micro elasticity as an independent parameter effectively captures labor elasticities in the model that generates a 40-hour spike in hours distribution should be considered.

Table 7 presents implied macro elasticities in both models, with and without wage penalty, sharing the same levels of average micro elasticities.Three values—0.79, 0.58, and 0.36—are examined for micro elasticities, derived from the benchmark model with the γ values of 1.5, 1.0, and 0.5, respectively. To clarify, fixing a row in Table 7, both economies exhibit the same average level of micro elasticity. As discussed earlier in Figure 6, the model featuring the 40-hour work week friction exhibits heterogeneity across households, whereas the model without a wage penalty does not. Crucially, treating micro elasticity as an independent parameter tends to underestimate those implied by the model with a 40-hour work week. For example, when micro elasticity is 0.58 in the model without wage penalty, the implied macro elasticity is 0.97, around 25 percent less than the 1.3 in the model with a wage penalty.

The main reason for this difference lies in the source of micro elasticity. In the model featuring the 40-hour work schedule, the inability of constrained households to adjust hours results in a micro elasticity smaller than the parameter value. On the contrary, in the model without a wage penalty, micro elasticity is solely determined by the curvature parameter. By construction, to achieve the same average micro elasticity, the economy without a wage penalty incorporates a markedly diminished curvature parameter, making the utility function more curved. This amplifies the negative welfare effect of fluctuating hours worked over business cycle fluctuations, resulting in a significantly smaller macro elasticity, particularly along the extensive margin. This occurs even with a larger intensive margin elasticity, owing to the absence of friction.

Based on the findings so far, it can be concluded that the 40-hour work week highlights the endogenous nature of labor supply elasticities and the intricate interplay among them: i) both macro and micro elasticities are endogenously determined, ii) within macro elasticity, the composition of intensive and extensive margins is affected, iii) micro elasticities exhibit heterogeneity across households, and iv) treating micro elasticity as an independent parameter may introduce a downward bias in macro elasticity. These findings underscore the interconnected nature of these variables within the context of the 40-hour work week and challenge the conventional assumption that elasticity should be regarded as an isolated parameter.

Another interesting finding is that the 40-hour work week friction plays a crucial role in distributional consequences over the business cycle, significantly impacting inequali-

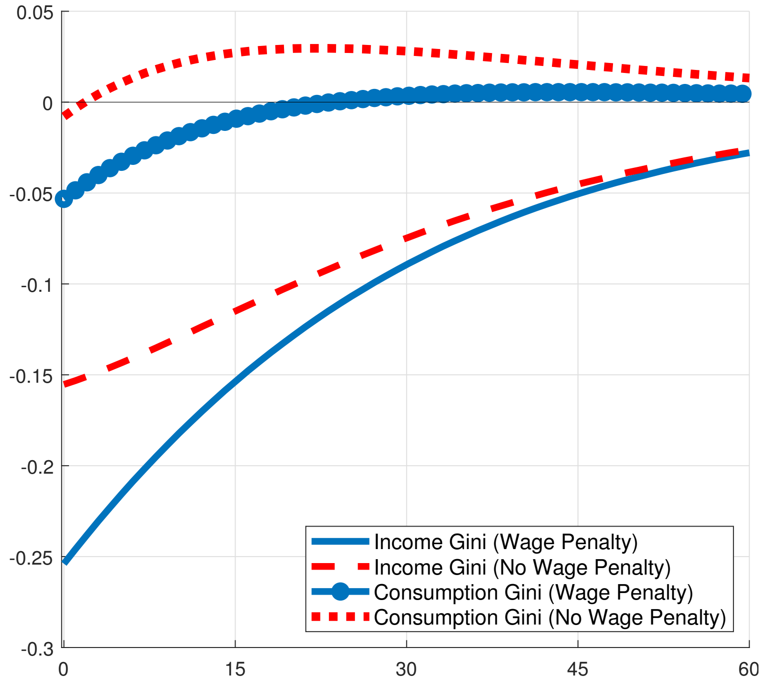

Figure 7: RESPONSES OF INCOME AND CONSUMPTION GINI COEFFICIENTS

Note: The figure shows the responses of income and consumption Gini coefficients to aggregate productivity shocks in the models with and without a wage penalty. The y-axis represents the percentage deviation from the long-run average, while the x-axis denotes quarters after aggregate productivity shocks.

ties among household. When a wage penalty is in effect, the importance of the intensive margin diminishes, as households are less inclined to alter their working hours due to associated costs. Consequently, they are more likely to make substantial changes to their extensive margin. Less-productive households operate at this margin, potentially resulting in increased cyclical variation in income and consumption inequalities.

