Reservation Raises:
The Aggregate Labor Supply Curve at the Extensive Margin*

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Abstract
We present and put to use a simple sufficient statistic for employment preferences: an individual’s hypothetical percent change in her idiosyncratic potential earnings that would render her indifferent between employment and nonemployment. We call this concept the "reservation (pay) raise." The reservation raise generalizes the standard reservation wage concept to the context of heterogeneity in potential earnings. The population CDF of the reservation raises is the aggregate labor supply curve at the extensive margin. We directly elicit the reservation raise distribution in a household survey – thereby mapping out the global labor supply curve of the U.S. population. Locally, the curve exhibits large Frisch elasticities above 3, consistent with business cycle evidence. The empirical arc elasticities shrink towards 0.5 for larger, upward shifts, thereby also consistent with recent quasi-experimental evidence from tax holidays. Existing models fail to match the global shape of this empirical curve.

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1 Introduction

The short-run aggregate labor supply curve at the extensive margin – the total number of individuals desiring to work as a function of prevailing wages – is a crucial factor in business cycle models, as cyclical fluctuations in total hours are largely due to employment shifts (see, e.g., Heckman, 1984; Hansen, 1985). In market-clearing equilibrium models, the curve forms the iron link between wages and employment. In New Keynesian models, it shapes the trade-off between wage-inflation pressure and output, and hence also the price Phillips curve. In models of wage bargaining and wage posting, the curve enters workers’ reservation wages. The curve also determines the cyclical amplitude of potential labor market disequilibria and their welfare costs.

However, despite its theoretical centrality, many macro models sidestep extensive-margin labor supply entirely, instead relying on intensive-margin adjustment of average hours per worker only. If they do feature an extensive-margin labor supply curve, it tends to either be tangible and simple-to-parameterize but relies on abstractions (e.g., a fictional utilitarian head of a large household). Or, more realistic models may feature atomistic households making binary extensive-margin choices arising from overwhelming multi-dimensional heterogeneity, which obscures the labor supply curve, the particular factors of which are model-specific, and which would be challenging to calibrate to empirical moments germane to labor supply.

We present and put to use a simple framework for the extensive-margin aggregate labor supply curve. The framework builds a micro sufficient statistic we call the reservation (pay) raise: the hypothetical percent shift in an individual’s potential labor earnings required to render her indifferent between employment and nonemployment. Throughout, we use the term "raise" – positive or negative (a pay cut) – as an abstract placeholder for labor-tax-like percent shifters of potential labor earnings. For any given model, an individual’s reservation raise summarizes potentially heterogeneous tastes for leisure, marginal utilities of consumption, hours constraints, or productivity and hence potential wages. The cumulative distribution function of the micro reservation raises fully characterizes – is – the extensive-margin aggregate labor supply curve. Its argument is a homogeneous, tax-like percent shifter of potential earnings. This shifter can be thought of a generalized wage concept we call the prevailing aggregate raise. It could stand in for specific experiments such as aggregate productivity fluctuations, linear tax reforms, labor demand shocks, or certain labor market frictions.

The reservation raise concept is the sole scalar sufficient statistic characterizing employment preferences in the presence of heterogeneity in earnings. It is a simple, versatile extension of standard reservation wages, which are a sufficient statistic only under homogeneous potential earnings. The reservation raise concept thereby is consistent with, and generalizes, existing important approaches by Chang and Kim (2006, 2007); Gourio and Noual (2009);
Park (2017), who also model (and structurally estimate) employment adjustment as driven by marginal workers – but who draw on standard reservation wage distributions. By explicitly formulating the reservation raises, our framework aims to clarify, sharpen, and apply intuitions likely implicit in this existing work (chiefly Chang and Kim, 2006, 2007). While a basic additional step, our explicit scalar sufficient-statistics formulation is a handy and robust tool for measuring the extensive-margin labor supply curve empirically as well as quantitatively in calibrated models.

Our first application of the framework is to nonparametrically measure the global extensive-margin aggregate labor supply curve for the U.S. We do so by conducting a representative survey of U.S. households with tailored questions directly eliciting individual-level reservation raises. Our reservation raise question differs from existing reservation wage questions in three ways. First, it takes into account heterogeneity in potential earnings. Second and crucially, we elicit the preferences comprehensively from individuals across all labor force statuses, not just unemployed job seekers. Finally, our survey questions appeal to the Frischian, neoclassical labor supply notion rather than one rooted in frictional, sequential search.

The empirical reservation raise distribution exhibits a large mass around one – where an individual’s reservation wage equals her actual wage. This large mass of marginal workers implies a large local Frisch elasticity around and above 3. The local mass echoes the key properties from models of homogeneity and small employment surplus (e.g., Hansen, 1985; Rogerson, 1988; Hagedorn and Manovskii, 2008). Since business cycles feature small changes in wages (or productivity), this portion of the curve exhibits the high local elasticities implied by empirical business cycle evidence read through the lens of equilibrium labor market models.

Globally however, the empirical curve features arc elasticities that are far from constant. For large, upwards shifts, the arc elasticities drop to around 0.5. The global curve is therefore additionally consistent with quasi-experimental evidence for small Frisch elasticities, which draws on realized employment adjustment to very large, positive "raises", such as from income tax holidays (Bianchi, Gudmundsson, and Zoega, 2001; Chetty, Guren, Manoli, and Weber, 2012; Martinez, Saez, and Siegenthaler, 2018; Sigurdsson, 2018). In other words, the

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1 In this spirit, Chang and Kim (2006) plot model-implied reservation-wage graphs (i.e. quarterly earnings, in their Figures 3-5, where Figure 5 (the inverse CDF of reservation wages) in our understanding does not sufficiently pin down the labor supply curve with respect to an aggregate shifter, exactly because their model features heterogeneity in idiosyncratic productivity/wages). Chang and Kim (2007) refer to the same concept of reservation wages. By contrast, their model’s market wage would map into our prevailing aggregate raise, so indeed, their specific setting can easily be directly translated into our framework. Similarly, Chetty, Guren, Manoli, and Weber (2012) informally allude to aggregate labor supply in terms of reservation wages: "The size of the extensive margin responses depends on the density of the distribution of reservation wages around the economy’s equilibrium" (our emphasis).

2 The nonstant curve implies a trade-off between statistical power and overcoming adjustment costs (e.g., Chetty, Friedman, Olsen, and Pistaferri, 2011; Chetty, 2012), and measuring the local elasticities relevant for
empirical reservation raise distribution is widely dispersed, implying that the typical worker is inframarginal in that she derives considerable worker surplus, consistent with models of substantial heterogeneity in job surplus (e.g., Mortensen and Pissarides, 1994; Bils, Chang, and Kim, 2012; Jäger, Schoefer, and Zweimüller, 2019).

Methodologically, our approach, to trace out the global labor supply curve by eliciting nonparametric reservation raises in survey form, offers a new, third strategy to characterize the aggregate labor supply curve. It thereby complements structural estimations of specific parametric micro labor supply models with participation margins (e.g., Heckman and MaCurdy, 1980; Blundell, Pistaferri, and Saporta-Eksten, 2016; Attanasio, Levell, Low, and Sánchez-Marcos, 2018; Beffy, Blundell, Bozio, Laroque, and To, 2019), and emerging quasi-experimental estimates of specific arc elasticities from, e.g., income tax holidays (Bianchi, Gudmundsson, and Zoega, 2001; Chetty, Guren, Manoli, and Weber, 2012; Martinez, Saez, and Siegenthaler, 2018; Sigurdsson, 2018). These existing methods rely on realized employment allocations and hence need not isolate solely preferences.

Our nonparametric approach is consequential as we show that no existing model’s extensive-margin labor supply block comes close to capturing the empirical curve. By translating them into the reservation raise framework, the reservation raises serve as a bridge to illuminate and interrelate otherwise opaque model-implied curves. We study representative, full-insurance households with indivisible labor Hansen (1985); Rogerson (1988); MaCurdy (1981); Galí (2011a,b); Galí, Smets, and Wouters (2012). We also study the Rogerson and Wallenius (2009) lifecycle model with extensive and intensive margins. Finally, we introduce an extensive-margin choice into atomistic heterogeneous agent models with borrowing constraints (Bewley, 1986; Huggett, 1993; Aiyagari, 1994; Chang and Kim, 2006, 2007).

To assess the macroeconomic consequences of the empirical labor supply curve taken at face value, we reverse-engineer one model to tightly match the empirical curve. We then conduct a business cycle accounting exercise (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009) and measure the gap between the aggregate MPL and MRS time series ("labor wedge"). This exercise is in the spirit of, e.g., Lucas and Rapping (1969); Hall (1980, 1997), by relating empirical employment fluctuations to wage (productivity) driven movements along a stable aggregate labor supply curve. The model with the survey-consistent, fitted labor supply curve implies less countercyclical labor market disequilibria, and appears well approximated by one with high (2.5) constant elasticity.

smaller shocks (away from isoelasticity). Keane and Rogerson (2012, 2015) and Peterman (2016) discuss other factors potentially masking larger macro extensive-margin elasticities such as frictions, mismeasurement or heterogeneity.

The exercise in the spirit of Lucas and Rapping (1969) however assumes efficient rationing i.e. that employment allocations follow the pecking order implied by workers’ ranks in the reservation raise distribution. More broadly, our framework and its empirical implementation trace out desired spot-market labor supply, i.e. underlying preferences. Frictions may detach realized from desired employment allocations. Yet, the reservation raise framework may provide one handle in a dedicated future study on this related, long-standing question in labor and macroeconomics notoriously challenging to assess empirically. In fact, using the panel dimensions of our custom US survey and additionally drawing on large German household surveys linked to administrative social security data, we provide some suggestive evidence, relegated to the appendix, that in the micro data, realized employment outcomes are only imperfectly correlated with reservation raises.⁴

In Section 2, we present the reservation raise framework. In Section 3 we construct the empirical counterparts. In Section 4, we compare various models’ distributions with the empirical one, and calibrate one model to tightly match the empirical curve. In Section 5, we study macro implications of the empirical curve through business cycle accounting.

2 The Reservation Raise

We start at the micro level, defining the reservation raise as a sufficient statistic for employment preferences. The cumulative distribution function (CDF) of the reservation raises is the aggregate labor supply curve, of which we define arc elasticities. We finally discuss robustness of the framework to extensions beyond the baseline model.

2.1 Micro Labor Supply: Defining the Reservation Raises

We now derive the individual-level reservation raise for a benchmark spot labor market model. Consider an individual $i$ with time-separable utility $u_i(c_{it}, h_{it})$ from consumption $c_{it}$ and hours worked $h_{it}$, with budget Lagrange multiplier $\lambda_{it}$, and assets $a_{it}$ earning interest rate $r_{t-1}$:

$$\max_{a_{it},h_{it},c_{it}} \mathbb{E}_t \sum_{s=t}^{t_{\max}} \beta^{s-t} u_i(h_{is}, c_{is})$$

s.t. $a_{is} + c_{is} \leq a_{i,s-1}(1 + r_{s-1}) + (1 + \Xi_s) \theta_{is}(h_{is}) + T_{is}(\cdot) \quad \forall t_{\max} \geq s \geq t$. (2)

For now labor is indivisible, such that $h_{it} \in \{0, \bar{h}_{it}\}$; we permit intensive-margin hours choices below in Section 2.4. Pre-raise earnings at a given hours choice are $\theta_{is}(h_{is})$. For example, a specific version of earnings is $\theta_{is}(\bar{h}_{it}) = w_{it} h_{it}$, i.e. the standard linear schedule

⁴ For analyses of the efficiency of group-level employment cyclicalities and respectively employment adjustment at the separation margin, see Bils, Chang, and Kim (2012); Jäger, Schoefer, and Zweimüller (2019).
with constant wage rates. \( T_{it}(\cdot) \) denotes other taxes and transfers (unrelated to labor income and employment status). The framework would also permit other assumptions about asset market completeness such as borrowing constraints or richer state-specific assets.

**The Aggregate Labor Earnings Shifter vs. Idiosyncratic Earnings** \((1 + \Xi_t)\) is a *homogeneous* labor income shifter of *heterogeneous* baseline labor earnings \( \theta_{it}(h_{it}) \). For convenience, we will usually refer to multiplier \( 1 + \Xi_t \) rather than \( \Xi_t \) as the raise (such that a unit raise, \( 1 + \Xi_t = 1 \) refers to a zero percent raise). We permit also negative raises (pay cuts), of course.

Raise \((1 + \Xi_t)\) stands in for experiments such as aggregate wage fluctuations, changes in labor demand, or changes in labor taxes. Individual labor earnings \( \theta_{it}(h_{it}) \) are always defined *gross* of this aggregate raise \( 1 + \Xi_t \), and the individual’s allocative, post-raise earnings are \((1 + \Xi_t)\theta_{it}(h_{it})\). The prevailing aggregate raise \((1 + \Xi_t)\) will operationalize the question: how much would aggregate labor supply change if all labor earnings shifted by a percent amount given by raise \( 1 + \Xi_t \)? For example, if \( 1 + \Xi_t \) denotes linear labor income taxes, \( \theta_{it}(h_{it}) \) in turn denotes gross-of-tax earnings. Alternatively, one can define \( \theta_{it}(h_{it}) \) as being post-tax earnings, and \( 1 + \Xi_t \) in turn denotes an incremental linear tax. If \( 1 + \Xi_t \) is to represent a shift in labor productivity and the model has workers be paid their marginal product, then individual-level earnings \( \theta_{it}(h_{it}) \) will be baseline earnings gross of that shift, or normalized accordingly.

**Micro Labor Supply** The discrete employment choice compares costs and benefits of working. On the labor disutility side, working rather than not comes at (net opportunity) utility cost \( v_{it} = u_i(c_{it}^{h=0,\lambda_{it}},0) - u_i(c_{it}^{h=\tilde{h}_{it},\lambda_{it}},\tilde{h}_{it}) \), where consumption is respectively optimized against a constant \( \lambda \), corresponding to the Frischian experiments below and thereby also accommodating nonseparable preferences conditional on the labor supply choice. \( v_{it} \) may also include fixed participation costs (Cogan, 1981). On the benefit side, labor earnings if working are equal to potential earnings \( y_{it} = \theta_{it}(\tilde{h}_{it}) \) (and zero otherwise).

Labor supply assigns each individual \( i \) her desired hours \( h^*_{it} \in \{\tilde{h}_{it},0\} \), a binary discrete choice due to indivisible labor, according to a cutoff rule:

\[
 h^*_{it} = \begin{cases} 
 0 & \text{if } (1 + \Xi_t)\theta_{it}(\tilde{h}_{it})\lambda_{it} < v_{it} \\
 \tilde{h}_{it} & \text{if } (1 + \Xi_t)\theta_{it}(\tilde{h}_{it})\lambda_{it} \geq v_{it}.
\end{cases}
\]  

(3)

Equivalently, desired extensive-margin labor supply (the desired employment status) \( e^*_{it} \in \{0,1\} \) is given by:

\[
e^*_{it} = \begin{cases} 
 0 & \text{if } (1 + \Xi_t)y_{it}\lambda_{it} < v_{it} \\
 1 & \text{if } (1 + \Xi_t)y_{it}\lambda_{it} \geq v_{it}.
\end{cases}
\]  

(4)
That is, an individual prefers employment if the utility benefits, \((1 + \Xi_t) y_{it} \lambda_{it}\), outweigh the utility cost, \(v_{it}\) (such that the post-raise earnings exceed the extensive-margin MRS). For marginal – i.e. indifferent – individuals, the condition holds with equality.

**Reservation (Pay) Raises** The sufficient statistic for an individual’s extensive-margin labor supply preferences is her idiosyncratic reservation raise \(1 + \xi_{it}^*: \) the hypothetical aggregate prevailing labor income raise \(1 + \Xi_t\) that would render her marginal in a Frischian (\(\lambda\)-constant) setting:

\[
1 + \xi_{it}^* \equiv \frac{v_{it}}{y_{it} \lambda_{it}}.
\]  

The reservation raise captures the *rent, or surplus, from employment*. It encodes three basic elements: potential labor earnings \((y_{it})\), budget multipliers \((\lambda_{it})\), and labor disutility \((v_{it})\). In turn, these three components capture rich model-specific sources of heterogeneity, such as wealth, borrowing constraints, skills, hours requirements, job amenities, time endowments, or tastes for leisure.

Micro labor supply is then a cutoff rule of reservation vs. prevailing aggregate raise:

\[
e^*_it = \begin{cases} 
0 & \text{if } 1 + \xi_{it}^* > 1 + \Xi_t \\
1 & \text{if } 1 + \xi_{it}^* \leq 1 + \Xi_t.
\end{cases}
\]  

**Reservation Raises Vs. Reservation Wages** Our reservation raise concept is a generalization of the more standard reservation wage to the context of wage heterogeneity. The reservation raise is the reservation wage normalized by potential earnings. Of course, when potential earnings are homogeneous, reservation wages \(y_{it}' \equiv \frac{v_{it}}{\lambda_{it}}\) would sufficiently characterize labor supply preferences at the extensive margin. However, with heterogeneity in potential earnings, reservation wages alone do not sufficiently characterize employment preferences without simultaneous reference to each individual’s potential earnings. By contrast, the reservation raise concept \(1 + \xi_{it}^* \equiv \frac{v_{it}}{y_{it} \lambda_{it}} = \frac{y_{it}'}{y_{it}}\) is the one-dimensional statistic sufficient to rank individuals on an aggregate labor supply curve with respect to a homogeneous shift in earnings such as in form of \(1 + \Xi_t\). We provide a more empirically focused discussion of the distinction in Section 3.1, where we measure the reservation raises in a custom survey.

In the introduction, we have already discussed related work explicitly referring to standard reservation wages, specifically Chang and Kim (2006, 2007), with which our current section is entirely consistent. Our main contribution is our explicit definition, formulation and study of the reservation raise concept, results that are almost certainly implicit in such existing work.

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5 The lower case differentiates the micro reservation raise from the aggregate prevailing raise. The *-symbol denotes the indifference condition rather than a potential idiosyncratically prevailing micro raise.
The rest of the paper is devoted to putting the reservation raise concept to use conceptually, quantitatively, and empirically.

**Frischian Focus** The framework does not depend on the Frischian assumption of constant \( \lambda \). The concept of the reservation raise can be defined also in the presence of income effects, which no longer hold \( \lambda \) constant (for one example, see Section 2.4). We focus on the Frischian context mainly because it does not require reference to the temporal dimension of the shift in the benefit of working, because of the attention the Frischian variant specifically has received in the literature, and because this focus streamlines the formal exposition.

### 2.2 Aggregate Extensive-Margin Supply: the CDF of Reservation Raises

The distribution of reservation raises in period \( t \), given by CDF \( F_t(1+\xi^*) \), is the sufficient statistic for any given model’s aggregate short-run labor supply curve as a function of Frischian (\( \lambda \)-constant) shifts in \( 1+\Xi_t \), summarizing all heterogeneities relevant to extensive-margin labor supply.

Aggregate desired employment rate \( E_t \) equals the fraction of workers (defined by index \( i \in [0, 1] \)) with \( 1 + \xi^{*i} \leq 1 + \Xi_t \):

\[
E_t (1 + \Xi_t) = \int e^{*i} d\xi = \int_{-\infty}^{\infty} 1 (1 + \xi^* \leq 1 + \Xi_t) dF_t(1 + \xi^*) \\
= F_t (1 + \Xi_t). \tag{7}
\]

Employment adjustment to the aggregate raise- or tax-like income shifter from \( (1 + \Xi_t) \) to \( (1 + \Xi'_t) \), is driven by the mass of nearly-marginal workers (for whom \( 1 + \Xi_t < 1 + \xi^{*i} \leq 1 + \Xi'_t \)), namely \( F_t(1 + \Xi'_t) - F_t(1 + \Xi_t) \).

### 2.3 The Aggregate Extensive-Margin Frisch Elasticity

**Definition** In the reservation raise framework, the extensive-margin Frisch labor supply elasticity emerges as one local property. For discrete raise changes, the arc elasticity is:

\[
\epsilon_{E_t, (1+\Xi_t) \rightarrow (1+\Xi'_t)} = \frac{F_t \left( 1 + \Xi'_t \right) - F_t (1 + \Xi_t)}{F_t (1 + \Xi_t)} \frac{(1 + \Xi'_t) - (1 + \Xi_t)}{1 + \Xi_t}. \tag{9}
\]

For infinitesimal changes in \( (1 + \Xi_t) \), the elasticity is:

\[
\epsilon_{E_t, 1+\Xi_t} = \frac{F_t}{E_t} \frac{\partial E_t}{\partial (1+\Xi_t)} = \frac{(1 + \Xi_t) f_t(1 + \Xi_t)}{F_t(1 + \Xi_t)}. \tag{10}
\]

For a pre-existing labor-tax-like shifter normalized to \( 1 + \Xi_t = 1 \), the elasticity is the reverse hazard rate (or inverse Mills ratio) at threshold 1, i.e. \( f_t(1)/F_t(1) \) (any pre-existing tax system
can be subsumed as net earnings $y_{it}$ without loss of generality).

**Constant Elasticity** We now clarify the general conditions on the reservation raise distribution for constant elasticities, a property convenient for calibration and often assumed in modeling practice. Additionally, empirical work often thinks of a single elasticity to be measured, hence taking isoelasticity as the implicit point of departure (e.g., Chetty, Guren, Manoli, and Weber, 2012). Isoelasticity requires a power law reservation raise distribution. Suppose $1 + \xi^*$ follows a distribution $G_{1+\xi^*}(1 + \xi^*) = \left( \frac{1 + \xi^*}{(1 + \xi^*)_{\max}} \right)^{\alpha_{1+\xi^*}^*}$ with shape parameter $\alpha_{1+\xi^*}^*$ and maximum $(1 + \xi^*)_{\max}$.\(^6\) All interior arc elasticities of this reservation raise distribution are constant and equal to $\epsilon_{E_{it},1+\xi_t} = \alpha_{1+\xi^*}^*$ (using Equation (9)). The arc elasticities mechanically shrink once a perturbation is large enough to cross full nonemployment or employment. Finally, such a power law distribution can emerge as long as any one of the reservation raise components $(v_{it}, 1/\lambda_{it}, 1/y_{it})$ is power-law-distributed conditional on the other two.\(^7\)

### 2.4 Extensions and Robustness

The reservation raise concept remains robust to a series of extensions within the spot-labor market setting.

**Heterogeneous Shocks** While business cycle or tax reforms studies often consider homogeneous income shifters, the framework can be extended to accommodate heterogeneous shocks by partitioning individuals into groups within which shocks are homogeneous, and then applying the framework within each group. Rather than taking one aggregate raise as

\(^6\)Specifically, the distributional assumptions specify a standard power law distribution $F(X) = P(X < X) = a \cdot (x/X_{\min})^{-\gamma}$ with shape parameter $\gamma > 0$. A comparison with our reservation-raise-based power law distribution $G_{1+\xi^*}(1 + \xi^*) = \left( \frac{1 + \xi^*}{(1 + \xi^*)_{\max}} \right)^{\alpha_{1+\xi^*}^*}$ clarifies that we require the inverse of the reservation raises to follow a power law distribution: $G_{1+\xi^*}(1 + \xi^*) = P(X < 1 + \xi^*) = \left( \frac{1 + \xi^*}{(1 + \xi^*)_{\max}} \right)^{-\alpha_{1+\xi^*}^*}$, which is a power law distribution of $\frac{1}{1 + \xi^*}$ with minimum $\frac{1}{(1 + \xi^*)_{\max}}$, and shape parameter $\gamma = \alpha_{1+\xi^*}^* + 1$.

\(^7\) For example, let $v_{it}$ follow a power law distribution with maximum $v_{\max}$ and shape parameter $\alpha_{v_{it}}$ independent from $g(y, \lambda)$, the joint distribution of $y_{it}$ and $\lambda_{it}$. The distribution of $1 + \xi_{it}^*$ is then: $F_{i}(1 + \xi_{it}^*) = P \left( 1 + \xi_{it}^* \leq 1 + \Xi_{it} \right) = P \left( v_{it} < (1 + \Xi_{it})y_{it}\lambda_{it} \right) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \min \left\{ (1 + \Xi_{it})y_{it}\lambda_{it}^{\alpha_{v_{it}}} / v_{\max}, 1 \right\} g_{i}(y, \lambda) dy d\lambda$. A powerful case is $(1 + \Xi_{it})y_{it}\lambda_{it}/v_{\max}^{\alpha_{v_{it}}^*} < 1$ for each $(y, \lambda)$-type. Economically, this property implies positive nonemployment in each $(y, \lambda)$-type at $1 + \Xi_{it}$. Then the distribution becomes a "clean" power law distribution with shape parameter $\alpha_{v_{it}}$ and maximum $1 + \xi_{\min}^v = v_{\max} \left[ \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (y\lambda)^{\alpha_{v_{it}}} g_{i}(y, \lambda) dy d\lambda \right]^{-1/\alpha_{v_{it}}}$. That is, we have indexed the population by $(y, \lambda)$. Within each $(y, \lambda)$-type, the reservation raise is power law distributed since $v_{it}$ is. So each $(y, \lambda)$-type exhibits a constant elasticity $\alpha_{v_{it}}$. The aggregate elasticity – the weighted average of $(y, \lambda)$-types’ elasticities $\alpha_{v_{it}}$ – is hence also $\alpha_{v_{it}}$. By contrast, if $\Xi_{it}$ or $\xi_{\min}^v$ is low enough for full employment in some types, these types’ labor supply will be locally inelastic, so the aggregate elasticity will be smaller than $\alpha_{v_{it}}$, at $\alpha_{v_{it}} \cdot P(1 + \Xi_{it})y\lambda < v_{\max}$. A special case of the power law distribution is if the disutility follows that specific distribution. The New Keynesian models presented in Gali (2011a,b); Gali, Smets, and Wouters (2012) thereby also microfound the isoelasticity at the extensive margin, hence a special case of the general condition.
the argument, aggregate labor supply is then a function of a vector of group-specific shifters. Specifically, it is equal to the weighted average of the group-specific CDFs each evaluated by their respective prevailing group raise.

**Job Menus and Intensive-Margin Choices** We show robustness to intensive-margin choices in a general way using job menus. Rather than having one choice of a job \((h_{it} \in \{\bar{h}_{it}, 0\})\), suppose job choice \(j\) is from a job menu \(J_{it} = \{(y_{it,j}, v_{it,j})\}_j\), in which each job \(j\) is defined by its attributes \((y_{it,j}, v_{it,j})\) and hence may differ in earnings and disutility (or amenities). This extension to job menus thereby also nest standard simple hours choices with constant wages, for example.

Our solution proceeds in two steps. First in the "inner loop," for any given prevailing raise \(1 + \Xi_t\), we define the intensive-margin job choice – at which stage we therefore intentionally ignore the participation constraint i.e. the extensive-margin choice:

\[
\max_{a_{it}, j_{it} \in J_{it}, c_{it}} \mathbb{E}_t \sum_{s=t}^{t_{max}} \beta^{s-t} u(j_{is}, c_{is}, e_{it} = 1, e_{i,s>t}) \quad \text{(11)}
\]

\[
\text{s.t. } a_{is} + c_{is} \leq a_{i,s-1}(1 + r_{s-1}) + (1 + \Xi_s) y_{is,j_{is}} + T_{is}(.), \quad \forall t \leq s \leq t, \quad \text{(12)}
\]

where optimal job choice is defined as a discrete choice maximizing utility. This "inner loop" gives the best job choice conditional on working and conditional on the prevailing raise \(1 + \Xi_t\):

\[
j^*(1 + \Xi_t) = \arg\max_{j \in J_{it}} \{\text{(11) s.t. (12)} | 1 + \Xi_t\}. \quad \text{(13)}
\]

Second, in the "outer loop," extensive-margin labor supply is determined by an augmented cutoff rule for employment, where the job choice from the job menu is optimized, given a prevailing raise \(1 + \Xi_t\), as defined in Equation (13):

\[
e^*_it = \begin{cases} 
0 & \text{if } (1 + \Xi_t) y_{it,j^*(1+\Xi_t)} \lambda_{it} < v_{it,j^*(1+\Xi_t)} \\
1 & \text{if } (1 + \Xi_t) y_{it,j^*(1+\Xi_t)} \lambda_{it} \geq v_{it,j^*(1+\Xi_t)}.
\end{cases} \quad \text{(14)}
\]

Here, the individual-level reservation raise is an implicitly defined fixed point: it is the prevailing raise that would render the individual indifferent between working and not working, conditional on having (re-)optimized job choice:

\[
1 + \xi^*_it = \frac{v_{it,j^*(1+\Xi_t)}}{y_{it,j^*(1+\Xi_t)} \lambda_{it}}. \quad \text{(15)}
\]

These results also formally clarify that the job/hours choice under a prevailing raise \(1 + \Xi_t\)
need not be the hours choice relevant to the reservation raise, since job switching and hours reoptimization may occur towards the marginal job \( j^*(1 + \xi_{it}^*) \).

This extended reservation raise framework also illustrates how nonconvexities generate extensive margins. Consider the specific case in which jobs differ by hours only, so potential earnings from working \( h_{it} \) hours is \( y_{it} = h_{it}w_{it} \). With perfectly unrestricted hours choice and no nonconvexities, such as with standard MaCurdy (1981) hours disutility, the hours choice is \( h_{it}^{1/\eta} = (1 + \Xi_t^*)\lambda_{it}w_{it} \): employment is positive at any positive prevailing raise level. Intuitively, at zero hours of work, there is no first-order disutility of work but a first-order consumption gain – precluding a meaningful extensive margin. This consideration emerges in the Rogerson and Wallenius (2009) model in our model meta-analysis in Section 4.

Non-Frischian, Uncompensated Variation The paper focuses on Frischian labor supply, but the framework generalizes to non-Frischian contexts where \( \lambda \) need not remain constant. Examples are longer-lived shifts that entail wealth effects, amplified by borrowing constraints or adjustment costs in asset liquidation.

To study non-Frischian settings, we extend the one-period raise to an explicit horizon. Let \( 1 + \Xi_{t,t+\Delta} \) denote a raise perturbation lasting for duration \( \Delta \) (e.g., a discrete amount of periods, with \( \Delta = 0 \) denoting a one-period deviation). Extreme cases are an instantaneous, perfectly transitory shift \( 1 + \Xi_{t,t} \), and a permanent raise \( 1 + \Xi_{t,t+\infty} \). Consider settings in which at least for the time interval of the perturbation \( \Delta \), the other parameters are stable. \( \lambda_{it}(1 + \Xi_{t,t+\Delta}) \) denotes the budget multiplier, which in this non-Frischian context may be \((1 + \Xi_{t,t+\Delta})\)-dependent. The decision rule for period-\( t \) employment then is:

\[
\begin{align*}
    e_{it}^* &= \begin{cases} 
    0 & \text{if } (1 + \Xi_{t,t+\Delta})y_{it} \lambda_{it}(1 + \Xi_{t,t+\Delta}) < v_{it} \\
    1 & \text{if } (1 + \Xi_{t,t+\Delta})y_{it} \lambda_{it}(1 + \Xi_{t,t+\Delta}) \geq v_{it}.
    \end{cases}
\end{align*}
\]

The reservation raise continues to be defined analogously to the Frischian raise, yet now (as in the intensive-margin case), as a fixed point \( 1 + \xi_{t,t+\Delta}^* \), implicitly defined as the hypothetical prevailing raise \( 1 + \Xi_{t,t+\Delta} \) of duration \( \Delta \) that would leave the worker indifferent between working for that time interval \([t, t + \Delta]\) and not working:

\[
1 + \xi_{t,t+\Delta}^* = \frac{v_{it}}{y_{it} \cdot \lambda_{it}(1 + \xi_{t,t+\Delta}^*)}.
\]

Non-Frischian raises \( 1 + \Xi_{t,t+\Delta} \) with \( \Delta > 0 \) capture two effects. First, the substitution effect going along the reservation raise distribution holding \( \lambda \) constant – i.e. the Frischian case studied previously. Second, a wealth effect may also shift \( \lambda_{it}(1 + \Xi_{t,t+\Delta}) \), working in the
opposed direction. As a result, Frischian contexts may to some degree not provide accurate descriptions of the full labor supply adjustment. (In principle, even in the context of wealth effects, a Frischian variation can be induced in practice or theory by offsetting lump sum tax or transfers $T$.)

We quantitatively evaluate the divergence between uncompensated and Frischian labor supply curves in three specific calibrated models (which we further study in Section 4, and derive in detail in Appendix Section A): a representative household with a 2.5 Frisch labor supply isoelasticity, a finitely-lived atomistic household with also an intensive margin, and a heterogeneous agent model with uninsured potential-earnings shocks and borrowing constraints. Computational details for these uncompensated exercises are in Appendix Section A. In each exercise, we simulate an unexpected aggregate raise perturbation lasting for one quarter, a useful horizon for business-cycle frequencies. Appendix Figure A.2 plots the 3x2 aggregate labor supply curves. The uncompensated curves are very close to their reservation-raise-implied Frischian curves. We conjecture that larger divergence may arise with illiquid assets such as those studied in Kaplan, Violante, and Weidner (2014); Kaplan, Moll, and Violante (2018), although these specific models do not feature extensive margins but rely on intensive-margin labor supply only.

**Net vs. Gross Earnings, Nonemployment Subsidies, and Home Production** Monetary (nondisutility) opportunity costs of working, such as nonemployment-subsidizing programs (e.g., unemployment insurance) or home production, which we denote as $b_{it}$, affect labor supply by shaping the outside option to market work (taxes $T(.)$, since taken as parametric in labor supply, do not capture such terms).

First, if the opportunity costs $b_{it}$ itself is subject to the raise (e.g., home production if shifting with TFP as the shifter), it can be folded into a richer net potential earnings concept $\hat{y}_{it} = y_{it} - b_{it}$ (gross earnings $y_{it}$ minus $b_{it}$). The reservation raise logic then goes through where $b_{it}/\hat{y}_{it}$ is a "replacement rate":

$$1 + \xi^*_{it} = \frac{v_{it}}{(y_{it} - b_{it})\lambda_{it}} = \frac{v_{it}}{y_{it}(1 - \frac{b_{it}}{y_{it}})\lambda_{it}} = \frac{v_{it}}{y_{it} \hat{y}_{it} \lambda_{it}},$$

(18)

Second, if $b_{it}$ is not marked up by the prevailing raise (e.g., acyclical nonemployment sub-
sities), then $b_{it}$ can (albeit with some obfuscation, since also marked up by $\lambda_{it}$) fold into disutility of labor $\bar{v}_{it} = v_{it} + b_{it}\lambda_{it}$:

$$1 + \xi^*_it = \frac{v_{it} + b_{it}\lambda_{it}}{y_{it}\lambda_{it}} = \frac{\bar{v}_{it}}{y_{it}\lambda_{it}}. \quad (19)$$

The framework clarifies that the effect of $b_{it}$-like factors on labor supply is two-fold. First and conventionally, $b_{it}$ may shift the level of labor supply. Second, institutional arrangements working through $b_{it}$ may also affect labor supply elasticities, namely by shifting the threshold of the marginal individual in the presence of nonconstant elasticities (complementing mechanisms explored in Prescott, 2004; Schoefer, 2010).

**Nonwage Job Amenities** Nonwage job amenities can simply be folded into a net disutility of work $v'_j$ for each job $j$, encompassing all nonmonetary flow utility gains.

**Multi-Member Households and Family Labor Supply** In Frischian contexts, the framework directly extends to multi-member households, under the assumption of members’ disutility of labor being separate (as in, e.g., Blundell, Pistaferri, and Saporta-Eksten, 2016; Beffy, Blundell, Bozio, Laroque, and To, 2019). Away from this assumption, as with general utility specifications in unitary household models or in collective models (Chiappori, 1992; Rogerson and Wallenius, 2019), individual-level reservation raises interact through disutility of labor $v_{it}$. Still, we suspect that individuals can be ordered by their reservation raise taking into account the optimization of the other members, somewhat akin to the fixed point arguments underlying the intensive-margin job menu choices above.

**Dynamic Considerations** Deviations from the spot frictionless benchmark generates additional dynamic considerations, for instance with human capital accumulation on the job, as in Imai and Keane (2004), or its decumulation when nonemployed as in Ljungqvist and Sargent (1998).

**Frictions and Unemployment** Frictions (such as search) generate gaps between the desired and realized employment status. For example, the unemployed in our setting are more similar to the employed rather than to those out of the labor force (as the unemployed will have have reservation raises below one i.e. they would like to work yet perhaps due to search frictions have yet to obtain an employment opportunity). This classification contrasts with the focus on how to divide the nonemployed into the unemployed vs. out of the labor force as in (Flinn and Heckman, 1983). Dedicated treatments of labor supply notions in the context of search frictions are provided by Hall (2009), Krusell, Mukoyama, Rogerson, and Sahin (2017) and Cairo, Fujita, and Morales-Jimenez (2019).
3 Measuring the Reservation Raise Distribution in a Survey

Having formulated the theoretical extensive-margin aggregate labor supply curves as the reservation raise distribution, we now trace out the empirical distribution drawing on a custom U.S. household survey. We follow three steps, mirroring the model steps from Section 2:

E1 Elicit individual-level reservation raises $1 + \xi^*_i$.

E2 Construct and plot CDF $F_t(1 + \xi^*)$, the aggregate labor supply curve.

E3 Compute extensive-margin labor supply arc elasticities from the CDF.

3.1 Eliciting Individual-Level Reservation Raises

Our primary data set is a custom survey of U.S. households comprising all labor force segments (aged 18 and older), of which we ask a tailored question eliciting directly their idiosyncratic reservation raises. We are to our knowledge the first to attempt to elicit any reservation wage concepts (let alone reservation raises) from non-job-searchers.

Survey We implement this approach with a tailored survey questionnaire in a nationally representative U.S. survey of 2,000 respondents. Our survey was fielded by NORC (University of Chicago), in a sample drawn from the AmeriSpeak Omnibus survey program. We also obtain additional demographic variables permitting us to study the covariates of the reservation raises and to conduct subsample analyses. We also ask a series of additional questions related to the individuals’ previous and forward-looking labor supply biography. We present summary statistics in Table 3, for all workers, and separately by labor force status.

Ideal Measure of the Reservation Raise To fix ideas, we start with the ideal survey question tightly mirroring the theoretical reservation raise:

You are currently [non]employed. Suppose the following thought experiment: you (and only you) receive an additional temporary linear incremental tax [or subsidy] on your take-home earnings (at whichever hours or job you may choose to work). At what incremental tax [or subsidy] rate would you be indifferent

---

9 Our survey was conducted in two waves in March and April, 2019. NORC provides sample probability weights to match the American adult demographic. We rescale the weights in each wave to represent the proportion of the total sample obtained from each wave. The first wave, dated March 19th 2019, contributed 809 observations with non-missing reservation raise responses; the second wave, dated April 19th 2019, contributed 870 individuals with non-missing reservation raise responses. Then, we reweight the observations so that the weighted labor force status proportions precisely match the February 2019 BLS population shares for employment, labor force participation, and unemployment (although the raw sample was very close to the BLS targets, see Table 3).
between working for this period and not (at whichever job would be your best choice at that tax [subsidy] rate)?

This approach invokes an additional tax [subsidy] on top of any potentially pre-existing taxes and frictions, thereby normalizing the marginal worker’s reservation raise to one. One therefore does not have to take a stance on the level of the already-prevailing aggregate labor tax or tax-like factors, broadly defined, in the data. Formally, we would elicit a normalized reservation raise \(1 + \tilde{\xi}_{it}^*\) corresponding to:

\[
v_{it} = (1 + \tilde{\xi}_{it}^*) \left[ (1 + \Xi_t) y_{it} \right] \lambda_{it}
\]

\[
\Leftrightarrow 1 + \tilde{\xi}_{it}^* = \frac{v_{it}}{\left[ (1 + \Xi_t) y_{it} \right] \lambda_{it}} = \frac{1 + \xi_{it}^*}{1 + \Xi_t}.
\]

**Comparison to Standard Reservation Wage Measures** Our attempt to empirically measure the reservation raise concept contrasts with more standard existing reservation wage measures in at least two important ways. First, as we theoretically described in Section 2, conceptually the reservation raise measure is the sole sufficient statistic for employment preferences in the presence of wage heterogeneity. A reservation wage only plays this role in the knife-edge case of wage homogeneity, an empirically (and in many of our models also theoretically) uninteresting case. (As we clarify in Section 2 and implement for a series of surveys of job seekers in Appendix Section B, one could in principle construct reservation raises by dividing reservation wages by proxies for potential earnings.) Rather than a wage level, the reservation raise corresponds to the individual-specific percent change in her potential earnings corresponding to her indifference point between employment and nonemployment.

Second, and as importantly, existing reservation wages have only been measured in surveys of (mostly unemployed) job seekers, which make up a selected section of the population, thereby not providing a lever on the aggregate labor supply curve. By contrast, our concept and survey aims to capture a representative cross-section of the full population and thereby includes additionally the out of the labor force and the employed. Third and less fundamentally, we attempt to identify a Frischian variation rather than the kind of sequential-search job-specific wages in the existing surveys.

**Actual Survey Implementation of Reservation Raise Measure** The actual questions we implement are the result of piloting in online samples and iterations with survey administrators, leading us to formulate relatively concrete hypotheticals. While the ideal question formulation permits job switching and reoptimization (see Section 2.4), we in practice invoke a "job-constant" perspective yielding job-\(j\)-specific reservation raises \(1 + \tilde{\xi}_{it,j}^* = \frac{v_{it,j}}{(1+\Xi_t) y_{it,j} \lambda_{it}}.\) Throughout, we keep the frequency of the Frischian wage change constant at one month. We
discuss caveats and trade-offs of the specific implementation in Section 3.4.

Below we present our questions eliciting the reservation raise from respondents in each of the three labor force statuses.

**Question for the Employed** To keep the scenario sufficiently realistic, we allude to unpaid time off. To avoid capturing frictions associated with job mobility (an insight from piloting), we also guarantee the worker to be able to return to the original job in this specification. The question is:

The following is a hypothetical situation we ask you to think about regarding your current job, so please read [listen] carefully and try to think about what you would do if presented with this choice.

Suppose, for reasons unrelated to you, your employer offers you the following choice: Either you take unpaid time off from work for one month, or you stay in your job for that month and only receive a fraction of your regular salary. No matter what choice you take, after the month is over, your salary will return to normal.

In this hypothetical scenario, you cannot take an additional job to make up for the lost income during that month.

Assume this choice is real and you have to make it. At what point would the cut in your salary be just large enough that you would choose the unpaid month of time off over working for the month at that lower salary?

For example, an answer of 5% means that a 5% wage cut would be the point where you would choose to take unpaid time off for the month instead of working for 5% lower pay during that month. But if the wage cut was less than 5%, you would instead choose to work for that than take unpaid time off. Choose any percentage between 1% to 100%, where the cut wage cut is just large enough that you would prefer to not work at all for no pay than work at reduced pay for that month.

**Question for the Unemployed** While for the unemployed, reservation wage questions have been measured in empirical research, our challenge was to keep the answer comparable to the Frishian perspective presented to the other respondents groups. We therefore induce a scenario in which a prospective job permits a one-month earlier start date than regular, albeit at a wage reduction. The particular reason is left unspecified, although we clarify that this interim month is to be spent in nonemployment. By construction, the reservation raises – which reflect the desired employment status – of the unemployed will be at most one, as for the employed. The question is:

The following is a hypothetical situation we ask you to think about a potential job you may be looking for, so please read [listen] carefully and try to think about what you would do if presented with this choice.

---

10 Our questionnaire features an additional variant of the question for the temporarily laid off that mirrors that of the employed (supposing the respondent is back at the previous job). We do not ask the self-employed, given the missing wage concept. We do not differentiate multiple-job holders.
Suppose you have found the kind of job you are looking for and the employer would like to hire you. The regular start date for the job is one month away. As an alternative, your employer offers you the option to start working immediately, rather than waiting a month.

However, if you chose to start work immediately, for that first month, you will only receive a fraction of the regular salary. The job is otherwise exactly the same. No matter what choice you take, after the month is over, the salary will then resume at the regular salary.

In this hypothetical scenario, you cannot take an additional job to make up for the lost income during that month.

Assume this choice is real and you have to make it. At what point would the cut in your salary be just large enough that you would choose the waiting a month without working and without the salary over starting the job immediately for the first month at that lower salary?

For example, an answer of 5% means that a 5% wage cut would be the point where you would choose to wait a month without working instead of working for lower pay during that month. But if the wage cut was less than 5%, you would instead choose to work at that wage than wait a month without working. Choose any percentage between 1% to 100%, where the cut wage cut is just large enough that you would prefer to not work at all for no pay than work at reduced pay for that month.

**Question for the Out of the Labor Force**  Those out of the labor force presented the most significant challenge in formulating our questions. This group is comprised of those least likely to consider taking up employment (including the disabled, the retired, or students), but also of some marginal workers (as evidenced by the high rate of transitions between employment and nonemployment). For this group, we ask about the required wage increase to induce a respondent into employment, since by self-classification and revealed preference these individuals likely have reservation wages exceeding their expected potential wages. Crucially, for our Frischian perspective, this wage change is only supposed to occur for a single month. For concreteness and realism, we implement this scenario in the form of a sign-up bonus on top of the first-month salary. We also specify that the employment relationship is to last for at least (rather than exactly) one month. The question is:

The following is a hypothetical situation that may not have anything to do with your actual situation, but please read [listen] carefully and try to think about what you would do if presented with this choice.

Think of the range of jobs that you would realistically be offered if you searched for jobs (even if you currently are not looking for a job and may not accept any of these potential jobs).

Suppose you had such job offers in hand. Currently you would likely not take such jobs, at least not at the usual salary. However, suppose the employer were
nevertheless trying hard to recruit you, specifically by offering an additional sign-up bonus. The requirement to receive the bonus is that you will work for at least one month. The bonus comes as a raise of the first month’s salary. This sign-up bonus will only be paid in the first month (on top of the regular salary that month), afterwards the salary returns to the regular salary.