Figure 7 depicts the responses of income and consumption Gini coefficients to positive aggregate shocks in the benchmark model and the model without a wage penalty where average micro elasticity is 0.36 in both models.[32] In terms of income inequality, the response is more pronounced in the model with the 40-hour work week friction. The income Gini decreases by approximately 0.25 percent upon impact in the benchmark model, compared to an approximately 0.15 percent decrease without the wage penalty function. This difference is primarily attributed to more households being employed from the lower end of the distribution. Concerning consumption inequality, the distributional effect is also more prominent in the benchmark model. The consumption Gini decreases by 0.05

[32] This specific choice facilitates a comparative analysis aimed at revealing a distinct contrast and emphasizing the pivotal role of the 40-hour work week friction.

percent in the benchmark model but barely changes in the absence of the wage penalty function. Therefore, neglecting a role of 40-hour work week tends to underestimate distributional consequences over the business cycle.

5.2 Welfare Implications over Business Cycles

Individuals bound by the constraints of a 40-hour work week exhibit a lower degree of elasticity in their labor supply, which has noteworthy implications for their welfare in the presence of business cycle uncertainty. This is primarily due to their limited ability to adjust working hours in response to substantial shifts in wages. Put simply, households adhering to this traditional work schedule may be more susceptible to the ups and downs of the business cycle. With these insights, this subsection examines how the 40-hour work week, coupled with its inherent inflexibility, shapes the welfare outcomes associated with business cycle fluctuations and seeks to elucidate the underlying mechanisms driving these effects.

To quantify the welfare effect of economic fluctuations for individual households, the value function of an individual household under aggregate uncertainty is compared with its value function in a steady state. Let $V(a, z; \overline{K}, \overline{\lambda})$ represent the value function for an individual with a and z, and with steady-state aggregate states of $\overline{K}$ and $\overline{\lambda}$.[33] The value function with aggregate uncertainties, conditional on aggregate states $\overline{K}$ and $\overline{\lambda}$, is denoted as $\mathbb{E}[V(a, z; K'\lambda')|\overline{K}, \overline{\lambda}]$.[34] The welfare effect of business cycles for the individual household is expressed as the consumption-equivalent welfare effect, ω, equalizing the two value functions.[35] A positive ω indicates that the household benefits from aggregate volatility; a negative value implies the opposite. Notably, ω depends on individual state variables, specifically represented as $\omega = \omega(a, z)$.

Given the rich heterogeneity among individual households in the model, the welfare measure, ω, displays considerable variation at the individual level, depending on the individuals' ability to hedge against business cycle uncertainties. Figure 8 illustrates

[33] In this model economy, analogous to the approach in Krusell and Smith (1998), all aggregate variables can be closely approximated through mean capital and the aggregate productivity shock. Accordingly, the aggregate state, μ, in the value function can be replaced by aggregate capital, K.

[34] Numerically, there is almost no difference if I use $\mathbb{E}[V(a, z; \overline{K}, \lambda')|\overline{K}, \overline{\lambda}]$ instead.

[35] Please refer to Section (C) in the Appendix for a comprehensive definition and detailed discussion of the welfare measure.

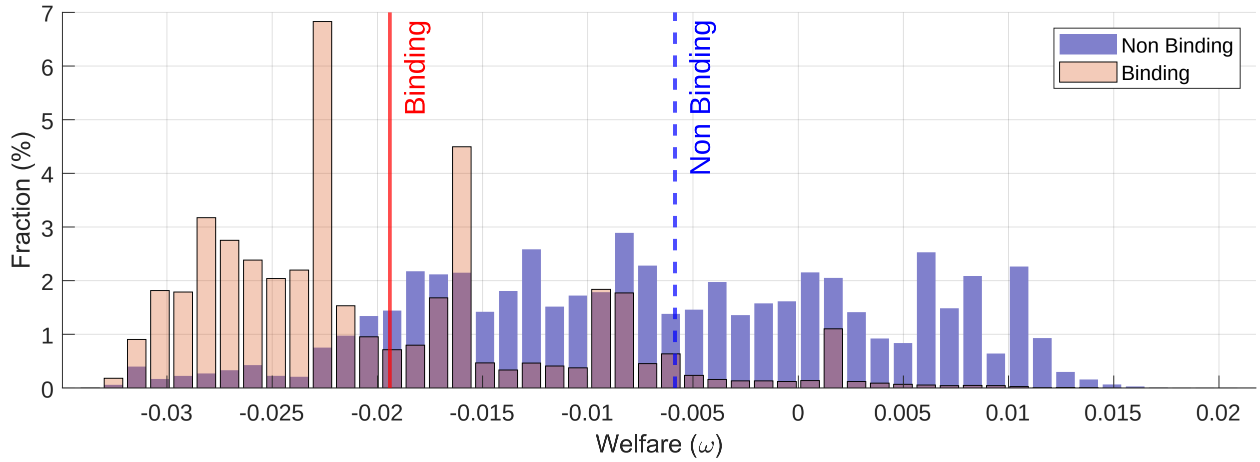

Figure 8: WELFARE EFFECTS OF BUSINESS CYCLES

Note: The x-axis is the consumption-equivalent welfare measure. The numbers are multiplied by 100, and are interpreted as a percentage of consumption.