Assume this choice is real and you have to make it. We would like to learn whether there is a point at which the bonus in the first month is just high enough that you would take the job.

5% means you would take the job if your employer paid a bonus of just 5% of the regular salary in the first month. 100% means you would require a bonus as large as the regular salary. 500% would mean you require a bonus equal to five times as large as the regular salary.

Choose any percentage bonus that would be just high enough that you would take the job. You can enter a very high number (e.g., 100,000%) if you think you would not take any job, even if it paid a lot.

3.2 Results: The Empirical Aggregate Labor Supply Curve

**Distribution of the Reservation Raise** We present histograms of the empirical reservation raises from the reported reservation raises in the US survey data in Figure 1 Panel (a), where gray (white) [black] bars denote observations from the sample that are employed (unemployed) [out of the labor force]. We report the summary statistics of the distribution of the log reservation raise in Table 1.

The empirical histogram of the reservation raise distribution exhibits a large mass around one – where the reservation wage is close to the individual’s actual wage i.e. the location of marginal workers. Globally, the distribution is widely dispersed, implying that the typical worker is inframarginal in that she derives considerable worker surplus (or, in the case of the nonemployed, would suffer considerable net disutility) from employment with tremendous heterogeneity in worker surplus.

**Aggregate Labor Supply Curves** To trace out the aggregate extensive-margin labor supply curve, we aggregate the micro reservation raises into a cumulative distribution function. Figure 1 Panel (b) plots the CDF of the empirical distribution of the empirical reservation raises, with the cumulative distribution function \( F(1 + \xi^*) \) on the y-axis, and a given raise cutoff on the x-axis \( 1 + \xi^* \). By setting the placeholder cutoff \( 1 + \xi^* = 1 + \Xi \), the curve will ask what the employment rate is as a function of any given prevailing raise \( 1 + \Xi \). (The empirical reservation raises are measured as \( 1 + \tilde{\xi}^* \) defined in Equation (21) and hence correspond to the actual raises simply normalized around 1.)

To facilitate visual inspection with regards to implied elasticities, we additionally take logs of both axes, thereby plotting changes in desired log employment against changes in
\[ \log(1 + \Xi). \] We do so in Figure 2 (and Appendix Figure A.3, which is simply Figure 2 zoomed into the local behavior).

**Implied Arc Elasticities** Complementing this interpretation, we report descriptive statistics for various intervals in Table 1. In Table 2, we illustrate the local behavior of the labor supply curve around marginal workers, reporting shares as well as *arc elasticities*. These elasticities are simply the share of the population in a given upward, downward or symmetric distance from the prevailing unit raise, given by Equation (9) following the definition in Section 2.3,

\[ \epsilon_{E,(1+\Xi)\rightarrow(1+\Xi')} = \frac{F(1+\Xi') - F(1+\Xi)}{F(1+\Xi)} \cdot \frac{(1+\Xi') - (1+\Xi)}{1+\Xi}, \]

from baseline \( 1 + \Xi = 1 \). To detect potential nonconstant elasticities or asymmetries, we construct a set of arc elasticities over varying sizes of raise deviations from the unit raise and the employment baseline, reported in the table and additionally visualized in Figure 3 (in solid curves with hollow circles. The figure additionally contains a fitted empirical line and various model analogues, all of which we develop in Section 4.

**Large Local Elasticities** Inspecting the empirical curve, we find local Frisch elasticities of around 3 (even higher with very small perturbations). The underlying concentration of marginal workers mirrors, in an attenuated way, intuitions from models of homogeneity (Hansen, 1985; Rogerson, 1988). That is, on both sides, lots of individuals will prefer to move in or out of employment in response to small percent changes in potential earnings (captured by our raise).

**Nonconstancy: Smaller Arc Elasticities to Large (In Particular Upward) Deviations** Non-local perturbations imply dramatically lower arc elasticities to large raise changes than local ones. That is, while locally an increase in potential earnings crowds in nearly 2.26 percent of the employment rate around a 1% change in the raise (implying an elasticity of \( \frac{d(\text{Emp}/\text{Pop})}{\text{Emp}/\text{Pop}}/0.01 = \frac{0.0226}{0.01} = 3.72 \)), the implied elasticity falls to 0.96 when considering a larger raise perturbation of 10%. Downward, arc elasticities fall from 5.66 for the 1% interval to 1.68 for the 10% drop in potential earnings.

The nonconstant elasticities are salient in the arc elasticities plot in Figure 3. Arc elasticities are largest locally around the baseline prevailing raise, and are smaller for larger perturbations. Taken at face value, Figure 3 suggests that constant elasticities do not provide a realistic description of the global aggregate extensive-margin labor supply curve. As one concrete implication, the empirical curve suggests that the small arc elasticities identified by large positive increases in net wages may mask large local elasticities. For example, Chetty, Guren, Manoli, and Weber (2012) infer a 0.42 Frischian extensive-margin labor supply elasticity by interpreting employment responses to a tax holiday in Iceland, studied by Bianchi, Gudmundsson, and Zoega (2001), which reduced average tax rates from 14.5% to 0.0% for
one year. In our framework, this experiment corresponds to an increase in $1 + \Xi_t$ from 1.00 to 1.17. Our survey-implied labor supply curve, too, taken at face value, indicates an arc elasticity of 0.60 for that large a perturbation. It does so despite dramatically larger arc elasticities for smaller raises.

Therefore, such low estimated specific arc elasticities with respect to large upward net wage increases need not provide tight bounds on the arc elasticities in the local portions of the curve, which are those relevant to business cyclical fluctuations. We illustrate how the nonconstancy plays out for macro, business cycle contexts in Section 5.

These shrinking arc elasticities also imply a trade-off between statistical power and overcoming adjustment costs (e.g., Chetty et al., 2011; Chetty, 2012), and measuring the local elasticities relevant for smaller shocks, away from the strong assumption of isoelasticity.

Lastly, we note that the histogram exhibits some likely spurious mass points at 0.5 and 1.5, likely due to respondents’ rounding and anchoring; our fitted line, in detail derived in Section 4.2, smooths out those bunching points (which if spread out more evenly would distribute mass towards a locally more elastic and far-away less elastic curve, thereby further accentuating the asymmetries already present, we conjecture). We discuss this and other limitations of the survey in Section 3.4.

### 3.3 Covariates of the Reservation Raises

We now ask which micro covariates are associated with between-worker variation in reservation raises. We regress the logged reservation raise on covariates in Table 4. Appendix Table A.2 additionally controls for labor force status and hence studies within-status variation. We conduct covariate-by-covariate regressions (including baseline controls) and then one kitchen-sink multivariate regression in the last column. In Appendix Figure A.6, we additionally portray some associations graphically in histograms of subgroups and age gradients.

Another quasi-experiment reviewed in Chetty, Guren, Manoli, and Weber (2012) is the Self Sufficiency Program in Canada, studied by Card and Hyslop (2005), which raised average net of tax rates by dramatically more, from 0.25 to 0.83, for 36 months, with an implied employment elasticity of 0.38.

To some degree, the nonconstant elasticity is of course expected, as the employment rate cannot exceed 100%. A priori, the large macro elasticity benchmarks of around 2.5 cited by Chetty, Guren, Manoli, and Weber (2012) for cyclical macro contexts would, out of a baseline employment rate of 79.2% in their Icelandic example of a tax holiday, imply employment rates exceeding 100%, similarly for some of the other case studies with large net-of-tax increases the authors discuss. Of course, in the case studies the empirical employment rates do not reach 100% in response to the subsidies, and therefore do not actually hit the full-employment constraint. By contrast, Martinez, Saez, and Siegenthaler (2018) also study a large tax holiday, in Switzerland, and find no treatment effects on employment rates, which therefore implies small elasticities across all intermediate arcs.


The regression sample shrinks by a quarter due to missing covariates (in part retrieved from previous waves for these repeat respondents).
We also present summary statistics of our sample in Table 3, along with observation counts, for all workers, and by labor force status.

To increase sample size, we have also supplemented our analysis with larger existing surveys of the German population, namely the German Socio-Economic Panel (GSOEP) and Panel Study Labour Market and Social Security (PASS), which elicit standard reservation wages from subpopulations. We proxy for an individual’s reservation raises as the ratio of reservation wages to lagged or expected earnings. We describe the surveys and the construction of these reservation raise proxies in Appendix Section B, and report the associated regressions in Appendix Tables A.4 (GSOEP) and A.5 (PASS).

Overall, besides some systematic predictors of reservation raises, we find largely find that (in particular stable) observables provide limited guidance in reservation raise variation, either suggesting that transitory or unobservable factors largely shape the preferences, or indicating some degree of mismeasurement and noise.

**Age**  Life cycle models imply that marginal workers arise predominantly from the extremes of the age distribution, due to the triangle-shaped productivity profile and the resulting cutoff ages for labor force participation (as chiefly the Rogerson and Wallenius, 2009, model, reviewed in Section 4). Appendix Figure A.6 (f) plots the raise-age gradient, binning ages to the nearest multiple of five. Before age 60, the relationship is flat, then reservation raises increase after age 60. Perhaps the flat raises among the younger reflects training on the job incentives, as in Imai and Keane (2004).

**Sex**  The regression analysis reveals a noisily estimated 10% higher reservation wage among the female population on average (which disappears once we control for labor force status in Appendix Table A.2).

**Financials**  High net and gross asset to income ratio individuals (perhaps with a high $\lambda$ and low $y$; only a handful of observations have zero household income) exhibit higher reservation raises. By contrast, though noisily estimated, credit card debt (binned; continuous amounts not provided) lead to lower reservation net of raise rates, perhaps indicating higher $\lambda$ as in heterogeneous agent models with borrowing constraint (reviewed in Section 4).

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15 Appendix Figure A.6 Panel (e) plots the gradient for the GSOEP (unemployed). Here, the younger workers (aged 20 to 25) have higher reservation raises, consistent with lower productivity or higher-valued nonwork outside options such as schooling. Interestingly, older workers’ reservation raise proxies are nearly flat and finally fall – inconsistent with the prediction of the Rogerson and Wallenius (2009) lifecycle model.

16 In GSOEP, where we do not see financials, perhaps counterintuitively, satisfaction with income has a negative effect, while concern about ones’ finances has a positive one.

17 In GSOEP, where we do not see financials, perhaps counterintuitively, satisfaction with income has a negative effect, while concern about ones’ finances has a positive one.
**Education**  Worker surplus should increase in education (e.g., Oi, 1962). For the U.S. survey, we do find a noisily estimated but negative effect of college education on the reservation net of raise rate (omitted category: less than high school diploma).\(^{18}\)

### 3.4 Limitations and Trade-Offs

We here discuss a series of caveats to our empirical labor supply curve, the shape of which we will hereafter take at face value for the rest of the paper.

**Micro Vs. Aggregate Perturbation**  First, our survey induces a scenario in which the variation in the reservation raise is at the micro level, as we aim to have an all-else-equal scenario that directly maps into the model. Yet, it is conceivable that due to shifts in stigma, leisure complementarities, frictions in labor supply adjustment that differ by idiosyncratic vs. coordinated adjustment, or wealth effects resulting in added worker effects, micro responses may differ in response to an aggregate shock.

**Spot Market Vs. Adjustment Frictions**  Second, our formulation in particular for the employed evokes a spot-market scenario in which adjustment frictions are attenuated. For example, in the case of the employed, a post-nonemployment-spell return to work is at least implicitly permitted. This scenario may overstate employed workers’ reservation raises compared to a scenario in which such return is only not possible or would require costs, subsequent wage cuts, or job switching. Future work, theoretical or in form of variations in survey questions, may tease out how important such refinements are.\(^{19}\) These concerns may be less important for the other labor force statuses.

Ultimately, we believe that such discomfort with these aspects of our questions should likely imply discomfort with models of spot labor markets more generally, perhaps in favor of approaches that implement labor supply in frictional settings (Hall, 2009; Krussel, Mukoyama, Rogerson, and Sahin, 2017).

That is and more broadly, frictions may detach desired from actual employment allocations. We relegate a tentative assessment of these issues into Appendix Section C, where we compare respondents’ realized employment outcomes past, present and future (using the panel structure in the surveys and administrative data) with their idiosyncratic reservation raise statements. We find some evidence that in the micro data, realized employment out-

\(^{18}\) In Appendix Figure A.5 Panel (f), we plot average reservation raises by education level for GSOEP (the survey with the richest education information). The employment rate of highly-educated individuals is higher and the ratio of the reservation wages to lagged wages is lower. The GSOEP and PASS regressions reveal a significantly negative effect of years of education on the reservation net of raise rate.

\(^{19}\) To investigate this issue and to also investigate overall data quality concerns, the authors have integrated a follow-up custom questionnaire into the German Socio-Economic Panel that will adjudicate between these views, presenting half of the employed sample with the current scenario, and not specifying the return option to the other half. This survey will tell whether the local mass will shrink among the employed. This questionnaire will ask the entire sample across all labor force statuses. Results will become available in mid-2020.
comes correlated – but far from perfectly so – with the predictions from the reservation raise measures, perhaps suggesting either rationed labor supply due to frictions, or mismeasurement or imperfect persistence of the reservation raises across years.

Response Quality  Third and relatedly, as contingent valuation surveys more generally, and specifically more standard reservation wage measures among the unemployed, the survey measures may be of poor quality. In our setting, excess dispersion in form of noise would generate lower elasticities rather than higher local elasticities, unless respondents overestimate the degree to which they are willing to change their employment status.

Stationary Vs. Time-Dependent Distribution  Fourth, our survey elicits the labor supply curve for one cross-section representative of the U.S. population only; in subsequent Section 5 we assume this economy to reflect a steady-state with a stationary Frischian distribution from which we study deviations throughout U.S. business cycle history.

Uncompensated Variation  Fifth, in practice in the survey, we set the duration of the wage perturbation to one month to balance sufficient shortness to plausibly induce Frischian variation still of sufficient length to capture a meaningful extensive-margin choice. An interesting extension would be to study longer-lasting deviations, for example by instead invoking a quarter-long or even year-long temporary raise. On the one hand, potential wealth effects will grow with longer duration. On the other hand, adjustment costs may be more easily overcome, working in the opposite direction.

In Section 2.4, we have discussed such wealth effects and shown that for the models discussed below in Section 4, the uncompensated and Frischian/reservation-raise-based labor supply curves are extremely close, even at the quarterly (as in the simulations) rather than monthly (as in our survey) frequency, reported in Appendix Figure A.2.

4 Meta-Analysis of Existing Models, and Comparison to Data

We now compare the global empirical curve with those implied by various macroeconomic models’ labor supply blocks, using the reservation raise distribution as a unifying bridge between structurally different labor supply blocks. Details for each model and the calibrations are in Appendix Section A.1. We each model, we proceed in three steps and analogously to our empirical steps:

M1 Construct the individual-level reservation raise \(1 + \xi_{it}^*\) in the model at hand.

M2 Compute its (steady-state) equilibrium reservation-raise distribution \(F_t(1 + \xi^*)\), and plot the implied aggregate labor supply curve.

M3 Compute arc elasticities of extensive-margin labor supply from the CDF of the reservation raises \(F_t(1 + \xi^*)\).
Our meta-analysis of existing models in Section 4.1 reveals that none of these models would provide an accurate description of the global curve. In Section 4.2, we therefore calibrate one model to provide a tight fit.

4.1 Overview of Results

We plot the reservation raise distributions (as aggregate labor supply curves) of a series of models we now review in detail, along with the empirical curve from our survey for the U.S. population, in Figure 2 and companion Appendix Figure A.3 (which is simply Figure 2 zoomed into the local behavior). We plot the arc elasticities of each of the models’ labor supply curves as a function of the raise deviation in Figure 3. We report descriptive statistics and arc elasticities for various intervals in Tables 1 and 2 respectively.

We parameterize each model so that its steady state employment rate (the employment to population ratio) is 60.7%, an empirical target that reflects the U.S. 16+ civilian employment population ratio in February 2019 from the BLS (FRED series EMRATIO), also reflected in our survey.²⁰

In each model, we normalize the prevailing aggregate raise around 1, without loss of generality, and study deviations from this baseline raise (or any preexisting taxes). We extract the reservation raise distributions from the models’ steady state equilibria.

Our specific definition of the reservation raise traces out Frischian labor supply, but as we discussed in Section 2.4, these curves turn out to be extremely similar to uncompensated variants with wealth effects for the specific models we study here. We report these uncompensated variants in Appendix Figure A.2. Appendix Figure A.4 plots histograms for specific models’ reservation raises and supplementary items.

4.1.1 Representative Household Models with Full Insurance

A common specification of aggregate labor supply appeals to a large representative household, comprised of a unit mass of potentially heterogeneous individual members. The large household has a pooled budget constraint and assigns consumption levels and employment statuses to its individual members.²¹ Full (cross-sectional) insurance implies that the marginal utility of consumption is optimally set homogeneous across households, equal to the multiplier on the pooled budget constraint, which eliminates \( \lambda_{it} \) as a source of cross-sectional variation in reservation raises. Below we review specific cases of this representative-household class of labor supply model block, to study more concrete curves.

---

²⁰ Rather than restricting the sample to the prime working age population, we target a fuller population definition because our survey targets workers 18 and older without an upper age limit.

²¹ We take a perspective, as, e.g., Gali (2011a,b); Gali, Smets, and Wouters (2012), that the household head directly assigns allocations. Hansen (1985) and Rogerson (1988) present incentive-compatible lotteries. The Hansen (1985) set-up is equivalent to a representative household with utility function \( U(c_t, E_t) = \log(c_t) - \bar{\nu}E_t \), with intratemporal first-order condition \( \lambda_{it} \bar{w}_i = \bar{\pi} \).
**Homogeneity (Hansen, 1985)** Qualitatively, the empirical reservation raise distribution does mirror some intuitions of the homogeneity model of Hansen (1985); Rogerson (1988) (and also textbook DMP models without heterogeneity), as a large set of the workforce appears to be bunching around the prevailing raise, generating the large local elasticities. However, as is evident from the histogram of reservation raises in Figure 1 Panel (a), the empirical reservation raises exhibit tremendous heterogeneity, consistent with models of heterogeneity in job surplus (Mortensen and Pissarides, 1994; Bils, Chang, and Kim, 2012; Jäger, Schoefer, and Zweimüller, 2019) and present in lifecycle models (Rogerson and Wallenius, 2009) or with heterogeneous disutility of labor supply (Galí, 2011a,b; Galí, Smets, and Wouters, 2012; Boppart and Krusell, 2020), or potential earnings (as in the heterogeneous agent model), i.e. models we review below.

**Isoelasticities (MaCurdy, 1981)** Another convenient specification has homogeneous potential earnings but heterogeneity in the employment disutility. A special case of the power law distribution we derive in Section 2.3 can therefore occur if the disutility follows that specific distribution. The New Keynesian model presented in Galí (2011a,b); Galí, Smets, and Wouters (2012) (which also microfounds the isoelasticity at the extensive margin by appealing to the shape of the disutility distribution and a representative household) additionally features wage heterogeneity.

We include the 0.32 and 2.5 isoelasticity "MaCurdy (1981)" setups we present and microfounds in Section 4. We follow Chetty, Guren, Manoli, and Weber (2012) in considering the 0.32 case to correspond to the average of quasi-experimental estimates of realized employment adjustment to short-run and large net-wage changes, whereas the 2.5 isoelasticity case is a "large elasticity" the authors associate with various macroeconomic calibrations in particular equilibrium business cycle models. Neither the low nor the high Frisch elasticity curves accurately describe the empirical global labor supply curve. Interestingly, around the baseline prevailing raise, the local elasticity is closer to the large elasticity case. To the left, a high elasticity of around 3 may best describe the empirical curve. However, as one examines larger intervals in particular positive perturbations, the data exhibit smaller arc elasticities below 1.00, towards 0.50, closer to the 0.32 isoelasticity benchmark in this far-away region.

4.1.2 **Heterogeneous Agent Model**

We now move to heterogeneous agent models, where atomistic households make labor supply and consumption decisions with separate budget constraints potentially facing incomplete markets. Heterogeneity between households arises from stochastic productivity. Incomplete financial markets mean that income shocks pass through into budget constraints, and thence into consumption/savings policies, assets, consumption, and $\lambda_{it}$. To study this setting through the lens of the reservation raise framework, we introduce indivisible labor

The extensive-margin labor supply curves become substantially less transparent in heterogeneous agents models with stochastic potential-earnings processes, in which individuals are differ across multiple, equilibrium dimensions. The reservation raises and their distribution summarize this heterogeneity in labor supply preferences, providing an alternative way to characterize the curve rather than by brute force simulating the model for a series of shocks.

**Baseline Model** The heterogeneous agent model generates very small local labor supply elasticities (0.12–0.31) upward, but exhibits larger (up to 0.72) elasticities downward, albeit quickly settling in below 0.5 for large perturbations towards 0.10. Qualitatively, these asymmetries are in line with the empirical curve. But the amplitudes of the deviations are dramatically compressed, with the model implying too small a range of elasticities throughout. Interestingly, the model generates stable elasticities for larger perturbations and asymptotes strikingly tightly towards the 0.32 benchmark corresponding to the Chetty, Guren, Manoli, and Weber (2012) quasi-experimental estimates.

**The Role of Incomplete Financial Markets** The equilibrium reservation raise distribution and hence labor supply curve inherit the joint distribution of \( \lambda \) and \( y \), so that the curve is particularly inelastic if low earnings realizations are offset by associated high \( \lambda \) values. This pattern emerges due to incomplete markets. To show this, we shut off the equilibrium heterogeneity in \( \lambda \) by instead ad-hoc setting a homogeneous \( \bar{\lambda} \) (normalized to generate the same baseline employment rate). This experiment evokes complete markets, where \( y \)-state-contingent claims would neutralize the effects of stochastic potential earnings on \( \lambda \), generating a reservation raise distribution that mimics a variant of the representative full-insurance household.\(^{22}\)

Aggregate Frischian labor supply implied by homogeneous \( \lambda \) is dramatically more elastic for large downwards perturbations. This is because \( \lambda \) and \( y \) in the incomplete markets setup covary negatively: low productivity agents have higher shadow values of income than their better-earning peers. Full insurance eliminates this negative covariance, so the labor supply with full insurance is highly elastic. This intuition, based on cross-sectional covariance of \( \lambda \)

\(^{22}\) The underlying sparse discrete Markov process renders the full-insurance curve choppy, while the smooth asset distribution serves to smooth out the reservation raise distribution for incomplete markets baseline. In reality, earnings levels are continuous and the sparse set of earnings levels is chosen for computational reasons, so we additionally plot the reservation raise distribution arising from continuous earnings (for the parametric process which Kaplan, Moll, and Violante (2018) discretize into the 33 states).
and \( y \), is specific to the extensive and Frischian margin (and hence differs from intensive-margin-only life-cycle intuitions as in Domeij and Floden, 2006; Heathcote, Storesletten, and Violante, 2014). It also differs from the attenuating effect of incomplete markets on uncompensated elasticities, whereby the within-worker \( \lambda \) would be more sensitive to, and hence offset, income shocks. The Frischian curve holds \( \lambda \) fixed. However, at least for our calibrated model, the wealth effect is quantitatively small, as evidenced by small difference between the Frischian and Marshallian labor supply curve in Appendix Figure A.2, which we discuss in Section 2.4. The divergence may be larger for other earnings processes and for other specifications of asset markets, e.g., those that would rationalize wealthy hand-to-mouth agents Kaplan, Violante, and Weidner (2014); Kaplan, Moll, and Violante (2018). This exercise also illustrates how the reservation raise framework can serve as a diagnostic tool to study labor-supply implications also of richer asset market structures, which in turn would further shape the cross-sectional joint distribution of \( \lambda \) and \( y \).

4.1.3 Lifecycle and Intensive Margin

As in the general intensive-margin case in Section 2.4, permitting hours choices preserves the reservation raise logic. A leading model with both margins is that by Rogerson and Wallenius (2009), which also features lifecycle patterns (and the Frischian behavior of which Chetty, Guren, Manoli, and Weber, 2012, studied as a leading example of macro models with an extensive margin). This model also features lifecycle dynamics. Our baseline model largely follow the parameterization choices of Chetty, Guren, Manoli, and Weber (2012).

**Baseline Rogerson and Wallenius (2009) Model** The calibrated economy exhibits a high local elasticity. In the upwards direction, it generates a nearly constant elasticity, mirroring the 2.5 isoelasticity line. Arc elasticities range from 2.60 to 3.20, with local elasticities (from 0.01 raise pertubations) between 2.84 and 2.90 Interestingly, the model generates some asymmetry, implying smaller elasticities upward than downward, qualitatively in line with our empirical benchmark. Quantitatively however, the model misses the steep decline in the elasticity in response to positive net of raise rate shifts, where the empirical benchmark implies elasticities below one and towards 0.5, whereas the model-implied elasticities remain above 2.\(^{23}\)

**The Role of the Intensive Margin** To assess the importance of intensive-margin reoptimization on extensive-margin labor supply preferences, in Figure 2 and Figure 3 we plot two labor supply curves for this model, first the baseline one allowing for hours choice reoptimization (solid line). This curve "envelopes" the second curve (dotted line), which shuts off such hours reoptimization and instead holds hours fixed at the optimal hours choice at "pre-experiment" 1 + \( \Xi \) = 1 levels. That is, for noninfinitesimal raise shifts, extensive-margin

\(^{23}\) Consistent with our global clarification, Chetty et al. (2012), who simulate reforms of specific large tax reductions in the model, find it to exhibit large Frisch elasticities.
adjustment is attenuated. Intuitively, intensive-margin reoptimization weakly raises the return of work. As a result, the flexible-hours employment curve always is equal or exceeds the fixed-hours analogue.

The Role of the Wage-Age Profile In the model, wages are a triangular function of age, and so the wage distribution is given by the age distribution. This suggests the possibility that seemingly unrelated changes in the model structure, specifically in the wage-age gradient around the marginal ages (labor force entry and exit) may have dramatic effects on local elasticities. Our additional exploration thereby refines the study by Chetty, Guren, Manoli, and Weber (2012), who enlist the Rogerson and Wallenius (2009) model as a representative macro model example with indivisible labor featuring inherently large extensive-margin Frisch elasticities. To illustrate this flexibility, we recalibrate the model and now target a lower Frisch elasticity, by allowing a higher level of peak lifetime productivity and a steeper slope of the wage-age productivity gradient. We additionally plot the labor supply curves (dotted-dashed line) in Figure 2 and Figure 3. Under this parameterization, the density around 1.0 is lower, and so the local elasticity falls. Quantitatively, the calibration implies a local Frisch elasticity (using an arc from 0.995 to 1.005) of only 1.6 – nearly half of the baseline 2.9 elasticity. More flexible nonlinear functional forms of the wage-age gradient would likely deliver even lower Frisch elasticities.

4.2 Calibrating one Specific Model To Match the Empirical Curve

Our meta-analysis in Section 4.1 above has revealed that no existing model generates a global empirical labor supply curve that comes close to the empirical example from our survey. We now take the empirical curve at face value, and reverse-engineer a model to fit the empirical curve by means of the reservation raise bridge.

4.2.1 Inverting the Model Heterogeneity Into Reservation Raises

Broadly, calibrating a given model’s implied reservation raise distribution to match the empirical target, requires inverting the distributions of the model-specific heterogeneity sources. The easiest case features a single dimension of heterogeneity among the reservation-raise-relevant components $\lambda, y$ and $v$. Our example draws on a representative household full-insurance setting. Potential earnings $\bar{y}_t$ are homogeneous by assumption. Due to full insurance, $\bar{\lambda}_t$ is homogeneous too. Heterogeneous disutility of labor $v$ is distributed according to CDF $G^v_t(v)$, such that individuals can be indexed by type $v$. As detailed in Appendix
Section A.1.1 for this class of model, the household maximizes:

\[
\max_{\bar{c}_t, \{e_{rt}\}, A_t} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left[ u(\bar{c}_s) - \int e_{vs} v dG^v_s(v) \right]
\]  
(22)

s.t. \(A_s + \bar{c}_s \leq A_{s-1}(1 + r_{s-1}) + (1 + \Xi_s) y_s \int e_{vs} dG^v_s(v) + T_s \quad \forall s \geq t.
\]  
(23)

The empirical reservation raise, \(1 + \tilde{\xi}_{vt}\), corresponds to the theoretical reservation raise of type \(v\):

\[
1 + \tilde{\xi}_{vt} = \frac{1 + \xi_{vt}}{1 + \Xi_t} = \frac{v}{\left[ (1 + \Xi_t) \bar{\lambda}_t \right] \bar{\lambda}_t}
\]  
(24)

\[
\Leftrightarrow v = (1 + \tilde{\xi}_{vt}) \cdot \left[ (1 + \Xi_t) \bar{\lambda}_t \right] \bar{\lambda}_t.
\]  
(25)

To match the empirical reservation raise distribution, the distribution of \(v\) corresponds to that of the empirical reservation raises adjusted by \((1 + \Xi_t) \bar{\lambda}_t \bar{\lambda}_t\). Let \(\tilde{f}(\cdot)\) denote the empirical density distribution of \(1 + \tilde{\xi}_{vt}\). Because the multiplication \((1 + \Xi_t) \bar{\lambda}_t \bar{\lambda}_t\) is a positive monotone transformation, the density distribution of \(v\), denoted as \(g(v)\), can be written as a function of \(\tilde{f}(\cdot)\):

\[
g(v) = \tilde{f} \left( \frac{v}{(1 + \Xi_t) \bar{\lambda}_t} \right) \frac{1}{(1 + \Xi_t) \bar{\lambda}_t}. 
\]  
(26)

We can thus discipline the theoretical disutility distribution by the empirically recovered reservation raise distribution for any given values of \(\bar{\lambda}_t\) and \(\bar{\lambda}_t\).

**Specifying Aggregate Labor Supply Disutility \(V(E)\)** It is convenient to write aggregate labor supply disutility directly in terms of the employment rate \(E_t\) as function \(V(E)\):

\[
V(E) = \int e_v v dG^v(v) = \int_{-\infty}^{\mu(E)} v dG^v(v),
\]  
(27)

where \(\mu(E) \equiv (G^v)^{-1}(E)\) is the quantile function of the disutility distribution.

We have therefore constructed a representative household setting that is consistent with any given reservation raise distribution and hence extensive-margin labor supply curve, by
imposing the \( V(E) \) function in Equations (26) and (27):

\[
\max \sum_{s=t}^{\infty} \beta^s \left[ u(\tilde{c}_s) - V(E_s) \right] \\
\text{s.t. } A_s + u(\tilde{c}_s) \leq A_{s-1} (1 + r_{s-1}) + (1 + \Sigma_s) y_s E_s + T_s \quad \forall s \geq t.
\]  

\[ (28) \]

\[ (29) \]

**Theoretical Properties of \( V(E) \)** Aggregate labor supply disutility function \( V(E) \) has intuitive and convenient properties. Its slope is the disutility of the marginal worker at the verge of (non)employment, at a given aggregate employment rate. Due to optimal rationing, \( V'(E) > 0 \) and convexity \( V''(E) > 0 \) are implied as the marginal worker has higher disutility of labor than her inframarginal predecessor already at work. Formally, these properties follow from Leibniz’s rule, the definition of \( \mu(\cdot) \) and assuming smoothness of \( G^v(\cdot) \). We can then write \( V'(E) = \mu(E) g(\mu(E)) \mu'(E) = \mu(E) > 0 \) over the support, as \( \mu'(E) = \frac{1}{g(\mu(E))} \). It is immediate that \( V''(E) = \frac{1}{g(\mu(E))} > 0 \) over the support.

**4.2.2 Analytical Approximation to \( V(E) \): Fitted Polynomial**

We now construct a continuous and differentiable analytical function \( V(E) \) by fitting a polynomial to the empirical curve. This procedure smooths out and interpolates the discrete empirical distribution to permit fine-grained labor supply levels in the model. Our procedure ultimately approximates the inverse empirical CDF of the reservation raises. We start by exploiting the aforementioned property of \( V(E) \) that its derivative, \( V'(E) = \mu(E) \), is the disutility of the marginal person at a given \( E \) – hence corresponding to the empirical reservation raise \( 1 + \tilde{\xi} \) (times a homogeneous factor \( \bar{\lambda}(1 + \Xi) \)).

We finally apply a polynomial approximation to \( V'(E) = v \) (rather than \( V(E) \) directly) over the support of \( E \). We then analytically (anti-)differentiate the polynomial to recover \( V''(E) \) and \( V(E) \). We use an eighth-degree polynomial approximation to the inverse empirical CDF of the disutility distribution (corresponding to employment rate \( E \)), placing greater weight on local perturbations. We constrain the first derivative of the polynomial to be positive over the support \( E \in [0, 1] \)

---

\[ \text{In principle, the polynomial fit can be done in two ways. The first, which we choose, is to fit the extensive-margin MRS analogue to the employment rate, namely by fitting reservation raise levels to the CDF. This procedure minimizes the error between the model MRS and the empirical reservation raise at each given employment point. This route accords with the goal of the business cycle accounting labor wedge analysis in Section 5, which takes a given empirical employment rate and imputes the MRS. Moreover, estimating the MRS as a function of the employment rate delivers the functional form for \( V(E) \). Alternatively, we could have fit the employment rate as a function of the raise, hence providing a reduced-form labor supply curve (to our knowledge there is no feasible existing total least square procedure for higher-degree polynomial that would minimize errors on both axes). Fortunately, our reverse implementation successfully closely matches the labor supply curve.} \]

\[ \text{Fitting } V'(E) \text{ rather than } V(E) \text{ (e.g., through taking conditional expectations of } v \text{ by } E \text{ in the data) is appealing because } V(E) \text{ would nature be smooth and easily fitted, but its curvature determines elasticities, making } V'(E) \text{ a more informative target for our purposes.} \]
to ensure an always-increasing marginal disutility of labor. Details of the polynomial approximation are in Appendix Section D.\textsuperscript{26} The fitted coefficients for $V'(E)$ are reported in Appendix Table A.6, along with those for the corresponding antiderivative $V(E)$ and for the derivative $V''(E)$. In Appendix Figure A.8, we plot the three corresponding functions. We also include the associated fitted line in form of dashed line as labor supply curves in Figure 2 and the zoomed-in version Appendix Figure A.3, along with the associated arc elasticities in Figure 3.

Next, in Section 5, we apply this survey-consistent curve to study its implications for the cyclical fluctuations of the U.S. labor market.

5 Potential Business Cycle Implications of the Empirical Curve

We close by applying the survey-consistent labor supply curve to revisit the cyclical fluctuations of the U.S. labor market. In our exercise, we calibrate a representative agent business cycle model with our empirical labor supply curve and measure the implied business cycle accounting labor wedges (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009), in the form of gap between the marginal product of labor and the imputed MRS. We compare this model with two alternative constant-elasticity labor supply specifications. Figure 4 presents results as time series and binned scatter plots for quarterly U.S. postwar data, with all time series logged, seasonally adjusted, and detrended using an HP filter with a smoothing parameter of 1,600.\textsuperscript{27} To quantify these patterns, in Table 5, we report standard deviations as well as procyclicalities (the elasticity with respect to employment deviations, for all, but to detect asymmetries, also separately for above and below trend dates).

Three Specifications of Preferences We posit separable balanced growth preferences for the representative household, with log consumption utility $U(C_t,E_t) = \ln C_t - V(E_t)$. We consider three variants for the disutility of labor term $V(E_t)$. The first two are isoelastic curves $V(E_t) = \Gamma E_t^{1+1/\eta}/(1 + 1/\eta)$, such that $\eta$ denotes the constant Frisch elasticity, for $\eta \in \{0.32, 2.5\}$, again the two benchmarks given by Chetty, Guren, Manoli, and Weber (2012) we have studied. Our third variant constructs $V(E_t)$ to perfectly match the reservation raise distribution fitted to the empirical curve as described in the previous section. Given that we only measure the labor supply curve at one point in time (in 2019) and hence around a

\textsuperscript{26} The weighting is performed through a weighted constrained polynomial regression of disutility $v$ on polynomials of the employment rate (or the quantiles of each associated $v$). The weight is based on raise deviation around the baseline raise (and hence employment rate) of the form $\omega_s = [(1 + \xi_s) - 1 + 0.01]^{-2}$, hence assigning more weight to local raise (and hence employment) deviations, e.g., relevant to business cycle fluctuations. We constrain the polynomials so that the disutility function is convex ($V''(E) > 0$).

\textsuperscript{27} We use real personal consumption experience per capita (FRED series A794RX0Q048SBEA), the employment to population ratio for all persons aged 15 and over (LREMTTTUSQ156S), and the nonfarm business sector real output per hour of all persons (OPHNFB). We have obtained similar results with real output per person, and with alternative consumption proxies including service flows from durables.
particular prevailing employment rate, we center the model employment rate in the data-consistent \( V(E) \) around a slow-moving trend (from an HP-filter with a smoothing parameter of 1,600) and assume that the survey captures the labor supply curve at trend employment, and that the shape of the labor supply curve around the trend employment rate is stable during the sample period.

**Fluctuations in the Marginal Disutility of Labor** Figure 4 Panels (a) and (b) present the detrended log deviations of \( V'(E_t) \), i.e. the employment disutility of the marginal worker. Since employment fluctuations have small amplitudes, they trace out a part of the labor supply curve with high elasticities (see Figure 2). So here, the empirically consistent curve resembles the high isoelasticity benchmark.

**Business Cycle Accounting** The business cycle accounting labor wedge \( 1 - \mathcal{L}_t \) is the time-varying tax-like gap between the MPL and the MRS implied by each conjectured benchmark model and the empirical time series \( (1 - \mathcal{L}_t) F_E(E_t, K_{t-1}) = -\frac{U_t(C_t, E_t)}{U_{C}(C_t, E_t)} \cdot 1 - \mathcal{L}_t \) reflects unmodeled frictions, taxes, model misspecification or measurement error (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009). We study the cyclical percent (log) deviations from trend in \( 1 - \mathcal{L}_t \).

We follow Chari, Kehoe, and McGrattan (2007); Shimer (2009) in specifying a Cobb-Douglas production function. The MPL time series then, once logged and HP-filtered, inherits that of average real output per hour. (We obtain similar wedges with average real output per worker.)

We plot the labor wedge time series in Figure 4, for each \( V(E) \) specification. As is well known, calibrating labor supply to a small Frisch elasticity generates a volatile and procyclical labor wedge, such that recessions are times when the gap between the MRS and the MPL widens. One possibility is that households are off their labor supply curves (Karabarbounis, 2014). Another reason is that the incidence of the labor market wedge is on firms (Bils, Klenow, and Malin, 2018). In any case, the larger Frisch elasticity of 2.5 reduces the amplitude of the wedge series.

Setting \( V(E) \) to the empirically consistent labor supply curve generates a low-amplitude wedge series – strikingly similar to the high-isoleasticity case. The binned scatter plots in Figure 4 Panel (b) and (d) illustrate this property.

One way to read the labor wedge, and cyclical departures from a labor market equilibrium more generally, is that desired employment reflects shifts in labor productivity and the marginal utility of consumption (which log wages, simply the inverse of consumption). The Frisch elasticity multiplies percent deviations in both components. While a high Frisch elasticity reconciles large employment movements with small productivity changes, it also amplifies the offsetting labor supply effects of procyclical consumption. Yet, our labor supply curve is most tightly linked to the Frischian component that holds \( \lambda \) constant. Hence, in
Panels (e) and (f) we additionally present the labor wedge that set $\lambda_t$ counterfactually to be acyclical – hence purely "Frischian". Here, the amplitudes in the time series in Panel (e) shrink, and moreover for the high-elasticity cases, the remaining variation becomes less procyclical, as evidenced by the near zero slope of the scatter plot in Panel (f).

Quantitatively, Table 5 Panel A confirms that the standard deviations of the survey-consistent wedges are well approximated by the high isoelasticity ones. Similar patterns hold for the procyclicals, even upward.

**Counterfactual Amplification into Asymmetric Segments** To show that the nonconstant and asymmetric elasticities only bite under counterfactually large amplitudes, in Table 5 Panel B and Appendix Figure A.1 we repeat the exercise but ad-hoc amplify the fluctuations in $E_t$ only entering the $U_E = V'(E_t)$, while $U_C$ and the MPL take the actual $E_t$ time series. The labor wedge now moves towards the low isoelasticity case during upswings, but during recessions still hugs the high elasticity case (reflecting the asymmetric arc elasticities discussed in Section 3).

6 Conclusion

We have provided a tractable and robust framework that formulates individual-level employment decisions and aggregates those decisions into an aggregate extensive-margin labor supply curve. The micro decisions are summarized by a sufficient statistic we call the reservation (pay) raise: the (net of) raise rate that would render a given individual indifferent between working and not working. This reservation raise captures worker surplus as a fraction of idiosyncratic potential earnings. The aggregate labor supply curve is the cumulative distribution function of that micro reservation raise. Its argument is a hypothetical average shifter in wages, i.e. a "prevailing raise" marking up potentially heterogeneous idiosyncratic wages. The framework accommodates rich individual-level heterogeneity, and can serve as a bridge between labor supply blocks where extensive-margin aggregate labor supply curves are otherwise hard to characterize and interrelate. We also elicit the reservation raises in a household survey, thereby nonparametrically tracing out the global extensive-margin labor supply curve of the U.S. economy.

One interesting question beyond the scope of our paper is to ask which deep sources of heterogeneity or equilibrium mechanisms drive the empirically observed curve implied by our survey. For example, we find that the purely preference-based empirical curve exhibits a large mass of nearly marginal individuals, and hence features a large local Frisch elasticity of desired labor supply. One may speculate whether wage bargaining or labor market monopsony could push wages close to the workers’ reservation wage. Alternatively and neoclassically, this mass may reflect homogeneity in terms of the reservation-raise-relevant
factors, or could emerge endogenously with persistent heterogeneity due to, e.g., lifecycle averaging (as we explore in Appendix Section A.1.2).

We close by reiterating that the labor supply curve represents preferences over desired labor supply. In the presence of frictions, the curve need not perfectly guide realized employment allocations. Under the assumption of efficient rationing of labor supply to jobs, such a curve could, for instance, rationalize business cycle fluctuations in employment in an equilibrium model. However, to the degree that real-world fluctuations may constitute inefficient extensive-margin movement – namely if the employment adjusts do not occur according to the pecking order established by the CDF of the reservation raises – the actual empirical employment movements can mask large inefficiencies. Empirically diagnosing the efficiency properties of employment adjustment is challenging (for analyses of the efficiency of employment adjustment at the group-level cyclical dimension and the separation margin, see respectively Bils, Chang, and Kim, 2012; Jäger, Schoefer, and Zweimüller, 2019). In principle, the tool of the reservation raise may provide an empirical handle, namely by eliciting the reservation raises from those individuals driving a given employment adjustment in the data.²⁸

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²⁸ We provide a tentative assessment of such inefficient rationing in Appendix Section C. We compare respondents’ realized employment outcomes past, present and future (using the panel structure in the surveys and administrative data) with their stated reservation raises, which determines her rank in the aggregate labor supply curve. We find some but far from a perfect relationship between actual and desired employment allocations. This could reflect measurement error in the original reservation raises, idiosyncratic shocks (limited persistence) in the reservation raises, or frictions that detach realized and desired employment allocations. We also include a highly speculative investigation, by checking whether higher aggregate unemployment, the canonical symptom of rationed labor and labor market frictions, may cause, or reflect, more severe allocational frictions inducing less-efficient rationing.
References


### Tables

Table 1: Reservation Raise Distributions: Descriptive Statistics for U.S. Data (Survey) and Calibrated Models

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Data: U.S. Pop (Authors’ Survey)</th>
<th>U.S. Pop (Fitted)</th>
<th>Hansen (Indiv. Labor)</th>
<th>Macurdy (0.32)</th>
<th>Macurdy (2.5)</th>
<th>Rogerson Wallenius</th>
<th>Het. Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
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<td>1.06</td>
<td>1</td>
<td>1.16</td>
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<td>0.96</td>
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<td>Median</td>
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<td>0.94</td>
<td>1</td>
<td>0.56</td>
<td>0.93</td>
<td>0.94</td>
<td>0.95</td>
</tr>
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<td>25 Pctile.</td>
<td>0.65</td>
<td>0.67</td>
<td>1</td>
<td>0.07</td>
<td>0.70</td>
<td>0.83</td>
<td>0.56</td>
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<tr>
<td>75 Pctile.</td>
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<td>1.42</td>
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<td>1.09</td>
<td>1.09</td>
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<td>Variance</td>
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<td>0.25</td>
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<td>Skewness</td>
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<td>1.10</td>
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<td>0.39</td>
<td>0.69</td>
</tr>
<tr>
<td>Kurtosis</td>
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<td>-0.87</td>
<td>-</td>
<td>3.00</td>
<td>2.76</td>
<td>-1.01</td>
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</tr>
</tbody>
</table>

**Note:** The table presents descriptive statistics of the reservation raise distributions for the data (U.S. population survey discussed in Section 3), as well as for the models with an extensive margin of labor supply (presented in the model meta-analysis Section 4). The associated aggregate labor supply curves and arc elasticities are jointly plotted in Figure 2 and Figure 3, and additional moments are provided in Table 2. For the survey data (and its polynomial fit), the mean, variance, skewness, and kurtosis were calculated according to Rimoldini (2014), truncating reservation raises above 2.0.
Table 2: Mass of Marginal Agents and Local Arc Elasticities: Reservation Raise Distribution Around 1.00 for U.S. Data (Survey) and Calibrated Models