the distribution of households across these consumption-equivalent welfare effects, ω. An important observation is that considerable heterogeneity exists in these effects across households, ranging from a minimum of -0.03 to a maximum of 0.02. Notably, a significant majority of households have negative welfare effects, underscoring that a large number of households suffer from business cycle fluctuations.

An important finding is that households bound by the constraints of the 40-hour work week friction tend to experience larger (than those not bound) adverse effects during economic fluctuations. Specifically, binding households[36] are willing to pay as much as around 0.02 percent of their lifetime consumption to reduce business cycle volatility, whereas the consumption-equivalent welfare cost for non-binding households is almost zero (0.006).[37]

To shed light on the fundamental mechanisms underlying these outcomes, the welfare effect is decomposed into labor supply and asset channels. Regarding the labor supply channel, households characterized by a more flexible labor supply enjoy relatively enhanced insurance coverage against aggregate risks (e.g.,Lester, Pries and Sims, 2014; Cho, Cooley and Kim, 2015). Turning to the asset channel, households utilize accumulated

[36]In this analysis, "binding or constrained households" is defined as those individuals whose working hours fall within the 39–41 hours bin in the steady state.

[37]Additionally, another welfare metric based on an unconditional value function is employed here, reported in Figure A.5 in the Appendix. The findings suggest that overall results remain consistent, implying that the "level effect" is relatively small in this economy due to the constraints faced by households.

Table 8: WELFARE EFFECTS OF BUSINESS CYCLES

	Wealth Dimension				Average
	P0–P40	P40–P80	P80–P95	P95–P100	
Binding Households	-0.0268	-0.0197	-0.0053	0.0015	-0.0194
Non-binding Households	0.0006	-0.0146	-0.0054	0.0101	-0.0058

Note: Consumption-equivalent welfare gains of business cycles. The numbers are multiplied by 100, and are interpreted as a percentage of consumption.

wealth to smooth their consumption variation, as already discussed in the literature on incomplete markets.

A comprehensive analysis of the welfare effect is reported in Table 8, detailing average welfare gains or losses based on binding status and net wealth. Regarding the labor supply channel, when controlling for the asset channel (within the same wealth group), households constrained by the 40-hour work week experience limited buffering of aggregate uncertainty through the labor supply channel. For instance, within the 40–80 percentile group, binding households experience more pronounced adverse effects (-0.0197) from business cycle fluctuations compared to their non-binding counterparts in the same group (-0.0146). In contrast, the asset channel remains active for all households. Overall, the welfare effect of business cycle fluctuations is larger for wealthier households, constrained or not.[38] As a result, households constrained by the 40-hour work week tend to face adverse consequences primarily due to the limited labor supply channel.

6 Conclusion

This paper investigates comprehensive implications linked to the 40-hour work week. A heterogeneous-agent model was developed to capture market incompleteness and the operative intensive and extensive margins of labor supply. The model's distinctive feature is the wage penalty function that households face when they work fewer hours than a specific threshold, resulting in a spike in the distribution of hours at that threshold.

After evaluating the model's ability to represent the distribution of individuals from various perspectives, the implications of the 40-hour work week are explored. This re-

[38] An exception arises for binding households in the bottom 40 percent, where the majority have negative wealth. The procyclical interest rate serves as a form of insurance for these households, enabling them to benefit from the business cycle. This insurance channel is limited for binding households in the same group.

veals three key findings. Firstly, the 40-hour work week significantly influences both micro and macro labor supply elasticities. Under the 40-hour work week restriction, micro elasticity is small, with significant heterogeneity among households. On the macro level, it yields a large elasticity with a composition effect between intensive and extensive margins. Secondly, under a 40-hour work schedule, both macro and micro elasticities respond modestly to changes in an underlying primitive—the curvature parameter for hours worked. Furthermore, treating micro elasticity independently underestimates macro elasticities implied by the model with a 40-hour work week. Therefore, one cannot regard both micro and macro elasticities as independent preference parameters, challenging traditional assumptions and emphasizing their interconnected nature within the context of the 40-hour work week. Lastly, households constrained by the 40-hour work week are more vulnerable to business cycles due to limited labor supply flexibility.

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Appendix

A The Computational Algorithm

A.1 Stationary Economy

The computational algorithm used for the steady-state economy is summarized. In this step, the stationary measure, $\overline{\mu}$ is determined. The detailed steps are as follows.