<table>
<thead>
<tr>
<th></th>
<th>$d_{\text{Emp}}$</th>
<th>Elasticity</th>
<th>$d_{\text{Emp}}$</th>
<th>Elasticity</th>
<th>$d_{\text{Emp}}$</th>
<th>Elasticity</th>
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</thead>
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<td>$\text{Pop} \times 100$</td>
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<td>$\text{Pop} \times 100$</td>
<td></td>
<td>$\text{Pop} \times 100$</td>
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<td></td>
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</tr>
<tr>
<td>U.S. Data</td>
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<td>5.66$^#$</td>
<td>2.26</td>
<td>3.72</td>
<td>4.61</td>
<td>7.59</td>
</tr>
<tr>
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<td>3.19</td>
<td>3.75</td>
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<td>100.0</td>
<td>$\infty$</td>
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<td>$\infty$</td>
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<td>0.20</td>
<td>0.32</td>
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<td>0.72</td>
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<td>100.0</td>
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<td>$\infty$</td>
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<td>15.85</td>
<td>2.61</td>
<td>19.37</td>
<td>3.19</td>
</tr>
</tbody>
</table>

Note: The table presents masses and local arc elasticities of the reservation raise distributions for the data (U.S. population survey discussed in Section 3), as well as for the models with an extensive margin of labor supply (presented in the model meta-analysis Section 4). The associated aggregate labor supply curves and arc elasticities are jointly plotted in Figure 2 and Figure 3, and additional descriptive statistics are provided in Table 1. For each model economy and the survey, in the left columns the table presents the mass of marginal agents (those with reservation raise levels around one) for various intervals around one, symmetrically ("+/−", e.g., between 0.995 and 1.005), above one, ("+", e.g., 1.00 and 1.01), and below one ("−", e.g., 0.99 and 1.00) The right columns present the implied local arc elasticities for each interval and economy. Superscript # denotes the approximation for the symmetric 0.01 interval in the survey ("U.S. Data"), where responses were restricted to percentage digits, hence this symmetric 0.01 interval is the average of the asymmetric intervals for this entry.
### Table 3: Summary Statistics: U.S. Household Survey with Custom Questionnaire on Reservation Raises (Unweighted, With Valid Reservation Wedge Response)

<table>
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<tr>
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<th>All</th>
<th>Employed</th>
<th>Unemployed</th>
<th>OLF</th>
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<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Obs</td>
<td>Mean</td>
<td>Obs</td>
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<tr>
<td>Log Res. Raise</td>
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<td>1624</td>
<td>-0.44</td>
<td>987</td>
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<tr>
<td>Unemployed</td>
<td>0.04</td>
<td>1624</td>
<td>0.00</td>
<td>987</td>
</tr>
<tr>
<td>Out of Labor Force</td>
<td>0.35</td>
<td>1624</td>
<td>0.00</td>
<td>987</td>
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<tr>
<td>Employed</td>
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<td>1.00</td>
<td>987</td>
</tr>
<tr>
<td>Age</td>
<td>49.63</td>
<td>1624</td>
<td>42.93</td>
<td>987</td>
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<tr>
<td>Female</td>
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<td>0.52</td>
<td>987</td>
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<tr>
<td>H.S. Diploma</td>
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<td>1624</td>
<td>0.14</td>
<td>987</td>
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<td>Some College</td>
<td>0.44</td>
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<td>0.43</td>
<td>987</td>
</tr>
<tr>
<td>College or Higher</td>
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<td>0.41</td>
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</tr>
<tr>
<td>Good Health</td>
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<td>0.91</td>
<td>934</td>
</tr>
<tr>
<td>Partnered</td>
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<td>1624</td>
<td>0.61</td>
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</tr>
<tr>
<td>Any Children</td>
<td>0.32</td>
<td>1624</td>
<td>0.40</td>
<td>987</td>
</tr>
<tr>
<td>Assets / HH Income</td>
<td>0.73</td>
<td>1585</td>
<td>0.49</td>
<td>976</td>
</tr>
<tr>
<td>Debts / HH Income</td>
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<td>1585</td>
<td>0.35</td>
<td>976</td>
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<tr>
<td>HH Income</td>
<td>63,128</td>
<td>1624</td>
<td>70,699</td>
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<tr>
<td>Net Assets</td>
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<td>18,822</td>
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<td>1077</td>
<td>0.45</td>
<td>688</td>
</tr>
<tr>
<td>C.C. Debt &gt; $3.5k</td>
<td>0.32</td>
<td>1077</td>
<td>0.36</td>
<td>688</td>
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<tr>
<td>Liquid Assets under $1000</td>
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</table>

**Note:** The table reports summary statistics (means and standard deviations) for our U.S. household survey. Construction of reservation raises, survey and sample are described in Section 3. **Source:** Authors’ questionnaire in NORC Amerispeak Omnibus Survey. It complements the regression analysis of reservation raise covariates in Table.
Table 4: Covariate Analysis: (Log) Reservation Raise for U.S. Population (Authors’ Survey)

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<th>(5)</th>
<th>(6)</th>
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<th>(8)</th>
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<tbody>
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<td>(0.944)</td>
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<td>(1.569)</td>
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<td>(Age / 100) Sq.</td>
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<td>4.174***</td>
<td>4.185***</td>
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<td>4.307**</td>
<td>4.657**</td>
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<tr>
<td>Debts / HH Income</td>
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<td></td>
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<tr>
<td>Net. Assets / HH Income</td>
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<td></td>
<td>0.058*</td>
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<td>$0 &lt; C.C. Debt &lt; $3.5k</td>
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<td>(0.115)</td>
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<td>Liquid Assets under $1000</td>
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<td>(0.211)</td>
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<td>(0.438)</td>
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<td>0.18</td>
<td>0.23</td>
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Note: *: p < 0.10, **: p < 0.05, ***: p < 0.01. Robust standard errors in parentheses. Construction of reservation raises, survey and sample are described in Section 3. Source: Authors’ questionnaire in NORC Amerispeak Omnibus Survey.

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<tr>
<th>Cyclical Measure $X_t$:</th>
<th>Marginal Disutility of Employment $V'(E_t)$</th>
<th>Labor Wedge $1 - L_t = \frac{V'(E_t)/\text{MUC}_t}{\text{MPL}_t}$</th>
<th>Frischian Wedge $1 - L_t = \frac{V'(E_t)/\text{MUC}_t}{\text{MPL}_t}$</th>
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</thead>
<tbody>
<tr>
<td>$V(E_t)$ Specification:</td>
<td>Survey $\eta = 2.5$ $\eta = 0.32$</td>
<td>Survey $\eta = 2.5$ $\eta = 0.32$</td>
<td>Survey $\eta = 2.5$ $\eta = 0.32$</td>
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<td>Volatility: $\text{SD}(X_t)$, in %</td>
<td>0.13 0.30 2.33</td>
<td>1.29 1.43 3.32</td>
<td>1.02 1.08 2.66</td>
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<tr>
<td>Pro cyclicality: $\frac{\text{Cov}(X_t, E_t)}{\text{Var}(E_t)}$</td>
<td>0.13 0.40 3.13</td>
<td>1.36 1.59 4.31</td>
<td>0.36 0.59 3.31</td>
</tr>
<tr>
<td>— Full Data</td>
<td>0.19 0.40 3.13</td>
<td>1.34 1.55 4.28</td>
<td>0.45 0.66 3.39</td>
</tr>
<tr>
<td>— For $E_t$ Above Trend</td>
<td>0.16 0.40 3.13</td>
<td>1.22 1.45 4.18</td>
<td>0.06 0.30 3.02</td>
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<tr>
<td>— For $E_t$ Below Trend</td>
<td>5.43 3.05 23.82</td>
<td>6.27 4.01 24.75</td>
<td>5.66 3.33 24.0</td>
</tr>
<tr>
<td>Panel A: Empirical Employment Fluctuations</td>
<td>0.13 0.40 3.13</td>
<td>1.36 1.59 4.31</td>
<td>0.36 0.59 3.31</td>
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<tr>
<td>— Full Data</td>
<td>0.19 0.40 3.13</td>
<td>1.34 1.55 4.28</td>
<td>0.45 0.66 3.39</td>
</tr>
<tr>
<td>— For $E_t$ Above Trend</td>
<td>0.16 0.40 3.13</td>
<td>1.22 1.45 4.18</td>
<td>0.06 0.30 3.02</td>
</tr>
<tr>
<td>— For $E_t$ Below Trend</td>
<td>4.33 4.00 31.25</td>
<td>5.38 5.44 35.26</td>
<td>4.22 4.28 34.10</td>
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<tr>
<td>Panel B: Ten-Fold Amplification of Emp. Fluctuations in $V(E_t)$</td>
<td>0.13 0.40 3.13</td>
<td>1.36 1.59 4.31</td>
<td>0.36 0.59 3.31</td>
</tr>
<tr>
<td>— Full Data</td>
<td>0.19 0.40 3.13</td>
<td>1.34 1.55 4.28</td>
<td>0.45 0.66 3.39</td>
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<tr>
<td>— For $E_t$ Above Trend</td>
<td>0.16 0.40 3.13</td>
<td>1.22 1.45 4.18</td>
<td>0.06 0.30 3.02</td>
</tr>
<tr>
<td>— For $E_t$ Below Trend</td>
<td>4.33 4.00 31.25</td>
<td>5.38 5.44 35.26</td>
<td>4.22 4.28 34.10</td>
</tr>
</tbody>
</table>

Note: The table presents descriptive statistics for U.S. business cycles in the form of results of the business cycle accounting analysis described in Section 5, complementing the time series plots in Figure 4. The first set of results denotes the marginal disutility of employment $V'(E_t)$. The second set reports the aggregate labor wedges, the gap between the MPL and the MRS. The third set reports the labor wedges that hold λ constant (by holding consumption constant under separable utility) i.e. only reflect shifts in the marginal disutility of labor $V'(E)$ against the marginal product of labor. The table reports underlying time series for three representative household models that only differ in their aggregate disutility of employment $V(E)$: MaCurdy (1981) Frisch isoelasticities of 0.32 and 2.50, and the data-consistent disutility curve $V(E)$, which we obtain by fitting a polynomial to the empirical reservation raise distribution as described in Section 4.2 (the empirical curve is discussed in Section 3). Panel B replicates Panel A but ad-hoc amplifies the employment fluctuations entering the marginal disutility of labor $V'(E)$ by a factor of 10, to highlight asymmetries (time series plotted in companion Appendix Figure A.1). For clarity, for this experiment, the isoelasticity entries for the disutility of employment are approximated to the parameters $\eta \cdot 10$, as the actual elasticities are not precisely equal to that number due to the centering of the employment concept around the steady state employment level imposed to parallel the treatment of the survey-given stable $V(E_t)$. The precise entries are 4.08 and 31.87 for the full data, 3.85 and 30.10 for the above-trend sample, and 4.38 and 34.20 for the below-trend sample. The isoelasticity wedge columns use the precise disutility of employment. Moreover, for all procyclicality values, the employment concept builds on the steady state employment/population ratio target, plus the empirical deviation therein (again since for the empirically consistent curve, we assume a stable labor supply curve around steady state (trend)). All time series are quarterly, and log deviations from trend using an HP filter with smoothing parameter of 1,600.
Figures

Figure 1: Empirical Distribution of Reservation Raise Proxy in U.S. Population

(a) Histogram

(b) Cumulative Distribution Function (Aggregate Labor Supply Curve of the U.S. Population)

Note: The figure plots the empirical distribution of reservation raises in a representative sample of the U.S. population. Panel (a) plots the histogram, separately by labor force status. Panel (b) plots the population-level CDF, with hollow circles denoting observations. This CDF is (when evaluated at the cutoff set to the prevailing aggregate raise) the aggregate labor supply curve at the extensive margin. We truncate the distribution at 2.00 (so the CDF does not appear to reach 1). Section 3 describes the data source, reservation raise construction and interpretations. Additional moments and summary statistics are provided in Tables 1 and 2. Figure 2 and Figure 3 plot the logged versions of Panel (b) and respectively arc elasticities around the unit raise (along with model-implied curves). Source: Authors’ questionnaire in NORC Amerispeak Omnibus Survey.
Figure 2: Comparing the Extensive-Margin Labor Supply Curves: Model-Implied vs. Data

Note: The figure plots the empirical and model-implied short-run aggregate labor supply curves at the extensive margin building on our reservation raise approach: the deviation in the log (desired) employment rate (y-axis) against deviations in the aggregate prevailing raise (x-axis). The empirical labor supply curve is described in Section 3 and its fitted version in Section 4.2. The curves for a series of macro models with an extensive margin of labor supply are described and calibrated in the meta-analysis in Section 4. All curves go from the same baseline employment level of 0.607, and from a corresponding baseline net of raise rate normalized to 1.0. The Hansen indivisible labor is plotted on a secondary y-axis denoting the employment level (rather than in log deviations). Companion Appendix Figure A.3 replicates the above figure but zooms into smaller raise deviations to highlight the local properties of the aggregate labor supply curves. Companion Figure 3 reports arc elasticities of the various labor supply curves.
Note: The figure plots arc elasticities of the employment rate with respect to deviations of the aggregate prevailing raise $1 + \Xi$, for range of deviations of the raise around the baseline level (the x-axis). The figure pools these arc elasticities for the empirical labor supply curve (described in Section 3) and for a series of macro models with an extensive margin of labor supply (from the model meta-analysis in Section 4). The arc elasticities are calculated as $\frac{d\text{Emp}}{\text{Emp}} / \frac{d(1+\Xi)}{1+\Xi}$, from the baseline employment level (harmonized across models by calibration) and from a corresponding baseline net of raise rate normalized to 1.0.
Figure 4: Business Cycle Implications: Marginal Disutility of Employment & Labor Wedges

Note: The figure reports the results of the business cycle accounting analysis described in Section 5. Panels (a) (time series) and (b) (binned scatter plot, against the detrended employment rate) plot the model-specific marginal disutilities of labor $V'(E)$. Panels (c) and (d) follow the same structure but plot the aggregate labor wedges, the gap between the MPL and the MRS. Panels (e) and (f) finally plot the labor wedges that hold $\lambda$ constant (by holding consumption constant under separable utility) i.e. only reflect shifts in the marginal disutility of labor $V'(E)$ against the marginal product of labor. Each panel plots these time series for three representative household models that only differ in their aggregate disutility of employment $V(E)$: MaCurdy (1981) Frisch isoelasticities of 0.32 and 2.50, and the data-consistent disutility curve $V(E)$, which we obtain by fitting a polynomial to the empirical reservation raise distribution as described in Section 4.2 (the empirical curve is discussed in Section 3). Companion Table 5 Panel A reports summary statistics of the time series. Appendix Figure A.1 replicates this figure but ad-hoc amplifies the employment fluctuations entering the marginal disutility of labor $V'(E)$ by a factor of 10, to highlight that locally, the curve acts as a high-elasticity one and that only unrealistically large employment fluctuations reach the lower-elasticity regions. All time series are quarterly, and log deviations from trend using an HP filter with smoothing parameter of 1,600.
Online Appendix of:
The Aggregate Labor Supply Curve at the Extensive Margin: A Reservation Raise Approach
Preston Mui and Benjamin Schoefer

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A.6 Distribution of Reservation Raises 

A.7 The Empirical Relationship Between Individual-Level Realized Employment Dynamics and Reservation Raises 

A.8 Visualizing the Fitted Polynomial Approximation
### Additional Tables on the Reservation Raise Survey

Table A.1: Descriptive Statistics of the Reservation Raise Proxy from Reservation Wage Surveys of Unemployed Job Seekers: GSOEP, PASS and Pole emploi

<table>
<thead>
<tr>
<th>Measure</th>
<th>A. GSOEP</th>
<th>B. PASS</th>
<th>C. Pole Emploi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.22</td>
<td>0.75</td>
<td>0.94</td>
</tr>
<tr>
<td>Median</td>
<td>0.83</td>
<td>0.84</td>
<td>0.93</td>
</tr>
<tr>
<td>25 Pctile.</td>
<td>0.64</td>
<td>0.75</td>
<td>0.83</td>
</tr>
<tr>
<td>75 Pctile.</td>
<td>1.2</td>
<td>≥ 1.0</td>
<td>1.01</td>
</tr>
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<td>Pct. &lt; 1</td>
<td>61.0%</td>
<td>72.8%</td>
<td>70.5%</td>
</tr>
<tr>
<td>Pct. = 1</td>
<td>6.00%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pct. ≥ 1</td>
<td>-</td>
<td>27.2%</td>
<td>-</td>
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<tr>
<td>Pct. &gt; 1</td>
<td>33.0%</td>
<td>-</td>
<td>29.5%</td>
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<td>Pct. &gt; 2</td>
<td>11.3%</td>
<td>-</td>
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<td>Skewness</td>
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<td>Kurtosis</td>
<td>70.83</td>
<td>5.55</td>
<td>7.44</td>
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Note: The table reports summary statistics of the empirical reservation raise proxies constructed as the individual-level ratio of reservation wage to potential wage (in turn proxied for with the previous wage (GSOEP, Pole Emploi) or expected wage (PASS)), with the construction and correspondence to the reservation raise concept described in Appendix Section B. Some PASS entries are empty due to disclosure restriction and/or due to the censoring above 1.00 in the reservation net of raise rate. Associated histograms are presented in Appendix Figure A.5. Sources: German Socio-Economic Panel (for GSOEP column); PASS-IAB linked data (for PASS columns); Le Barbanchon, Rathelot, and Roulet (2019) for the Pole Emploi columns.
Table A.2: Covariate Analysis: (Log) Reservation Raise for U.S. Population (Authors’ Survey) Additionally Controlling for Labor Force Status

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<th></th>
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<th>Column (3)</th>
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<tr>
<td>Age / 100</td>
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Note: ∗: $p < 0.10$, ∗∗: $p < 0.05$, ∗∗∗: $p < 0.01$. The table replicates Table 4 but additionally includes a fixed effect for labor force status (employed, out of the labor force, unemployed) as a control variable in each specification. Robust standard errors in parentheses. Construction of reservation raises, survey and sample are described in Section 3. Source: Authors’ questionnaire in NORC Amerispeak Omnibus Survey.
Additional Figure: Labor Market Wedge

Figure A.1: Marginal Disutilities and Labor Wedges With $E_t$ Fluct’s Amplified x10 in $V'(E_t)$

(a) Marginal Disutility of Labor: Time Series
(b) Marginal Disutility of Labor: Binned Scatter Plot
(c) Labor Wedge: Time Series
(d) Labor Wedge: Binned Scatter Plot
(e) Frischian ($\lambda$-constant) Labor Wedge: Time Series
(f) Frischian ($\lambda$-constant) Labor Wedges: Binned Scatter Plot

Note: The figure extends the business cycle accounting analysis described in Section 5. It replicates Figure 4 but ad-hoc amplifies the employment fluctuations entering the marginal disutility of labor $V'(E)$ ten-fold (while feeding the nonamplified empirical $E_t$ into the other elements). It thereby highlights that locally, the curve acts as a high-elasticity ones and at the aggregate business cycle level, unrealistically large employment fluctuations are needed for the curve to reach the lower-elasticity region. As in baseline Figure 4, Panels (a) (time series) and (b) (binned scatter plot of the model-specific marginal disutilities of labor $V'(E)$ against the employment rate for U.S. business cycles. Panels (c) and (d) follow the same structure but plot the aggregate labor wedges, the gap between the MPL and the MRS. Panels (e) and (f) finally plot the labor wedges that hold $\lambda$ constant (by holding consumption constant under separable utility) i.e. only reflect shifts in the marginal disutility of labor $V'(E)$ against the marginal product of labor. The plots reflect three representative household models that only differ only in aggregate disutility of employment $V(E)$: MaCurdy (1981) Frisch isoelectricities of 0.32 and 2.50, and the data-consistent disutility curve $V(E)$, as described in Section 4.2. Table 5 Panel B reports summary statistics of the time series. All time series are HP-filtered log quarterly time series with smoothing parameter of 1,600.
A Theoretical Appendix for Model Meta-Analysis Recast in Framework

We first present for each model detailed derivations and discussions, and then cover computational details.

A.1 Detailed Derivation and Discussion: Existing Models Recast in Reservation Raise Framework

We now present a detailed model-by-model meta-analysis applying the reservation-raise approach as a unifying bridge between structurally different labor supply blocks, proceeding in three steps:

M1 Construct the individual-level reservation raise \( 1 + \xi^*_{it} \) in the model at hand.

M2 Compute its (steady-state) equilibrium reservation-raise distribution \( F_t(1 + \xi^*_{it}) \), and plot the implied aggregate labor supply curve.

M3 Compute arc elasticities of extensive margin labor supply from the CDF of the reservation raises \( F_t(1 + \xi^*_{it}) \).

The parameters for our calibrated models in this meta-analysis are in Appendix Table A.3. Appendix Figure A.4 plots additional model-specific reservation raise histograms and supplementary items.

A.1.1 Representative Household: Full Insurance and "Command" Labor Supply

A common specification of aggregate labor supply appeals to a large representative household, comprised of a unit mass of individual members, which we explicitly index by \( i \in [0, 1] \).

Micro utility \( u_i(c_{it}) - e_{it}v_{it} \) is separable, where \( e_{it} \in \{0, 1\} \) is an employment indicator. Potential earnings are \( y_{it} \). There is potentially some uncertainty over the path of wages and interest rates. The large household has a pooled budget constraint and assigns consumption levels and employment statuses to its individual members:  

\[
\max_{\{c_{it}, e_{it}\}_{i}, A_t} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \int_{0}^{1} \left[ u_i(c_{is}) - e_{is}v_{is} \right] d i \\
\text{s.t.} \ A_s + \int_{0}^{1} c_{is}d i \leq A_{s-1}(1 + r_{s-1}) + \int_{0}^{1} (1 + \Xi_s)y_{is}e_{is}d i + T_s \ \forall s \geq t. \tag{B1}
\]

\[
\frac{\hat{\lambda}_t \hat{\omega}_t}{\overline{E}_t} = \overline{\sigma}, \tag{B2}
\]

\footnote{We take a perspective, as, e.g., Galí (2011a,b); Galí, Smets, and Wouters (2012), that the household head directly assigns allocations. Hansen (1985) and Rogerson (1988) present incentive-compatible lotteries. The Hansen (1985) set-up is equivalent to a representative household with utility function \( U(c_t, E_t) = \log(c_t) - \overline{\sigma}E_t \), with intratemporal first-order condition \( \hat{\lambda}_t \hat{\omega}_t = \overline{\sigma} \).}
Full (cross-sectional) insurance implies that the marginal utility of consumption is optimally set homogeneous across households, equal to the multiplier on the pooled budget constraint,

\[ \overline{\lambda}_t = \frac{\partial u_i(c_{it})}{\partial c_{it}} \quad \forall \ i, \]  

which eliminates \( \lambda \) as a source of cross-sectional variation in reservation raises even with heterogeneity in consumption utility function \( u_i(\cdot) \). Due to spot jobs, expectations and intertemporal aspects are subsumed in \( \overline{\lambda}_t \). Going forward, \( \overline{x}_t \) denotes idiosyncratic variables \( x_{it} \) that are homogeneous in the cross-section in a given model.

First, we define the allocative micro reservation raise in this large-household structure, here rendering the household head indifferent between sending that marginal member \( i \) to employment rather than nonemployment, where we can index an individual \( i \) by her disutility-earnings type \( v_{yt} \):

\[ 1 + \xi^*_{it} = \frac{v_{it}}{\overline{\lambda}_t y_{it}} = 1 + \xi^*_{v_{yt}}. \]  

Optimal labor supply assigns each \( i \) employment status \( e_{it} = e_{v_{yt}} \in \{ 0, 1 \} \) given by a reservation raise cutoff:

\[ e_{v_{yt}}^* = \begin{cases} 0 & \text{if } 1 + \xi^*_{v_{yt}} > 1 + \Xi_t \\ 1 & \text{if } 1 + \xi^*_{v_{yt}} \leq 1 + \Xi_t. \end{cases} \]  

Second, we trace out the aggregate labor supply curve from the distribution of the reservation raises, which in turn subsumes the detailed potential heterogeneity in wages and labor supply disutilities. Employment \( E_t \) is equal to the mass of workers with \( 1 + \xi^*_{it} \leq 1 + \Xi_t \):

\[ E_t(1 + \Xi_t) = F_t(1 + \Xi_t) = P \left( 1 + \xi^*_{it} \leq 1 + \Xi_t \right) = P \left( \frac{v_{it}}{y_{it}} \overline{\lambda}_t \leq (1 + \Xi_t) \overline{\lambda}_t \right) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} 1 \left[ \frac{v}{y} \leq (1 + \Xi_t) \overline{\lambda}_t \right] dG_t(v, y), \]  

where \( G_t(v, y) \) is the CDF of the joint distribution of \( v \) and \( y \).

Third, the arc elasticity properties then follow the definition in Equation (9) and depend on the joint distributions of \( v \) and \( y \).

Below we review specific cases of this representative-household class of labor supply
model block, to study more concrete curves.

**Hansen (1985)** The setup nests the model of indivisible labor and homogeneous households by Hansen (1985), where specifically \( \tilde{y}_t = \tilde{h} \tilde{w}_{it} \) and \( v_{it} = \bar{v} \) \( \forall i \) (which in the original paper is \( A \ln(1 - h_{it}) \)), with one exogenous hours option \( h_{it} \in \{0, \tilde{h} > 0\} \).

First, all individuals have the same reservation raise – i.e. all are exactly marginal:

\[
1 + \xi_{it}^* = 1 + \bar{v}_t = \frac{\bar{v}}{\lambda_t \tilde{y}_t}.
\]

Second, the reservation raise distribution, which we plot in Appendix Figure A.4 (a), is degenerate.

Third, the Frisch elasticity is locally infinite at \( 1 + \Xi_t \). Interior solutions are obtained through \( \lambda_t \) (decreasing marginal utility from consumption).

**Heterogeneity Only in Disutility of Labor** We now maintain wage homogeneity, but disutility of labor \( v \) is distributed between individuals according to CDF \( G^v_t(v) \). First, each individual \( i \) is now characterized by their type \( v(i) \), and the household head maximizes:

\[
\max_{\{c_{vt}, e_{vt}\}, A_t} \mathbb{E} \sum_{s=t}^{\infty} \beta^{s-t} \int [u(c_{vs}) - e_{vs}] g(v)dv
\]

s.t.

\[
A_s + \int c_{vs} g(v)dv \leq A_{s-1}(1 + r_{s-1}) + (1 + \Xi_s) y_s \int e_{vs} g(v)dv + T_s \quad \forall s \geq t.
\]

First, we define the reservation raise for each individual characterized by their type \( v(i) \):

\[
1 + \xi_{it}^* = \frac{v_{it}}{\tilde{y}_t \lambda_t}
\]

\[
= 1 + \xi_{vt}^*.
\]

Second, aggregate labor supply curve, i.e. distribution of \( 1 + \xi_{it}^* \) will follow directly from \( G^v_t(v) \) since consumption and wages are homogeneous. The household head sends off members with \( 1 + \xi_{it}^* < 1 + \Xi_t \) to employment, and all others to nonemployment:

\[
E_t(1 + \Xi_t) = F_t(1 + \Xi_t) = P \left( 1 + \xi_{it}^* \leq 1 + \Xi_t \right) = P \left( v_{it} \leq \frac{1 + \Xi_t}{\tilde{y}_t \lambda_t} \right) = G^v_t \left( \frac{1 + \Xi_t}{\tilde{y}_t \lambda_t} \right).
\]

Alternatively, pointwise optimization would lead to a disutility cutoff rule \( v_i^* = (1 + \Xi_t)\tilde{y}_t \lambda_t; \quad v_{it} \geq v_i^* \) types work, \( v_{it} < v_i^* \) types stay at home.
Third, the elasticity is given by \[
\left( 1 + \Xi_t \right) g^v_t \left( \frac{1 + \Xi_t}{\overline{y}_t \lambda_t} \right) / \left[ 1 - G^v_t \left( \frac{1 + \Xi_t}{\overline{y}_t \lambda_t} \right) \right].
\]

**MaCurdy (1981) Isoelastic Preferences**  A common representative household setup (pooled budget constraint and homogeneous wages) applies the familiar isoelastic intensive-margin MaCurdy (1981) preferences to the extensive margin (we review as an example a New Keynesian application to wage stickiness as the subsequent model):

\[
\frac{C_t^{1-\sigma} - \Psi E_t^{1+1/\eta}}{1 - \sigma} = \frac{F_t^{1+1/\eta}}{1 + 1/\eta}.
\]

We now reverse-engineer a distribution of disutility \( G^v_t(v) \) that delivers this labor supply specification. The micro reservation raise is again given by (B12). Suppose \( v \) follows a power law distribution \( G^v_t(v) = \left( \frac{v}{v_{\text{max}}} \right)^{\alpha_v} \) with shape parameter \( \alpha_v \) over support \([0, v_{\text{max}}] \). Then, aggregate employment is (building on Section 2.3, assuming positive nonemployment by all types):

\[
E_t(1 + \Xi_t) = F_t(1 + \Xi_t) = P \left( \frac{v_{lt}}{\overline{y}_t \lambda_t} \leq 1 + \Xi_t \right) = G^v_t \left( (1 + \Xi_t) \frac{\overline{y}_t \lambda_t}{v_{\text{max}}} \right)^{\alpha_v}.
\]

The reservation raise distribution then too is a power law distribution inheriting shape parameter \( \alpha_v \) – giving the constant extensive margin Frisch elasticity:

\[
\epsilon_{E_t, 1 + \Xi_t} = \frac{(1 + \Xi_t) F_t(1 + \Xi_t)}{F_t(1 + \Xi_t)} = \frac{(1 + \Xi_t) \alpha_v (1 + \Xi_t)^{-1} \left( \frac{(1 + \Xi_t) \overline{y}_t \lambda_t}{v_{\text{max}}} \right)^{\alpha_v}}{\left( \frac{(1 + \Xi_t) \overline{y}_t \lambda_t}{v_{\text{max}}} \right)^{\alpha_v}} = \alpha_v.
\]

To show that this household can be written as a representative household with a MaCurdy preference structure, consider a rearrangement the aggregate labor supply curve (B16):

\[
v_{\text{max}} E_t^{1/\alpha_v} = (1 + \Xi_t) \frac{1}{\overline{y}_t \lambda_t},
\]

which is the first order condition of objective function (B15) for \( \eta = \alpha_v \) and \( \Psi = v_{\text{max}} \).30

In Appendix Figure A.4 (b), we plot the density of reservation raises for a MaCurdy model.

---

30 Alternatively, we can directly derive total disutility of labor \( V(E_t) \) from employment rate \( E_t \in [0, 1] \), where the head optimally sorts the members by their disutility of labor up until \( v = \mu(E_t) \), a threshold defined as the disutility of working of the marginal worker for total employment \( E_t = G^v(\mu(E_t)) = \left( \frac{\mu(E_t)}{v_{\text{max}}} \right)^{\alpha_v} \), which gives
with potential earnings \( \tilde{y} \) and marginal utility of consumption \( \tilde{\lambda} \) are normalized to one, and the Frisch elasticity is 0.32. The maximum micro labor supply disutility is set to \( 0.607^{1/0.32} \) for an equilibrium employment rate at 60.7%.

**Heterogeneous (Sticky) Wages and Isoelasticity** (Galí, 2011a,b; Galí, Smets, and Wouters, 2012)  The New Keynesian model presented in Galí (2011a,b); Galí, Smets, and Wouters (2012) (which also microfound the isoelasticity) additionally features wage heterogeneity. Individuals are a unit square indexed by \((l, n) \in [0,1] \times [0,1]\). \( l \) denotes the type of labor, paid wage \( y_{lt} \), which may diverge across types due to wage stickiness. \( n \) indexes labor disutility, \( n^{1/\eta} \). The household head maximizes:

\[
\max_{c_t,\{E_{lt}\}} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left( \frac{c_s^{1-\sigma} - 1}{1 - \sigma} - \Psi \int_0^1 \int_0^{E_{ln}} n^{1/\eta} \, dn \, dl \right)
\]

s.t. \( A_t + \int_0^1 c_{lt} \, dl \leq A_{t-1} (1 + r_{t-1}) + (1 + \Xi_t) y_{lt} E_{lt} + T_t \ \forall s \geq t, \)  \( \) where the \( l \)-specific employment rate is \( E_{lt} = \int_0^1 e_{lt} \, dl \).

We now cast this setting into the reservation raise framework. First, we define the micro reservation raise, characterizing individual \( i \) by type \( nl \):

\[
1 + \xi^*_{nl} = \frac{\Psi n^{\eta}}{y_{lt} \tilde{\lambda}_t}.
\]

Second, \( 1 + \xi^*_{nl} \) follows (with some nonemployment within each wage-type \( l \) as in Section 2), a power law distribution with maximum \( \Psi \left( \left( \int_0^1 y_{lt} n^{1/\eta} \, dl \right)^{1/\eta} \tilde{\lambda}_t \right) \) and shape parameter \( \eta \).\(^{31}\)

\[\text{quantile function } \mu(E_t) = v_{\max}E_t^{1/\alpha_v}, \]  and hence:

\[
V(E_t) = \int_0^{\mu(E_t)} v dG_{t}^v(v) = \frac{\alpha_v}{v_{\max}^{\alpha_v}} \int_0^{\mu(E_t)} (v)^{\alpha_v} \, dv = \frac{\alpha_v}{v_{\max}^{\alpha_v}} v^{1+\alpha_v} \left[ \mu(E_t) \right]_{0}^{v_{\max} E_t^{1/\alpha_v} \left( 1 + 1/v_{\max} \right)} = v_{\max} E_t^{1/\alpha_v} \left( 1 + 1/v_{\max} \right),
\]

which again mirrors MaCurdy utility function (B15) for \( \eta = \alpha_v \) and \( \Psi = \tilde{v} \).

\( ^{31} \) Intuitively, the distribution of the reservation raise is power law distributed with the same parameter within each labor type. As a result, changes in \( 1 + \Xi_t \) elicit the same proportional employment changes from each labor type, and the aggregate employment elasticity inherits that homogeneous elasticity. Our expression holds for \( 1 + \Xi_t \) small enough that \( 1 + \xi^*_{nl} > 1 + \Xi_t \) holds for some \( n \) within all labor types \( l \), i.e. the aggregate net of raise rate must be high enough that some workers in each labor type are nonemployed. Otherwise, there is full employment from some labor types, and the labor response from those labor types is zero, so the aggregate
This implies the following aggregate labor supply curve:

\[
E_t(1 + \Xi_t) = F_t(1 + \Xi_t) = P \left( \frac{\Psi_s^{1/\eta}}{y_{it}^\lambda_t} \leq 1 + \Xi_t \right) = \int_0^1 \left( \frac{(1 + \Xi_t) y_{it}^\lambda_t}{\psi} \right)^{\eta} dl = \left( \frac{(1 + \Xi_t)}{\psi \left( \int_0^1 y_{it}^{\eta} dl \right)^{1/\eta} \lambda_t} \right)^{\eta}.
\]  
(B24)

Third, again as in Section 2 the elasticity is again precisely \( \eta \).

### A.1.2 Heterogeneous Agent Models: Atomistic Households Without Risk Sharing

We now move to heterogeneous agent models, where atomistic households make labor supply and consumption decisions with separate budget constraints potentially facing incomplete markets. These class of models can feature heterogeneity in \( \lambda_{it} \), which is determined in equilibrium.

A useful classification of heterogeneity is whether it is permanent or transitory.

**Permanent Heterogeneity** With atomistic agents with separate budget constraints but permanent differences, a mass point of marginal workers endogenously emerges (mirroring intuitions from labor indivisibility with homogeneity as in Hansen, 1985). Specifically, in this setting individuals choose a lifetime fraction of working \( l_i \), or equivalently a probability of working in a given period \( \Phi_{it} \) s.t. \( \int_0^\infty \Phi_{it} = l_i \), as in the time-averaging approach of Ljungqvist and Sargent (2006). Permanent heterogeneity in tastes, endowments or wages affects the average employment probability, yet at each given point in time, these "interior" households are exactly on the margin. This local mass of marginal actors makes up one minus the fraction of households that either never or always work – implying an empirically uninteresting case of the infinite local Frisch elasticity.\(^{32}\)

\(^{32}\) To see how permanent heterogeneity can generate trivial reservation raise dispersion (in continuous time), consider a household (indexed by \( i \in [0,1] \)) characterized by disutility \( v_i \), initial endowments \( a_{0i} \), and wages \( w_i \) (and consumption tastes \( u_i(c_{it}) \)), with stable interest rates \( r = \rho \) and no borrowing constraint. So the household’s problem is \( \max_{c_{it},e_{it},a_{it}} \mathbb{E}_t \int_{s=0}^{\infty} e^{-\rho(s-t)} \left[ u_i(c_{it}) - v_i e_{it} \right] ds \) subject to a lifecycle budget constraint

\[
a_{is} = (1 + \Xi_t) y_i e_{is} + r a_{is} - c_{is} + \mathbb{I}(s = t) \cdot a_{it} \forall s \geq t \iff \int_{s=0}^{\infty} e^{-\rho(s-t)} c_{is} ds = \int_{s=0}^{\infty} e^{-\rho(s-t)} (1 + \Xi_t) y_i e_{is} ds + a_{it}.
\]

First, labor supply is an employment policy \( e_{it}^* \) characterized by a constant-over-the-lifetime reservation raise 1 + \( \xi_{it}^* = \frac{v_i}{\lambda_t y_{it}} = 1 + \xi_{i}^* \). Second, the distribution of the reservation raise (labor supply curve) is \( E_t(1 + \Xi_t) = F(1 + \Xi_t) = \int \mathbb{I}[1 + \xi_{i}^* \leq 1 + \Xi_t] dl_i \). The constant raise structure implies that for a given prevailing raise 1 + \( \Xi_t \), there are three reservation raise regions. Two inframarginal regions denote workers that do not work even for
We therefore next move to more realistic models with time-varying heterogeneity, starting with stochastic wages below, then moving to deterministically time-varying wage-age profile in Appendix Section A.2

**Time-Varying Heterogeneity: Stochastic Wages (Huggett, 1993)** We now consider the popular case where the heterogeneity between households arises from stochastic productivity. Incomplete financial markets mean that income shocks pass through into budget constraints, and thence into consumption/savings policies, assets, consumption, and $\lambda_{it}$. To study this setting through the lens of the reservation raise framework, we introduce indivisible labor into the Huggett (1993) model as in Chang and Kim (2006, 2007).

There is a continuum of infinitely lived individuals, in discrete time. Assets $a_{it}$ earn or incur interest $r_t$. An individual chooses consumption $c_{it}$ and indivisible labor supply $e_{it} \in \{0, 1\}$. Potential earnings $y_{it}$ follow an exogenous Markov process. She maximizes separable preferences, subject to budget constraint and borrowing limit $a_{min} < 0$ (set so that positive consumption is always feasible if working even at the lowest earnings level and when at the borrowing constraint), with discount factor $\beta \leq 1$:

\[
\max_{c_{it}, e_{it}, a_{it}} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left[ \frac{c_{is}^{1-\sigma}}{1-\sigma} - \bar{c}_{is} e_{is} \right]
\]

s.t. 
\[
E_{i,s} = (1 + \Xi_s) y_{is} e_{is} + (1 + r_s) a_{i,s-1} - c_{is} \forall s \geq t
\]
\[
a_{is} \geq a_{min} \forall s \geq t.
\]

First, we calculate the reservation raise for each individual, indexed by $a$ and $y$ (since individuals of the same asset and productivity types face the same optimization problem):

\[
1 + \xi^{*}_{ay} = \frac{\bar{v}}{\lambda_{ay} y}.
\]

Second, we calculate the reservation raise distribution (CDF) from the joint distribution of assets and productivities, yielding the labor supply curve:

\[
E_t(1 + \Xi_t) = F_t(1 + \Xi_t) = \sum_{y \in Y} \int_{a_{min}}^{\infty} 1[1 + \xi^{*}_{ay} \leq 1 + \Xi] g_t(a, y) da,
\]

where $g(a, y)$ is the density of agents with assets $a$ and potential earnings $y$. (small) net of raise rate increases, as well as those that always work even for small net of raise rate declines. The third set is the set of marginal workers, who endogenously are exactly indifferent, and hence will all drop out of work for small net of raise rate declines, and all move into employment for small net of raise rate increases. Hence, if there is a mass point of these marginal individuals at the prevailing raise, the labor supply curve will exhibit an infinite Frisch elasticity at the extensive margin.
Third, the arc elasticities, following Equation (9), depend on the joint distributions of $\lambda$ and $y$.

Below we assess these properties at the example of two concrete earnings processes. We solve for consumption and labor supply rules, as well as the joint distribution of assets and productivity states, for an exogenous and constant interest rate $r_s = r \; \forall s \geq t$.

**Two-State Potential-Earnings Process** We start by describing a simple economy with a two-state Markov process for potential earnings, jumping from $y_1$ to $y_2 > y_1$ ($y_2$ to $y_1$) with probability $\lambda_{12}$ ($\lambda_{21}$). Our goal here is to convey intuitions, and to illustrate the complexity of aggregate labor supply already with only two wage states – and how reservation raises can unveil and organize the obscure labor supply curve. The parameters are not picked to match any empirical moments, except for an equilibrium employment rate of 60.7% when $1 + \Xi_t = 1$. We plot the distribution of the reservation raises in Appendix Figure A.4 Panel (c).

In the model, for both wage levels, $1 + \xi^*_{ay}$ is increasing in assets, since $\lambda_{ay}$, the individual’s budget multiplier, is decreasing in assets. As expected, $1 + \xi^*_{a_{y_2}} < 1 + \xi^*_{a_{y_1}}$ for any given asset level $a$, since higher wages raise consumption and the opportunity cost of not working. For $1 + \Xi_t = 1$, all high earners work for any asset holdings in the asset grid (i.e. $1 + \xi^*_{a_{y_2}} < 1 \forall a \in [a_{min}, a_{max}]$). Low earners work if assets (and consumption) are low, but above an asset threshold $a_{y_1}^*$ s.t. $1 + \xi^*_{a_{y_1}} = 1$ prefer leisure.

The implied labor supply curve is plotted in Appendix Figure A.4 Panel (d), and exhibits complex behavior even with only two wage types, due to the asset distribution. When the labor raise is at $1 + \Xi_t = 1$, the marginal worker is a low-wage worker with a relatively high asset level. As $1 + \Xi_t$ falls, low-earners drop out of employment in descending order of their assets holdings, with lower and lower density. At some point, the marginal worker is a low-wage earner with assets at the borrowing limit. Since there is a mass of such individuals, the labor supply curve is locally infinitely elastic at that point (echoing locally the logic in the models of homogeneity of Hansen, 1985; Rogerson, 1988). As $1 + \Xi_t$ falls further, all low-wage individuals become nonemployed, and the marginal worker is now a high earner (and again the pecking order is given by asset holdings).

**Realistic Earnings Process** We now apply a realistic 33-state potential-earnings process, mimicking that in Kaplan, Moll, and Violante (2018) (whose model features only intensive-margin labor supply), which in turn approximates the empirical patterns documented in Guvenen, Karahan, Ozkan, and Song (2015). We detail the construction of variant in Appendix Section A.3.3. The computational details for the full model are again described in Appendix Section A.3.2, and the full set of parameters are in Appendix Table A.3.

We plot the distribution of the reservation raises in Appendix Figure A.4 Panel (e). To
further illustrate the compositional origins of the reservation raise distribution, Panel (f) plots the reservation raise distribution for three particular out of the 33 total values of potential-earnings states. High-potential-earnings individuals tend to have lower reservation raises, as expected, but the states themselves are not completely informative without reference to the Markov process that guides expected earnings dynamics and equilibrium assets distributions, further highlighting the benefit of the reservation raises as the sufficient statistic.

Overall, in the heterogeneous agent model calibrated to a realistic earnings process, the reservation raise distribution is widely dispersed. Specifically and as a result, the model generates a small local Frisch elasticity. For a 0.01 perturbation, the downward arc elasticity is 0.72 on the high side, but much smaller upwards (0.18). For large perturbations towards 0.10, the elasticities quickly settle in below 0.5. The equilibrium reservation raise distribution and hence labor supply curve inherit the joint distribution of $\lambda$ and $y$, so that the curve is particularly inelastic if low earnings realizations are offset by associated high $\lambda$ values.

The Role of Incomplete Financial Markets  

We shut off the equilibrium heterogeneity in $\lambda$ by instead ad-hoc setting a homogeneous $\bar{\lambda}$, (normalized to generate the same baseline employment rate). This experiment evokes complete markets, where $y$-state-contingent claims would neutralize the effects of stochastic potential earnings on $\lambda$, generating a reservation raise distribution that mimics a variant of the representative full-insurance household (here with constant $v$ and $\lambda$), since $1 + \xi_y = \frac{x}{\lambda y}$. We plot the resulting reservation-raise-implied labor supply curve reflecting solely heterogeneity in potential earnings $y$ in Appendix Figure A.4 Panel (g), in the solid line marked by stars where the subset of potential-earning states from the 33 total states are within the range of raise deviations we plot.

The underlying sparse discrete Markov process renders the full-insurance curve choppy (so we do not plot it in our full Figure 2 and Figure 3, in particular compared to the full model’s incomplete-markets setting plotted also in form of a solid line without markers, where the smooth asset distribution serves to smooth out the reservation raise distribution. In reality, earnings levels are continuous and the sparse set of earnings levels is chosen for computational reasons, so we additionally plot one arising from continuous earnings (for the parametric process which Kaplan, Moll, and Violante (2018) discretize into the 33 states), which smooths out the earnings and hence reservation raise distribution even with homogeneous $\lambda$. This line is plotted as a dashed line, and we also include this benchmark in the overview Figure 2 and Figure 3.