Step 1. Make guesses for endogenous parameters such as β, κ, and so forth.

Step 2. Construct grids for as asset holdings, a and logged individual labor productivity, $\hat{z} = \ln z$. The number of grids for a and $\widehat{z}$ are denoted as N_a and N_z, respectively. The following are selected: $N_a = 151$ and $N_z = 21$. a falls in the range of $[-0.5, 300]$. More asset grid points are assigned on the smaller values of a, while $\widehat{z}$ is equally distributed in the range of $[-3\sigma_z/\sqrt{1-\rho_z^2}, 3\sigma_z/\sqrt{1-\rho_z^2}]$.

Step 3. Approximate the transition probability matrices for individual labor productivity, $\mathbf{Q^z}$, using the Tauchen (1986) algorithm.

Step 4. Solve the individual value functions. In this step, the optimal decision rules for saving $a'(a,z)$ and hours worked $h(a,z)$, the value functions, $V(a,z)$, are obtained. The detailed steps are as follow:

(a) Compute the steady-state real wage rate based on the firm's first-order condition, where the steady-state capital return, $\overline{r}$, is chosen to be 1 percent.

(b) Have an initial guess for the value function, $V_0(a,z)$ for each grid point.

(c) Solve the consumption-saving problem for each employment status:

$$V_1^E(a,z) = \max_{a' \geq \overline{a}, h \geq \underline{h}} \Bigg\{ \ln\left(\overline{w} z g(h) + (1+\overline{r})a - a'\right)$$

$$-\psi \tfrac{h^{1+1/\gamma}}{1+1/\gamma} + \beta \sum_{z'} \mathbf{Q^z}(z,z') V_0(a',z') \Bigg\},$$

and

$$V_1^N(a,z) = \max_{a' \geq \bar{a}} \left\{ \ln\left((1+\bar{r})a - a' + \bar{\xi}\right) + \beta \sum_{z'} \mathbf{Q^z}(z,z') V_0(a',z') \right\}.$$

(d) Compute $V_1(a,z)$ as $V_1(a,z) = \max\left\{V_1^E(a,z), V_1^N(a,z)\right\}$.

(e) If V_0 and V_1 are close enough for each grid point, go to the next step. Otherwise, update the value functions ($V_0 = V_1$), and go back to (c).

Step 5. Obtain the time-invariant measure, $\bar{\mu}$, with finer grid points for assets holding. Compute the optimal decision rules for asset holdings with the new grid points using cubic spline interpolation. $\bar{\mu}$ can be computed using the new optimal decision rules and the transition probability matrices for individual labor productivity.

Step 6. Compute aggregate variables using $\bar{\mu}$. If targeted moments are sufficiently close to the assumed ones, then the steady-state equilibrium of the economy is found. Otherwise, reset the endogenous parameters, and go back to Step 4.

A.2 Economy with Aggregate Shocks

The following is a summary of the computational algorithm used for the economy with aggregate shocks. To solve the dynamic economy, the distribution across households, μ, which will affect prices, should be tracked. Instead, following Krusell and Smith (1998), the first moment of the distribution and the parametric forecasting function are used. The steps are as follow.

Step 1. Construct grids for aggregate state variables such as TFP shocks and the mean capital, and individual state variables such as the individual labor productivity and asset holdings. Construct 7 grid points for the aggregate capital, K, and TFP shocks, λ. The grid points for K and λ are equally spaced. The grids for individual state variables are the same as those in the steady-state economy.

Step 3. Parameterize the forecasting functions for K' and w.

Step 4. Given the forecasting functions for K' and w, solve the optimization problems for the individual households.[39] Solve the optimization problems for households and ob-

[39]Given the wage rate, w, the real interest rate, r, can be obtained from the firm's profit maximization.

tain the policy functions for asset holdings, $a'(a, z; K, \lambda)$, and consumption $c(a, z; K, \lambda)$, and the hours decision rule, $h(a, z; K, \lambda)$.[40]

Step 5. Generate simulated data for 3,500 periods using the value functions for individuals obtained in Step 4. The details are as follow.

(a) Set the initial conditions for K, λ, and $\mu(a, z)$.

(b) Obtain the market-clearing wage, w. Choose $\hat{w}$ as a guess for w. Given the forecasting functions and the evaluated value function obtained in Step 4, obtain the hours decision rule, $h(a, z)$. Check if the labor supply is equal to labor demand, i.e., $\int zg(h(a, z))d\mu = L^D$.[41] If not, update $\hat{w}$.

(c) Given the forecasting functions, the evaluated value function obtained in Step 3, and obtained w, solve the optimization problems for individual households to obtain the policy functions for asset holdings, $a'(a, z)$, and the hours decision rule, $h(a, z)$.