The comparison highlights the stabilizing role of incomplete markets in extensive-margin

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33 To construct this continuous earnings-process-only labor supply curve, we obtain the steady-state distribution of the underlying earnings process described in Appendix Section A.3.3, by simulating 10,000 realizations to the 2,000th period. The labor supply curve is simply the CDF of this distribution, normalized in log changes around the 60.7% employment rate baseline.
labor supply in lowering elasticities. Aggregate labor supply implied by homogeneous \( \lambda \) is dramatically more elastic in the low end. This is because \( \lambda \) and \( y \) in the incomplete markets setup covary negatively: low productivity agents have higher shadow values of income than their better-earning peers. Full insurance eliminates this negative covariance, so the labor supply with full insurance is highly elastic. This intuition is specific to the extensive margin (and hence differs from intensive-margin-only life-cycle intuitions as in Domeij and Floden, 2006; Heathcote, Storesletten, and Violante, 2014).

This exercise also illustrates how the reservation raise framework can serve as a diagnostic tool to study labor-supply implications also of richer asset market structures, such as with illiquid assets with which wealthy households can act constrained too, further shaping the joint distribution of \( \lambda \) and \( y \) (e.g., as in Kaplan, Violante, and Weidner, 2014; Kaplan, Moll, and Violante, 2018, which do not feature an extensive margin).


As in the general intensive-margin case in Section 2.4, permitting hours choices preserves the reservation raise logic. A leading model with both margins is that by Rogerson and Wallenius (2009), which also features lifecycle patterns (and the Frischian behavior of which Chetty, Guren, Manoli, and Weber, 2012, studied as a leading example of macro models with an extensive margin). We discuss our parameterization in Appendix Section A.3.4, largely following the parameterization choices of Chetty, Guren, Manoli, and Weber (2012), but we change the tax rate and apply a 60.7% employment rate target for consistency with all our models and the survey, all hence matching our U.S. 2019 broad population benchmark.

The overlapping generations economy is set in continuous time and has a unit mass of individuals born at every instant, denoted by \( i \), and each lives for a length of time equal to one. The individual’s age at time \( t \) is denoted by \( d_{it} \in (0, 1) \). (In our calibration, we will set the discount rate to zero, and individuals can save and borrow at zero interest rate.) The individual freely chooses hours worked \( h_{it} \) and consumption \( c_{it} \) at some utility \( u(c_{is}) \), which is separable from disutility of hours, here following the MaCurdy isoelastic structure with \( v(h_{it}) = \frac{h_{it}^{1+1/y}}{1+1/y} \). Earnings \( \theta_{is}(h_{is}) \) depend on hours subject to a nonconvexity and age, as we discuss below. The optimization problem at time \( t \) for individual \( i \) of age \( d \) (with remaining lifetime \( 1 - d_{it} \)) is:

\[
\max_{c_{it}, h_{it}} \mathbb{E}_{t} \int_{s=t}^{t+(1-d_{it})} e^{-\rho(s-t)} \left[ u(c_{is}) - v(h_{is}) \right] ds
\]

s.t. \( c_{is} + \dot{a}_{is} = r_s a_{is} + (1 + \Xi_s) y_{is} \quad \forall t + (1-d_{it}) \geq s \geq t. \)
Earnings $\theta_{is}(h_{is})$ are structured as follows. Hourly wages $w_{it} = w_{dit}$ are a triangular, single-peaked function of age $d$, generating lifecycle aspects. Moreover, rather than $y = hw$, to generate an extensive margin, $\theta_{is}(h_{is})$ features a nonconvexity of earnings in hours, in form of fixed hours cost: labor hours are productive, and hence are paid wages $w_{d}$, only above hours threshold $\underline{h}$:

$$\theta_{it}(h_{it}) = w_{dit} \cdot \max\{h_{it} - \underline{h}, 0\}.$$ (B32)

Absent this fixed cost, the marginal disutility at $h = 0$ hours is zero, and so everyone works positive hours (provided positive wages) – eliminating the extensive margin, as in our intensive-margin example in Section 2.4.

First, in a given period $t$, heterogeneity in reservation raises solely reflect heterogeneity in age $d$, so we can write reservation raises and choices indexed by age types $d$. Hours choices $h^*_{dt}(1 + \Xi_t)$ are given by $(1 + \Xi_t)w_d \lambda_{dt} = \Gamma[h^*_{dt}(1 + \Xi_t)]^{1/\gamma}$. Since our context features an intensive margin, this reservation raise is implicitly defined as a fixed point, as in our general job-choice case in Section 2.4:

$$1 + \xi^*_{dt} = \frac{v \left( h^*_{dt}(1 + \xi^*_{dt}) \right)}{\lambda_{dt} \theta_{dt}(h^*_{dt}(1 + \xi^*_{dt}))} = \frac{\Gamma \left( \frac{\lambda_{dt}(1 + \xi^*_{dt})w_d}{\Gamma} \right)^{1/\gamma + 1}}{\lambda_{dt}w_d \left( \frac{\lambda_{dt}(1 + \xi^*_{dt})w_d}{\Gamma} \right)^\gamma - \underline{h}}.$$ (B33)

That is, individuals work when the (hourly) wage is above some threshold $w^*$. Also, setting $h = 0$ nests the MaCurdy intensive-margin-only setting, with $1 + \xi^*_{dt} = 0$ for all workers and ages, as in our general intensive-margin job choice in Section 2.4.

Second, Appendix Figure A.4 Panel (h) plots the histogram of the reservation raise distribution, which also gives the aggregate labor supply curve:

$$E_t(1 + \Xi_t) = F_t(1 + \Xi_t) = P \left( \frac{\Gamma \left( \frac{h}{1/\gamma + 1} \right)^{1/\gamma}}{\lambda_{dt}w_d} \leq 1 + \Xi_t \right) = P \left( \frac{1}{w_d} \leq \frac{1 + \Xi_t}{\Gamma \left( \frac{h}{1/\gamma + 1} \right)^{1/\gamma} / \lambda_{dt}} \right).$$ (B34)

Since out of a nonstochastic steady state as the one we depict, $\lambda_{dt}$ is homogeneous as we can reduce the budget constraint (B31) into a lifecycle budget constraint, the distribution of the

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34 In fact, without uncertainty and perfect capital markets and hence a lifetime budget constraint $\bar{\lambda}$, we could then solve for the age-specific reservation raise explicitly as $1 + \xi^*_{d} = \frac{\Gamma(h(1/\gamma + 1))^{1/\gamma}}{\lambda w_d}$, and therefore also solve for the reservation wage and hence marginal ages.
reservation raises solely inherits that of \(1/w_d\), a feature we discuss in detail below.

Third, we compute the extensive-margin arc elasticities. The Frisch arc elasticities range from 2.60 to 3.20 in this particular calibration, with local elasticities (from 0.01 net of raise rate perturbations) between 2.84 and 2.90.\(^\text{35}\)

**The Role of the Intensive Margin**  To assess the importance of intensive margin reoptimization on extensive margin labor supply preferences, in Figure 2 and Figure 3 we plot two labor supply curves for this model, first the baseline one allowing for hours choice reoptimization (solid line). This curve "envelopes" the second curve (dotted line), which shuts off such hours reoptimization and instead holds hours fixed at the optimal hours choice at "pre-experiment" \(1 + \Xi = 1\) levels. That is, for noninfinitesimal raise shifts, extensive-margin adjustment is attenuated. Intuitively, intensive-margin reoptimization weakly raises the return of work. As a result, the flexible-hours employment curve always is equal or exceeds the fixed-hours analogue.

**The Role of the Wage-Age Profile**  Our framework highlights that the particular wage-age profile and the uniform age distribution underlie the shape of the reservation raise distribution and labor supply curve: \(w_d\) is piece-wise linear in age (a single-peaked triangle), so the wage distribution is given by the age distribution, as clarified by Equation (B34). This suggests the possibility that seemingly unrelated changes in the model structure, specifically in the wage-age gradient around the marginal ages (labor force entry and exit) may have dramatic effects on local elasticities. Our additional exploration thereby refines the study by Chetty, Guren, Manoli, and Weber (2012), who enlist the Rogerson and Wallenius (2009) model as a representative macro model example with indivisible labor featuring inherently large extensive-margin Frisch elasticities.\(^\text{36}\)

To illustrate this flexibility, we recalibrate the model and now target a lower Frisch elasticity, by maintaining the same triangular-shaped wage-age profile but allowing for a higher level of peak lifetime productivity and a steeper slope of the wage-age productivity gradient. The parameter choices and targets are in Table A.3, and we additionally plot the labor supply curves (dotted-dashed line) in Figure 2 and Figure 3. Under this parameterization,

\(^{35}\) In principle, we could obtain the elasticity analytically from the reservation raise distribution. Our method to measure the arc elasticities on the basis of the reservation raise distribution complements the construction of the Frisch elasticity by Chetty, Guren, Manoli, and Weber (2012), who simulate a small, short-lived one percentage point tax change, which requires repeatedly solving the model for each generation, may include non-Frischian features, and only isolates one arc elasticity.

\(^{36}\) That is, since the age distribution is uniform, the slope of \(w_d\) in \(d\) around the cutoff ages (young and old, i.e. "entering the labor force" or "retiring") determines the extensive-margin Frisch elasticities, with a steeper \(w_d\) at those points yielding a lower elasticity of labor supply. At least locally, one could engineer a wide range of extensive-margin Frisch elasticities by retaining the calibrated productivity profile \(w_d\) (hence hitting lifetime labor supply calibration targets), but tilting the shape of \(w_d\) in an arbitrarily small region around the cutoff ages.
the density around 1.0 is lower, and so the local elasticity falls. Quantitatively, the calibration implies a local Frisch elasticity (using an arc from 0.995 to 1.005) of only 1.6 – nearly half of the baseline 2.9 elasticity. More flexible nonlinear functional forms of the wage-age gradient could likely deliver even lower Frisch elasticities.

**A.3 Further Computational Details**

We describe additional details of the models discussed in Section 4 and above.

**A.3.1 The Representative Household Model: A Short-Lived, Uncompensated Shock**

Here we describe how we model and quantify the uncompensated labor supply response of a representative household with MaCurdy-style convex labor supply disutility and shared consumption, depicted in Appendix Figure A.2.

We consider a household that maximizes

\[
\max_{C_s, E_t} \sum_{s=t}^{\infty} \beta^{s-t} \frac{C_s^{1-\sigma}}{1-\sigma} - \frac{\Psi E_s^{1-\eta}}{1-\eta}
\]

s.t.

\[
\sum_{s=t}^{\infty} \frac{1}{1+r} C_s \leq \sum_{s \geq t}^{\infty} \frac{1}{1+r}(1+\Xi_s) y_s E_s,
\]

so that wages are constant at \( y_t = y \forall t \). We also consider the case were \( \beta(1+r) = 1 \) so that \( C_t = CVt \). We also have assumed that initial assets \( A_0 \) are zero, which implies the largest wealth effect among the range of nonnegative initial asset holdings, thereby providing the largest difference between the Frischian and uncompensated setting (away from the representative household being borrowing-constrained, a setting covered by our heterogeneous agent model).

We study partial equilibrium, i.e. hold aggregate equilibrium variables (interest rates, net of aggregate prevailing raise potential earnings/wages) fixed.

We first construct the employment baseline for the unperturbed setting. Denote \( \bar{E} \) and \( \bar{C} \) as the employment and consumption levels in a stable setting in which \( 1 + \Xi_t = 1 \forall t \). The intratemporal substitution condition and the budget constraint imply, respectively:

\[
y\bar{C}^{1-\sigma} = \Psi \bar{E}^{1/\eta} \tag{B37}
\]

\[
\bar{C} = y\bar{E}. \tag{B38}
\]

Solving these conditions for \( \bar{E} \) delivers \( \bar{E} = \left[ \frac{y^{1-\sigma}}{\Psi} \right]^{\eta/(\eta+\sigma)} \).

Second, we turn to labor supply under a perturbation of the raise of size \( 1 + \Xi \) lasting \( T \) periods. In our uncompensated experiment, we set the baseline aggregate prevailing raise \( 1 + \Xi_t = 1 + \Xi \) for \( t = 1, \ldots, T \), potentially diverging at a constant level from the baseline
raise subsequently reset to unity at $1 + \Xi_t = 1$ for $t > T$. The labor response we plot is labor supply in period 1 under the initial raise level $1 + \Xi_t = 1 + \Xi$.

Let $E'$ and $E''$ denote labor supply when $1 + \Xi_t = 1 + \Xi$ and $1 + \Xi_t = 1$ respectively. Then, optimal intratemporal labor supply implies

$$yC^{-\sigma} = \Psi E'^{1/\eta}$$  \hspace{1cm} \text{(B39)}$$

$$(1 + \Xi)yC^{-\sigma} = \Psi E''^{1/\eta}.$$  \hspace{1cm} \text{(B40)}$$

Therefore, initial labor supply is the eventual labor supply times the Frisch-elasticity-scaled raise perturbation:

$$\implies E' = (1 + \Xi)^{\eta}E''.$$  \hspace{1cm} \text{(B41)}$$

The budget constraint then implies for consumption $C$ in this raise series (or for $\lambda$):

$$\sum_{t=T+1}^{\infty} \left( \frac{1}{1 + r} \right)^t yE'' + \sum_{t=1}^{T} \left( \frac{1}{1 + r} \right)^t (1 + \Xi)wE' = \sum_{t=0}^{\infty} \left( \frac{1}{1 + r} \right)^t C$$  \hspace{1cm} \text{(B42)}$$

$$\sum_{t=T+1}^{\infty} \left( \frac{1}{1 + r} \right)^t yE'' + \sum_{t=1}^{T} \left( \frac{1}{1 + r} \right)^t (1 + \Xi)^{1+\eta}wE'' = \frac{1 + r}{r} C$$  \hspace{1cm} \text{(B43)}$$

$$\frac{1 + r}{r} yE'' - \sum_{t=1}^{T} \left( \frac{1}{1 + r} \right)^t \left( 1 - (1 + \Xi)^{1+\eta} \right) yE'' = \frac{1 + r}{r} C$$  \hspace{1cm} \text{(B44)}$$

$$yE'' - \frac{r}{1 + r} \sum_{t=1}^{T} \left( \frac{1}{1 + r} \right)^t \left( 1 - (1 + \Xi)^{1+\eta} \right) yE'' = C$$  \hspace{1cm} \text{(B45)}$$

$$\left[ 1 - \frac{r}{1 + r} \sum_{t=1}^{T} \left( \frac{1}{1 + r} \right)^t \left( 1 - (1 + \Xi)^{1+\eta} \right) \right] yE'' = C. $$  \hspace{1cm} \text{(B46)}$$

Let $m(T, 1 + \Xi) \equiv \left[ 1 - \frac{r}{1 + r} \sum_{t=1}^{T} \left( \frac{1}{1 + r} \right)^t \left( 1 - (1 + \Xi)^{1+\eta} \right) \right]$. Combining the above with the intratemporal substitution condition (B40), one can solve for $L'$ in particular as a function of baseline employment level $\bar{E}$ in the unperturbed setting, duration of the perturbation $T$, and raise deviation $1 + \Xi$:

$$E' = \left[ (1 + \Xi)^{\eta}m(T, 1 + \Xi)^{-\sigma/\eta/(1+\sigma)} \right] \left( \frac{y^{1-\sigma}}{\Psi} \right)^{\eta/(1+\sigma)} = \left[ (1 + \Xi)^{\eta}m(T, 1 + \Xi)^{-\sigma/\eta/(1+\sigma)} \right] \bar{E}. $$  \hspace{1cm} \text{(B47)}$$

The model is calibrated so that the period length corresponds to one month, so this experiment simulates a one-quarter shift in the prevailing aggregate labor raise by implementing
a three-period duration of the shift. The quarterly interest rate is set to 0.764% (implying an annual discount factor of 0.97).

A.3.2 The Heterogeneous Agent Model with Extensive-Margin Labor Supply

We describe the model the solution algorithm, and how we simulate the short-lived uncompensated shock. We also describe the 33-state potential-earnings process.

The Model

In this section we describe our modification to Huggett (1993), with endogenous labor supply, which occurs along the extensive margin only.

Individuals solve

$$\max_{c_{it}, e_{it}} \sum_{s=t}^{\infty} \beta^{s-t} \left[ \frac{c_{is}^{1-\sigma}}{1-\sigma} - \frac{1}{\bar{\eta}} e_{is} \right]$$

subject to

$$a_{i,s} = (1 + \Xi_s) y_{it} e_{it} + b (1 - e_{it}) + (1 + r_s) a_{i,s-1} - c_{is} \quad \forall s \geq t$$

$$a_{is} \geq a_{\min} \quad \forall s \geq t,$$

where $y_{i,t}$ follows the Markov process described in Appendix Section A.3.3 below. Households endogenously choose their labor supply $e_{it}$, which is restricted to 0 or 1. As described in the main text, since individuals within the same asset and productivity levels face the same problem, consumption and labor supply decisions (and hence reservation raises) can be written as a function of assets and productivity.

The first-order condition on consumption is, as in the standard case,

$$u_c(c^*(a, y), e^*(a, y)) = V_a(a, y),$$

where $V$ is the value function for someone at asset level $a$ and earnings state $y$. The optimality condition on labor supply is

$$e^*(a, w) = \begin{cases} 1 & \text{if } V_a(a, y) y > \bar{\eta} \\ 0 & \text{if } V_a(a, y) y < \bar{\eta}. \end{cases}$$

A similar optimality condition should be used to solve the agent’s problem at the binding constraint $a_{\min}$:

$$e^*(a_{\min}, y) = \begin{cases} 1 & \frac{(y + ra)^{1-\sigma}}{1-\sigma} - v > \frac{(ra)^{1-\sigma}}{1-\sigma} \\ 0 & \text{otherwise}. \end{cases}$$

If $a_{\min} < 0$, this implies that individuals at the borrowing constraint are always employed.
Solution Algorithm  We solve the model with parameters $\sigma = 2, r = 0.03, \beta = 0.97$, and unemployment insurance $b = 0$. We set the borrowing constraint at $a_{\text{min}} = -z_1 r + 0.001$, so that positive consumption is possible at the lowest productivity and asset levels if the individual works. We choose the labor supply disutility shifter $\bar{v}$ to match the equilibrium employment rate 60.7%.

We use a grid of assets comprising a discrete set of asset levels $A$ with minimum $a_{\text{min}}$ and maximum $a_{\text{max}} = 50000000$. We place fifty asset levels equally spaced between $a_{\text{min}}$ and 0, 450 levels between 0 and 1000000, and 500 levels between 1000000 and 5000000. We solve the consumption and labor supply rules using value function iteration:

$$V^{n+1}(a, y) = \max_{a' \in A, e \in \{0, 1\}} \left\{ u(y e + (1 + r)a - a') + \beta \sum_{y'} T_{y, y'} V(a', y') \right\}, \quad (B54)$$

where $T_{y, y'}$ is the transition probability between productivity levels $y$ and $y'$. Consumption is given by $c(a, y) = ye^*(a, y) + (1 + r)a - a^*(a, y)$, where $e^*$ and $a^*$ are the solutions to the maximization problem in (B54) for an individual characterized by asset and productivity states $(a, y)$.

Once we solve for the consumption and labor supply rules, we calculate the equilibrium joint distribution of assets and productivity $g(a, y)$ by solving the system of equations:

$$g(a, y) = \sum_{\tilde{y}} \sum_{\tilde{a} \text{ s.t. } a^*(\tilde{a}, \tilde{y}) = a} g(\tilde{a}, \tilde{y}) T_{\tilde{y}, y}. \quad (B55)$$

With the joint distribution of assets and productivity assets, value functions, and consumption choices, we can solve for the distribution of reservation raises, and therefore the labor supply curve.

A Short-Lived, Uncompensated Shock  We describe how we obtain the uncompensated labor supply curve in response to a quarter-long raise perturbation depicted in Appendix Figure A.2. The purpose of this exercise is to simulate the aggregate extensive-margin labor supply response of a heterogeneous agent economy under an uncompensated (non-Frischian) one-period change in the benefit of working i.e. the prevailing aggregate labor raise. We study partial equilibrium, i.e. hold aggregate equilibrium variables (interest rates, potential earnings) fixed.

Consider an individual with assets $a$ and productivity $y$. That individual faces a temporary prevailing aggregate raise $1 + \Xi_s = 1 + \Xi$ during some period $s$, which then returns to a
raise of level $1 + \Xi_t = 1$ for $t > s$. Then, that individual solves

$$\max_{c,e \in \{0,1\}} \left\{ u(c,e) + \beta \sum_{y'} T_{y,y'} V(a', y') \right\}$$

(B56)

s.t. $a' = (1 + r)a - c + e y'$,

(B57)

where

$$u(c,e) = \frac{e^{1-\sigma}}{1-\sigma} - \bar{\sigma} e$$

(B58)

and where $V$ is the value function from the solution to the equilibrium with the baseline unit raise in all periods.

For a given prevailing labor raise, the solution is easily found by maximizing the utility over a grid of consumption points under employment and nonemployment, since the problem is not recursive. We then measure the labor supply response as the difference in the measure of individuals who choose employment under the temporary first-period-only labor raise $1 + \Xi$ versus the measure of individuals who choose employment in the baseline economy with the unit raise.

The model is calibrated so that the period length corresponds to one quarter, so this experiment simulates a one-quarter shift in the prevailing aggregate labor raise.

A.3.3 The Potential Earnings Process

We now apply a realistic 33-state potential-earnings process, mimicking that in Kaplan, Moll, and Violante (2018) (whose model features only intensive-margin labor supply), which in turn approximates the empirical patterns documented in Guvenen, Karahan, Ozkan, and Song (2015). Our Markov process represents an underlying process modeled as the sum of two independent components $\log y_{it} = \log y_{1, it} + \log y_{2, it}$, with the log of each component $y_{j, it}$ evolving according to a jump-drift process. Jumps arrive at a Poisson rate $\gamma_j$, and trigger new draws of the earnings component from a mean-zero normal distribution. Between jumps, the process drifts toward zero at rate $\beta_j$. Kaplan, Moll, and Violante (2018) implement this process as two finite-state continuous time Markov processes for each independent component. In our application, we do so as a single discrete-time Markov process in which the income states are hence combinations of the states of the two income

Of course, in our model not all individuals will work; we do not estimate a latent potential earnings process such that the modeled realized earnings, taking into account labor supply decisions, would generate realized empirical earnings dynamics.
processes.\footnote{Inconsequential for quantities, we normalize the earnings state levels so that the average steady-state potential earnings are equal to the 2015 U.S. average personal income.} We discretize the continuous time transition rates between states by using the matrix exponential; i.e. the discrete time transition matrix for income component \( j \) is calculated as:

\[ T_{j, d} = \exp \left( \sum_{k=0}^{\infty} \frac{1}{k!} T_{j, c}^{k} \right), \]

where \( T_{j, c} \) is the continuous time transition matrix for component \( j \). The continuous time transition rates are measured with quarters as the unit of time, so the discrete time transition matrix is also in quarters. Then, we collapse the discrete time transition matrices for the two components into a single transition matrix between one-dimensional income states.

\[ T_{d, y, y'}^{1, 2} = T_{1, d}^{y, y_1'} T_{2, d}^{y, y_2'} \]

For this process and the income levels chosen, conveniently each \( y \) state is uniquely defined by one \((y_1, y_2)\) combination.

### A.3.4 The Rogerson and Wallenius (2009) Model

We describe the solution of the model variants, and how we simulate the short-lived uncompensated shock.