(d) Obtain aggregate variables based on the type distribution, μ, where $C = \int c(a, z)d\mu$, $L = \int zg(h(a, z))d\mu$, $K' = \int a'(a, z)d\mu$, $H = \int h(a, z)d\mu$, $Y = \lambda K^\alpha L^{1-\alpha}$, and $I = K' - (1 - \delta)K$.

(e) Obtain the next period measure $\mu'(a, z)$ using $a'(a, z)$ and transition probabilities for z.

Step 6. Obtain the new coefficients for the forecasting functions by the OLS estimation using the simulated time series.[42] If the new coefficients are close enough to the previous ones, the simulation is done. Otherwise, update the coefficients, and go to Step 4.

Table A.1 summarizes the estimated coefficients, the goodness of fit, and the accuracy of the forecasting rules. It is clear that R^2s for all forecasting functions are very large. The accuracy of forecasting rules was check, based on the statistics proposed by Den Haan (2010). It is found that mean Den Haan (2010) errors are sufficiently small (not exceeding

[40] As in the steady-state economy, the transition probabilities for z and λ are approximated using the Tauchen (1986) method.

[41] Given the wage rate, labor demand, N^D, can be obtained from the firm's first order condition.

[42] I drop the first 500 periods to eliminate the impact of the arbitrary choice of initial aggregate state variables.

Table A.1: ESTIMATES AND ACCURACY OF FORECASTING RULES

Dependent Variable	Coefficient Cons.	$\ln K$	$\ln \lambda$	R^2	Den Haan (2010) Error Mean (%)	Max (%)
$\log K'$	0.11519	0.94885	0.10143	0.9999	0.0679	0.3565
$\log w$	-0.13604	0.37335	0.85731	0.9999	0.0881	0.4981

0.1 percent), and maximum errors are also reasonably small (less than 0.5 percent) for the two forecasting functions.

B Micro-level Data

B.1 Current Population Survey (CPS)

For information on income and occupation status, the Annual Social and Economic Supplement (ASEC) of the CPS was used, which covers the years from 1976 to 2019. The ASEC of the CPS contains detailed questions covering economic characteristics surveyed in every March and provides estimates based on a survey of around 65,000 households. The basic unit of observations for the CPS is a household. Data for the CPS are downloaded from Integrated Public Use Microdata Series (IPUMS).[43] The key variables in the CPS are the following.

- Usual hours worked (ID: uhrsworkly): the number of hours per week that respondents usually worked if they worked during the previous calendar year. Individuals were asked this question if: 1) they reported working at a job or business at any time during the previous year or 2) they acknowledged having done "any temporary, part-time, or seasonal work even for a few days" during the previous year.

- Hours worked last week (ahrsworkt): the total number of hours the respondent was worked during the previous week. For employers and the self-employed, this includes all hours spent attending to their operation(s) or enterprise(s). For employees, this is the number of hours they spent at work. For unpaid family workers, this is the number of hours spent doing work directly related to the family business or farm (not including housework).

[43] https://cps.ipums.org/cps/index.shtml.

- Weeks worked last year (wkswork1): the number of weeks, in single weeks, that the respondent worked for profit, pay, or as an unpaid family worker during the preceding calendar year. Respondents were prompted to count weeks in which they worked even for a few hours and to include paid vacation and sick leave as work.
- Annual hours = weekly usual hours $\times$weeks worked last year

B.2 Panel Study of Income Dynamics (PSID)

The PSID samples for period 1970–1997 were used to calculate hours distribution reported in Figure A.1. The 1994 survey is used for the income and wealth distribution reported in Table A.2 and the hours distributions over productivity and assets reported in Figure 4. The key variables in the PSID are the following.

- Usual hours worked for head: the average hours worked per week on the main job last year.
- Income: total taxable income of head and wife.
- Labor earnings: the sum of several labor income components including wages and salaries and other components.
- Hourly wage rate for head: labor earnings/annual hours.
- Wealth: the sum of values net of debt value, and value of home equity.

C Welfare Measures

Conditional Welfare Measure The impact of economic fluctuations on an individual household's welfare is quantified using the consumption-equivalent welfare measure denoted as ω. This measure is determined by the following equality:

$$\mathbb{E}[V(a,z;K',\lambda')|\overline{K},\overline{\lambda}] = V(a,\beta,z;\overline{K},\overline{\lambda},\omega). \tag{A.1}$$

where
$$V(a,z;\overline{K},\overline{\lambda},\omega) = \max_{c_t,h_t} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\frac{\{(1-\omega)\, c_t\}^{1-\sigma} - 1}{1-\sigma} - \psi \frac{h_t^{1+1/\gamma}}{1+1/\gamma} \right) \right]$$

subject to the budget constraint (1), with the steady-state factor prices, $\overline{w}$ and $\overline{r}$. It is crucial to note that the expectation is conditioned on the steady-state aggregate variables, $\overline{\lambda}$, and $\overline{K}$, on the left-hand side of Equation (A.1). This implies a comparison of the welfare of the steady-state economy with that of the volatile economy, assuming equal aggregate capital. In this context, the average capital values of the fluctuating economy and the steady-state economy are nearly identical. As a result, the conditional compensating variation, ω, effectively represents the direct welfare effect of volatile aggregate productivity while keeping aggregate capital fixed at its steady-state level.

Unconditional Welfare Measure An alternative welfare metric is based on an unconditional value function. The unconditional effect associated with business cycles for each household is determined by ω^U, which satisfies the following:

$$\mathbb{E}[V(a,z;K,\lambda)] = V(a,z;\overline{K},\overline{\lambda},\omega^U). \tag{A.2}$$

Here, $V(a,z;\overline{K},\overline{\lambda},\omega^U)$ is defined similarly to in Equation (A.1). The operator $\mathbb{E}$ denotes an unconditional expectations operator. This approach compares mean welfare across the two economies without conditioning on the same initial point in the state space.

A difference between the conditional and unconditional welfare measures arises due to the dependence of the mean capital stock and labor on the volatility of the aggregate shock process. Consequently, these two measures generally lead to distinct interpretations.

D Additional Figures and Tables

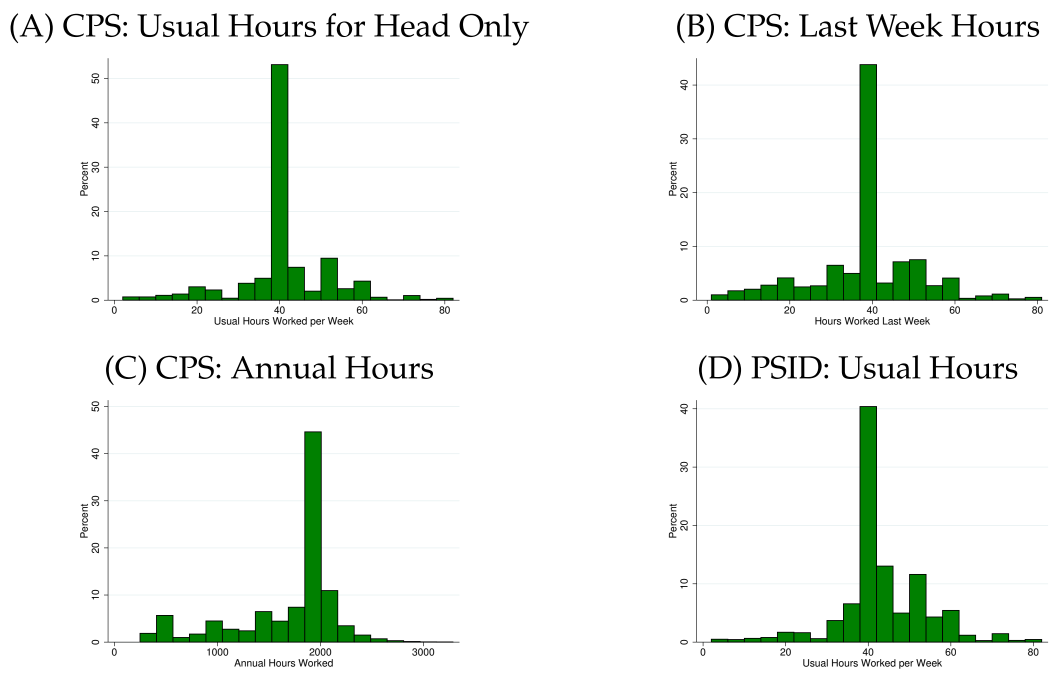

Figure A.1: ROBUSTNESS CHECK I: HOURS DISTRIBUTION

Note: Usual weekly hours for individual workers from the CPS over 1976-2019. Usual weekly hours from the PSID.

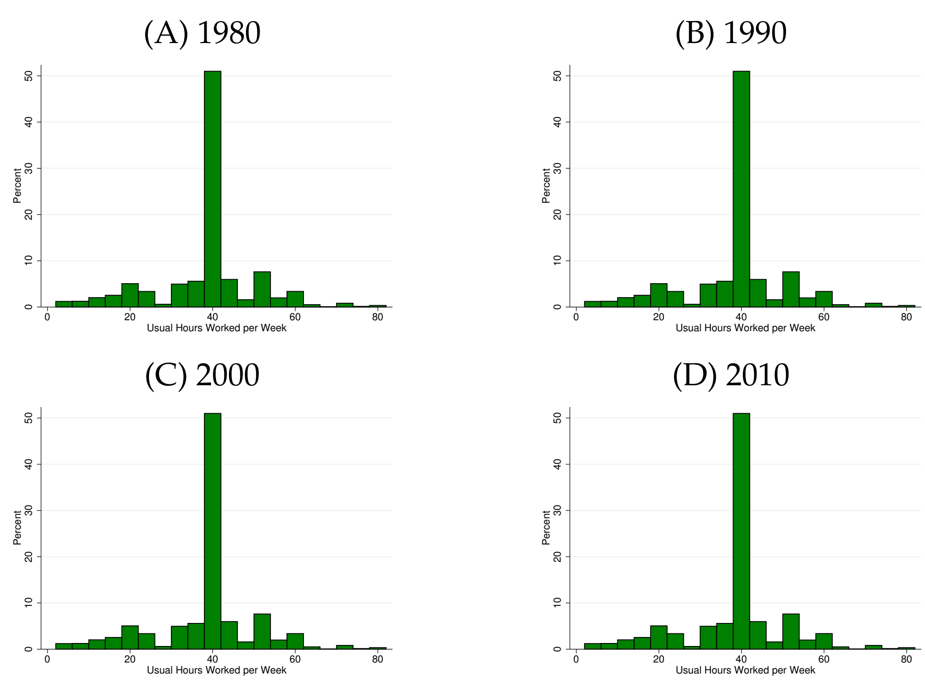

Figure A.2: ROBUSTNESS CHECK II: USUAL HOURS DISTRIBUTION ACROSS TIME

Note: Usual weekly hours for individual workers from the CPS.

Table A.2: WEALTH AND INCOME DISTRIBUTIONS

	Quintile					Gini
	1st	2nd	3rd	4th	5th	
			WEALTH DISTRIBUTION			
Data						
SCF 1992	-0.39	1.74	5.72	13.43	79.49	0.78
PSID 1994	-1.22	0.88	4.98	14.68	80.68	0.79
Model						
Benchmark	-0.82	0.74	5.62	18.47	75.97	0.74
No Wage Penalty	-0.86	0.62	5.30	18.12	76.83	0.75
			INCOME DISTRIBUTION			
Data						
SCF 1992	2.18	6.63	11.80	19.47	59.91	0.57
PSID 1994	-0.27	5.06	13.94	24.80	56.48	0.58
Model						
Benchmark	0.20	5.46	11.14	21.09	62.10	0.59
No Wage Penalty	0.02	5.20	11.04	20.66	63.07	0.61

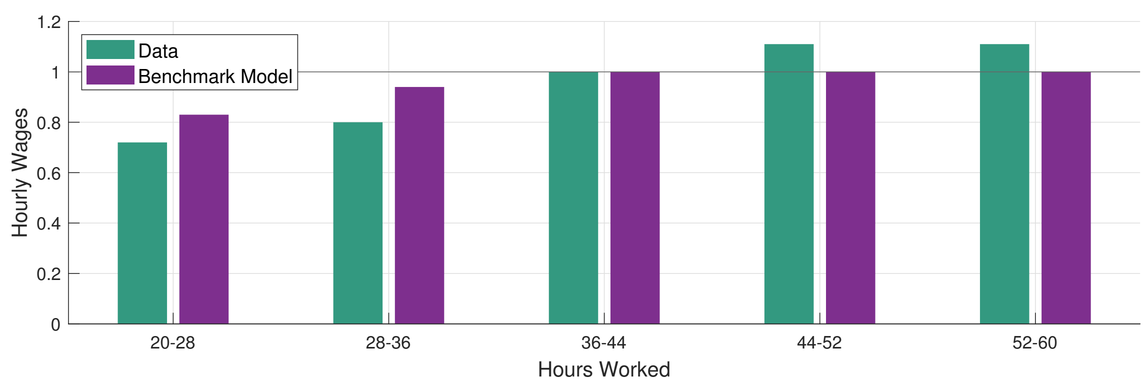

Figure A.3: WAGE-HOURS PROFILE II

Note: Average hourly wages across the hours bins in the benchmark model and the CPS. The hourly wage for the 36-44 hours bin is normalized to one for reference in both model and data. Hourly wages in the data are not controlled for various individual characteristics.

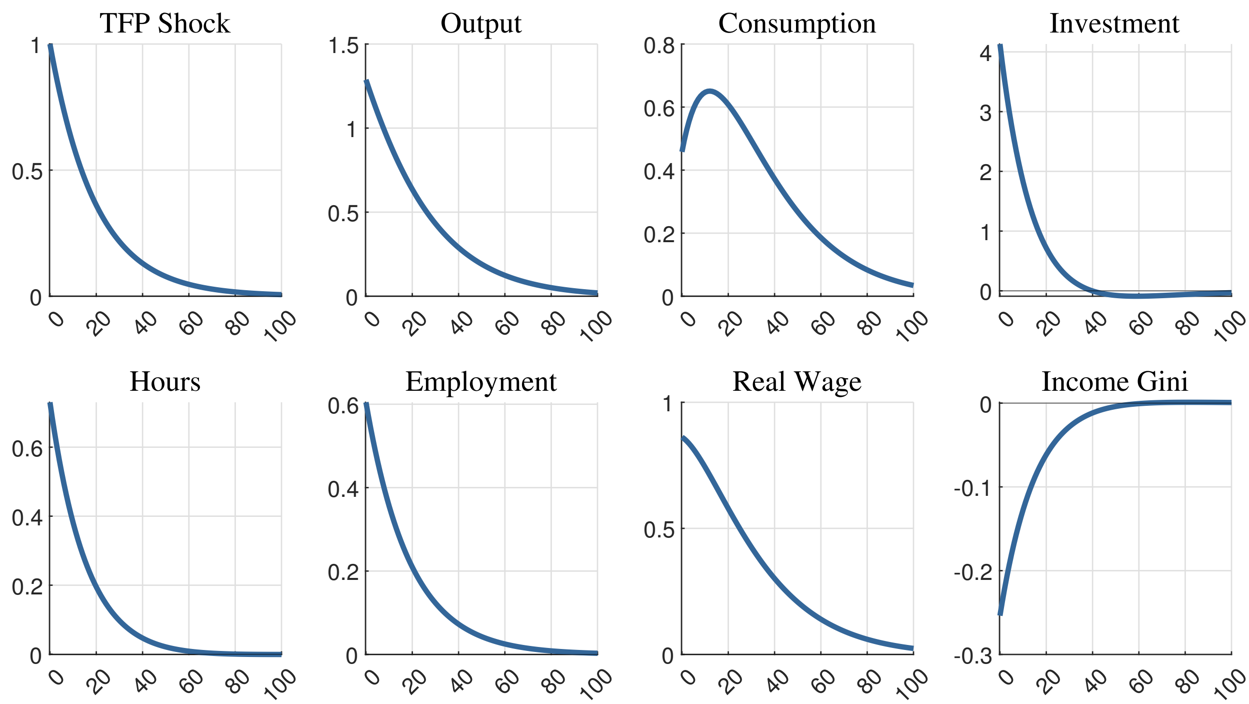

Figure A.4: Impulse Response to Aggregate Productivity Shock

Note: Impulse response to aggregate productivity shock. The y axis shows percent changes while the x-axis shows quarters after the shock.

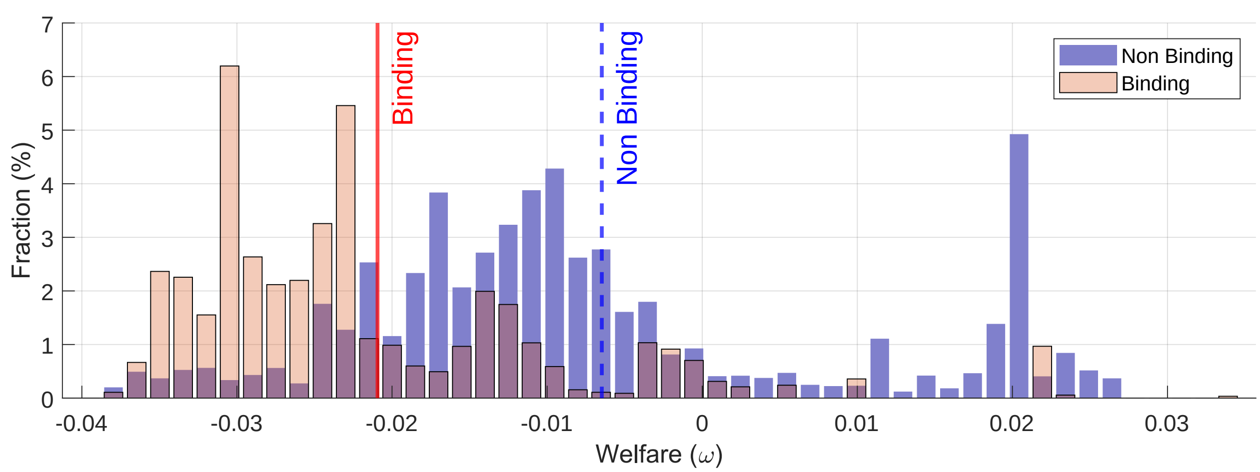

Figure A.5: Unconditional Welfare Effects of Business Cycles

Note: The x-axis is the consumption-equivalent welfare measure. The numbers are multiplied by 100, and are interpreted as a percentage of consumption.