#### Parameterizing the Baseline Model

The original Rogerson and Wallenius (2009) distribution of the hourly wage \( w_d \) (labor efficiency) arises from a uniform age distribution and a triangular wage-age gradient (single-peaked at \( d = 1/2 \) with \( w_{d=1/2} = \hat{w}_0 \) as the maximum wage level, and generally \( w(d) = \hat{w}_0 - \hat{w}_1 |d - 0.5| \)). We approximate the continuum of generations with 1,000,000 equally-spaced discrete generations, and solve the model following the Technical Appendix of Chetty, Guren, Manoli, and Weber (2012).

To parameterize the Rogerson and Wallenius (2009) model, we choose the utility function parameters (\( \Gamma \), the labor disutility shifter, \( \gamma \), the labor supply intensive-margin elasticity), effective labor supply parameters (\( h \), the minimum number of hours worked, and \( \hat{w}_1 \), the slope of the wage-age gradient) and the tax rate at which the model equilibrium is calculated. We assume CRRA log consumption utility (\( \sigma = 1 \)).

We set the initial tax (raise) rate at 26%, which was the average net tax rate faced by an average single worker in 2017. We set the labor supply intensive-margin elasticity to 2.0. From this point, we conduct two parameterizations. In the first, we choose the remaining three parameters, \( \Gamma \), \( \hat{h} \), and \( \hat{w}_1 \), to match three equilibrium targets, as in Chetty, Guren, Manoli, and Weber (2012): the employment rate (60.7%, as in the other model exercises), the maximum intensive-margin hours choice (0.45), and the ratio of the lowest wage to the highest wage received over the lifecycle (0.5). This parameterization sets \( \Gamma = 42.492, \hat{h} = 0.258, \) and \( \hat{w}_1 = 0.851 \).

For each generation/age, indexed by \( d \), we calculate hours at each age, \( h^*_d \), and then calculate the reservation raises using:

\[ 1 + \xi^*_d = \frac{(1-t)w_d(h^*_d - \hat{h})u'(c_d)}{v(h^*_d)}. \]

This formulation of the
reservation raise is "normalized" so that the relevant wage is the after-tax wage, and so the indifferent worker is that of the age \( d \) such that \( 1 + \xi_d^* = 1 \).

This, combined with the distribution of individuals along the age dimension (uniform), gives the distribution of reservation raises, from which we can compute the arc elasticities.

**Low-Frisch Elasticity Parameterization** In the second parameterization, we also choose the peak of the wage-age profile and target a lower extensive-margin Frisch elasticity. This parameterization sets \( \Gamma = 40.000, \bar{h} = 0.248, \hat{w}_1 = 1.319 \), and lifetime peak productivity at 1.110.

**Shutting off the Intensive Margin** In Figure 2 and Figure 3 we also add a variant that shuts off intensive-margin reoptimization. We do so by simply solving for the optimal policies, extracting the reservation raises, and then computing alternative reservation raises that hold hours fixed at the corresponding unit raise point, such that \( 1 + \xi = \frac{v(h_{d,1+\Xi=1})}{\varphi_d(h_{d,1+\Xi=1})^\lambda} \).

**A Short-Lived, Uncompensated Shock** We describe how we obtain the uncompensated labor supply curve in response to a quarter-long raise perturbation depicted in Appendix Figure A.2.

We simulate the labor supply response of the economy under a temporary, short, but noninstantaneous (and therefore non-Frischian) change in the benefit of working in form of a shift in the prevailing aggregate raise. As in the other models, we again study partial equilibrium, i.e. hold aggregate equilibrium variables (e.g., interest rates) fixed.

We suppress calendar time subscripts in what follows.

We continue to solve the model in continuous time, i.e. in the context of considering a time interval corresponding to a month-long duration, one could work for part of the period rather than having a period-long policy.

In our experiment, we suppose that households are subject to our aggregate prevailing labor raise \( 1 + \Xi \) for a time interval of duration \( m \). After this interval, the raise returns to unity. The introduction of the raise is unanticipated, and once occurring, the households perfectly foresee that the raise deviation will last exactly \( m \) time units before returning to unity. Upon realization of the shock, households will re-optimize their planned consumption and labor supply for the remainder of their lives.

To solve for assets, we first need to solve for household assets at age \( d \) before the raise shock. Currently held assets are determined by past earnings, government transfers (which are equal to \( \tau \bar{c} \), where \( \bar{c} \) taken as parametric by the household, is the equilibrium consumption level in turn equal to average income and hence \( \tau \bar{c} \) is the average labor income raise payment and
also government rebate), and consumption $c$:

$$
\int_0^d \left( (1 - \tau) e_d y_d + \tau \tilde{c} - c \right) \, d\tilde{d}, \quad (B59)
$$

where $e_d$ is desired employment and $y(\tilde{d})$ is potential gross earnings at age $\tilde{d}$. For $\tilde{d} \in [d_{\min}, d_{\max}]$, where $d_{\min}$ and $d_{\max}$ are the (endogenous) work-entry and -exit ages,

$$
e_d y_d = w_d (h_d - \tilde{h})
= w_d (h_0 \tilde{w}_0^{-1/\gamma} w_0^{1/\gamma} - \tilde{h})
= [h_0 \tilde{w}_0^{-1/\gamma} w_0^{1+1/\gamma} - \tilde{h} w_0^{1/\gamma}]
\begin{cases}
\left[h_0 \tilde{w}_0^{-1/\gamma} \left( \tilde{w}_0 - 0.5 \tilde{w}_1 + \tilde{w}_1 \tilde{d} \right)^{1+1/\gamma} - \tilde{h} \left( \tilde{w}_0 - 0.5 \tilde{w}_1 + \tilde{w}_1 \tilde{d} \right) \right] & \text{if } \tilde{d} < 0.5 \\
\left[h_0 e_0^{-1/\gamma} \left( \tilde{w}_0 + 0.5 \tilde{w}_1 - \tilde{w}_1 \tilde{d} \right)^{1+1/\gamma} - \tilde{h} \left( \tilde{w}_0 + 0.5 \tilde{w}_1 - \tilde{w}_1 \tilde{d} \right) \right] & \text{if } \tilde{d} \geq 0.5,
\end{cases}
\quad (B63)
$$

and 0 if $\tilde{d} \notin [d_{\min}, d_{\max}]$. The lifetime gross-of tax/raise labor income up to age $d$ is:

$$
\int_0^d e_d y_d \, d\tilde{d} = \begin{cases}
0 & \text{if } d < d_{\min} \\
\left( \frac{h_d}{(2 + \frac{1}{\gamma}) \tilde{w}_1} - \frac{\tilde{h}}{2 \tilde{w}_1} \right) \tilde{w}_0^2 \tilde{d}^{d_{\min}} & \text{if } d_{\min} \leq d < 0.5 \\
\left( \frac{d}{(2 + \frac{1}{\gamma}) \tilde{w}_1} - \frac{\tilde{h}}{2 \tilde{w}_1} \right) \tilde{w}_0^2 \tilde{d}^{d_{\min}} + (1 - \tau) \left( \frac{h_d}{(2 + (1-\tau) \frac{1}{\gamma}) \tilde{w}_1} + \frac{\tilde{h}}{2 \tilde{w}_1} \right) \tilde{w}_0^2 \tilde{d}^{0.5} & \text{if } 0.5 \leq d < d_{\max} \\
\left( \frac{h_d}{(2 + \frac{1}{\gamma}) \tilde{w}_1} - \frac{\tilde{h}}{2 \tilde{w}_1} \right) \tilde{w}_0^2 \tilde{d}^{d_{\max}} + \left( \frac{h_d}{(2 + \frac{1}{\gamma}) \tilde{w}_1} + \frac{\tilde{h}}{2 \tilde{w}_1} \right) \tilde{w}_0^2 \tilde{d}^{0.5} & \text{if } d \geq d_{\max},
\end{cases}
\quad (B64)
$$

from which follows lifetime net income if multiplied by $1 - \tau$.

Consider an individual of age $d$. Let $m$ denote the length of the temporary raise change. One solves for optimal consumption and labor supply by finding the consumption level $c_{x,d}$ that balances the income’s lifetime budget constraint, subject to (a) their labor income being subjected to a multiplier and (b) the individual adjusting the remainder of their lifetime’s labor supply to meet extensive and intensive-margin labor supply optimality conditions. In our experiment, for each given age level $d$, the time series of the aggregate prevailing raise
will be given by

\[
1 + \Xi_{\tilde{d}} = \begin{cases} 
1 + \Xi & \text{if } \tilde{d} \in [d, d + m] \\
1 & \text{if } \tilde{d} > d + m.
\end{cases}
\]  

(B65)

For a proposed consumption level \(c_{\Xi,d}\) (where subscript \(d\) denotes the time at which the raise perturbation started, rather than the period during which the consumption occurs, as consumption is constant across all post-raise ages \(\tilde{d} > d\)), during the ages \(\tilde{d} > d\), let \(h_{\tilde{d},d}\) be the age \(\tilde{d} > d\) labor supply choice of an individual that was age \(\tilde{d}\) when the temporary labor raise shift began.

For ages \(\tilde{d}\) where the individual works on the extensive margin, intensive-margin labor supply implies that

\[
\Gamma h_{\tilde{d},d}^\gamma = (1 - \tau)(1 + \Xi_{\tilde{d}})u'(c_{\Xi,d})w_{\tilde{d}}. 
\]  

(B66)

As in the standard setup, there will be cutoff rules that dictate extensive-margin labor supply. Under a temporary \(1 + \Xi\) shift, one cannot dictate age cut-offs since the benefit of working does not follow the same single-peaked shape as the original model. However, one can determine raise-productivity cutoffs in \((1 + \Xi_{\tilde{d}})w_{\tilde{d}}\).

At ages \(\tilde{d}\) at which the individual is indifferent to extensive-margin labor supply (conditional on optimizing on the intensive margin if working), the intensive and extensive-margin conditions imply respectively:

\[
\Gamma h_{\tilde{d},d}^\gamma = (1 - \tau)(1 + \Xi_{\tilde{d}})u'(c_{\Xi,d})w_{\tilde{d}} 
\]  

(B67)

\[
\frac{1 + \gamma}{1 + \gamma} \Gamma h_{\tilde{d},d}^{1+\gamma} = (1 - \tau)(1 + \Xi_{\tilde{d}})u'(c_{\Xi,d})w_{\tilde{d}}(h_{\tilde{d},d} - \tilde{h}). 
\]  

(B68)

Combining these two implies an hours choice at the marginal age of

\[
h_{\tilde{d},d} = \left(\frac{1 + \gamma}{\gamma} \right) \tilde{h} \]  

(B69)

on the basis of which we can solve for the marginal age (productivity level) as follows:

\[
\Gamma \left(\frac{(1 + \gamma)}{\gamma} \tilde{h}\right) = (1 - \tau)(1 + \Xi_{\tilde{d}})u'(c_{\Xi,d})w_{\tilde{d}} 
\]  

(B70)

\[
\Rightarrow (1 + \Xi_{\tilde{d}})w_{\tilde{d}} = \left(\frac{(1 + \gamma)}{\gamma} \tilde{h}\right)^\gamma \left(\frac{(1 - \tau)u'(c_{\Xi,d})}{(1 - \tau)u'(c_{\Xi,d})}\right). 
\]  

(B71)
The individual will prefer working over nonworking at age 
\( \tilde{d} \) if 
\[(1 + \Xi_{\tilde{d}})w(\tilde{d}) \geq \Gamma \left( \frac{(1+\gamma)\bar{h}}{\gamma} \right)^{\gamma} / ((1 - \tau)u'(c_{\Xi,\tilde{d}})) \]. From this cutoff, one can compute optimal planned extensive-margin supply for every age \( \tilde{d} > d \). For a proposed candidate for the consumption level, one can then compute the balance of the individual’s lifetime budget constraint given both the change in consumption and the lifetime extensive- and intensive-margin labor supply responses.\(^{39}\) The solution to the individual’s problem is the consumption level \( c_{\Xi,\tilde{d}} \) that balances the individual’s lifetime budget constraint. Repeating this for every individual in the economy (i.e. repeating this for every age \( d \in [0,1] \)) delivers the aggregate labor supply response. We measure the labor supply response to this temporary (but noninstantaneous) raise shift using the change in labor supply upon impact of the raise.

We set the length of the uncompensated raise shift to 1/240, to represent the length of one quarter out of a 60-year adult lifespan.

\(^{39}\) We isolate the labor supply responses, and therefore hold fixed in our partial-equilibrium experiment all aggregate variables except for the prevailing raise (i.e. government transfers and taxes, so the government budget is unbalanced in this exercise).
## Additional Model Tables

### Table A.3: Parameters of Macro Models with an Extensive-Margin of Labor Supply

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value (by Variant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment disutility</td>
<td>$\overline{v}$</td>
<td>1.0</td>
</tr>
<tr>
<td>Potential earnings</td>
<td>$\overline{y}$</td>
<td>1.0</td>
</tr>
<tr>
<td>Marginal utility of consumption</td>
<td>$\lambda$</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Panel A: Hansen (Indivisible Labor)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CRRA consumption parameter</strong></td>
<td>$\sigma$</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Potential earnings</strong></td>
<td>$\overline{y}$</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Shape parameter of labor disutility distutility</strong></td>
<td>$\alpha_v$</td>
<td>0.32 2.50</td>
</tr>
<tr>
<td><strong>Max. labor disutility</strong></td>
<td>$v_{max}$</td>
<td>4.759 1.221</td>
</tr>
<tr>
<td><strong>Panel B: MaCurdy (Isolesticity)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Low Frisch (0.32)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CRRA consumption parameter</strong></td>
<td>$\gamma$</td>
<td>2.0 2.0</td>
</tr>
<tr>
<td><strong>Potential earnings</strong></td>
<td>$\overline{y}$</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Shape parameter</strong></td>
<td>$\alpha_v$</td>
<td>0.32 2.50</td>
</tr>
<tr>
<td><strong>Low Frisch (2.50)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CRRA consumption parameter</strong></td>
<td>$\gamma$</td>
<td>2.0 2.0</td>
</tr>
<tr>
<td><strong>Potential earnings</strong></td>
<td>$\overline{y}$</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Shape parameter</strong></td>
<td>$\alpha_v$</td>
<td>0.32 2.50</td>
</tr>
<tr>
<td><strong>Max. labor disutility</strong></td>
<td>$v_{max}$</td>
<td>4.759 1.221</td>
</tr>
<tr>
<td><strong>Panel C: Heterogeneous Agent Model</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Toy Model</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>HANK Earnings Process</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Potential-earnings states</strong></td>
<td>$[y_{1}, y_{2}] = [0.0797, 0.15]$</td>
<td>33-State Markov process from Kaplan, Moll, and Violante (2018)</td>
</tr>
<tr>
<td><strong>Transition probabilities</strong></td>
<td>$[\lambda_{12}, \lambda_{21}] = [0.1, 0.2]$</td>
<td></td>
</tr>
<tr>
<td><strong>CRRA consumption parameter</strong></td>
<td>$\gamma$</td>
<td>2.0 2.0</td>
</tr>
<tr>
<td><strong>Interest rate</strong></td>
<td>$r$</td>
<td>0.03 0.03</td>
</tr>
<tr>
<td><strong>Discount rate</strong></td>
<td>$\beta$</td>
<td>0.95 0.97</td>
</tr>
<tr>
<td><strong>Labor disutility</strong></td>
<td>$\overline{v}$</td>
<td>3.0 2.083 $\times$ $10^{-5}$</td>
</tr>
<tr>
<td><strong>UI benefit/nonemp. payoff</strong></td>
<td>$b$</td>
<td>0.06 0.00</td>
</tr>
<tr>
<td><strong>Asset grid: min. assets</strong></td>
<td>$a_{min}$</td>
<td>-0.02 -1.775</td>
</tr>
<tr>
<td><strong>(&amp; borrowing limit)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Asset grid: max. assets</strong></td>
<td>$a_{max}$</td>
<td>0.75 5,000,000</td>
</tr>
<tr>
<td><strong>Panel D: Rogerson-Wallenius</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Baseline</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Low-Frisch Variant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Interest rate</strong></td>
<td>$r$</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>CRRA consumption parameter</strong></td>
<td>$\sigma$</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Labor disutility shifter</strong></td>
<td>$\Gamma$</td>
<td>42.492 40.000</td>
</tr>
<tr>
<td><strong>Minimum hours</strong></td>
<td>$\bar{h}$</td>
<td>0.258 0.272</td>
</tr>
<tr>
<td><strong>Maximum labor productivity</strong></td>
<td>$\overline{\hat{w}}_0$</td>
<td>1.000 1.112</td>
</tr>
<tr>
<td><strong>Slope of labor productivity</strong></td>
<td>$\overline{\hat{w}}_1$</td>
<td>0.851 1.320</td>
</tr>
<tr>
<td><strong>Intensive-margin Frisch elasticity</strong></td>
<td>$\gamma$</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Tax rate</strong></td>
<td>$\tau$</td>
<td>26.0%</td>
</tr>
</tbody>
</table>

*Note:* The table presents the parameters for the models with an extensive margin of labor supply presented in the model meta-analysis Section 4, generating the calibrated aggregate labor supply curves plotted in Figure 2 and Figure 3, with companion plots in Appendix Figure A.4. ∗: We describe the 33-state earnings process in Appendix Section A.3.3.
Additional Model Figures

Figure A.2: Frischian vs. Uncompensated Quarter-Long Deviation in the Aggregate Prevailing Raise: Extensive-Margin Aggregate Labor Supply Responses in Three Calibrated Models

Note: The figure compares aggregate labor supply curves that are purely Frischian (from our reservation raise distributions) and from non-Frischian, uncompensated perturbations in the aggregate prevailing raise that are short-lived and last one quarter in each model. The three curves are output from simulating three of the models we discuss in detail in Section 4: a representative household model with an isoelasticity of 2.5, a heterogeneous agent model with a realistic 33-state earnings process, and the Rogerson-Wallenius model with lifecycle aspects and an intensive-margin hours choice. The specific quantitative experiments are detailed in Appendix Section A.3 for each model. Model parameters are in Appendix Table A.3.
Figure A.3: Zoomed In: Comparing the Extensive-Margin Labor Supply Curves: Model-Implied vs. Data

Note: The figure replicates Figure 2 but zooms into smaller raise deviations to highlight the local properties of the aggregate labor supply curves. As companion Figure 2, the figure plots the empirical and model-implied short-run aggregate labor supply curves at the extensive margin building on our reservation raise approach: the deviation in the log (desired) employment rate (y-axis) against deviations in the aggregate prevailing raise (x-axis). The empirical labor supply curve is described in Section 3 and its fitted version in Section 4.2 and Appendix Section D. The curves for a series of macro models with an extensive margin of labor supply are described and calibrated in the meta-analysis in Section 4. All curves go from the same baseline employment level of 0.607, and from a corresponding baseline net of raise rate normalized to 1.0. The Hansen indivisible labor is plotted on a secondary y-axis denoting the employment level (rather than in log deviations).
Figure A.4: Further Details on Model Reservation Raises Distributions

(a) Hansen: Homogeneity & Rep. Household
(b) MaCurdy: Heterogeneity w/ Potential-Earnings State Variant, Potential-Earnings State Variant, Reservation Raise Multiplier, 0.32 Isoelasticity & Rep. HH
(c) Het-Agent: 2
(d) Het-Agent: 2
(e) Het-Agent 33-State Potential-Earnings Variant
(f) Het-Agent Model: Isolating 3/33 Potential-Earnings States
(g) Het-Agent Model (33 Potential-Earnings States): Het. vs. Homog. \( \lambda \)
(h) Rogerson-Wallenius

Note: The figure plots additional simulated data from the models reviewed in the meta-analysis in Section 4. Panel (a) plots the histogram of the Hansen (1985) model’s reservation raises. Panel (b) plots the histogram of the reservation raises that would emerge in an isoelastic representative household setting with an elasticity of 0.32. Panel (c) plots the reservation raise histogram from the two potential-earnings states heterogeneous agent model; Panel (d) plots the associated aggregate labor supply curve. Panel (e) plots the histogram of reservation raises in the 33 potential-earnings states heterogeneous agent model following the realistic earnings process. Panel (f) provides reservation raises for three earnings states: the low (1876.61), medium (24,489.68), and high (117,080.23) potential-earnings levels. The densities are normalized so that the total density by earnings level sums to one; however, there is 0.395, 0.164, and 0.033 of density for the low, medium, and high earnings levels that have reservation raises above 1.5 (which we censor in this histogram). Panel (g) plots the original aggregate labor supply curve for the 33-state heterogeneous agent economy and heterogeneous borrowing constraint multiplier \( \lambda \), but adds curves for two full-insurance models by setting the borrowing constraint multiplier \( \lambda \) homogeneous, for the original coarse discrete earnings process as well as a richer continuous-state version. It thereby highlights the role of the covariance of potential earnings and the shadow value of income in shaping the inelastic labor supply curve. Panel (h) plots the reservation raise histogram for the calibrated Rogerson and Wallenius (2009) model.
B Supplementary Data: Constructing Reservation Raise Proxies from Reservation Wage Household Surveys

We detail the supplementary data sources from household surveys for reservation raise proxies building on reservation wage data from the unemployed. We use these data for our covariate analysis in Section 3.3, as well as to enlarge our sample size and exploit a larger panel structure, we supplement our custom household survey analysis with data from a set of existing larger surveys limited to unemployed workers and show how reservation wage (rather than reservation raise) questions can be constructed into reservation raise proxies.

Additional Proxy: Reservation/Potential Wage Ratios

Specifically, the reservation raise proxy measurable in more standard reservation wage surveys (usually covering the unemployed): the ratio of an individual’s reservation wage to her (actual or potential) wage. We define an individual’s (Frischian) net-of-1 + Ξ reservation wage (earnings) y_{rt} (for indifference between employment and nonemployment for a short period of time, all else equal), by:

\[ (1 + \Xi_t)y_{rt} = v_{it,j} \lambda_{it} \]

\[ \Leftrightarrow y_{rt} = \frac{v_{it,j} \lambda_{it}}{(1 + \Xi_t)} \]

where we as in Section 2.4 permit intensive-margin reoptimization.

This route requires characterizing the worker’s actual or potential earnings y_{it,j} \lambda_{it}. We can write the reservation raise as reservation-to-actual/potential-wage ratio, again centered around one and hence mirroring the \( (1 + \tilde{\xi}_{it}) \) analog of the model object as in the direct reservation raise question presented in main text Section 3:

\[ \Rightarrow \frac{y_{rt}}{y_{it,j}} = \frac{\frac{v_{it,j}}{(1 + \Xi_t)}}{\frac{y_{it,j}}{(1 + \Xi_t)}} = \frac{1 + \tilde{\xi}_{it}}{1 + \Xi_t}. \]

Potential/actual wages for employed workers could be captured by their current wage. For nonemployed respondents, proxies for their potential wage are reported wage expectations for the reservation job, or their last job’s wage. There exist surveys that ask about both wages and reservation wages, but almost exclusively the unemployed and/or job seekers.

We enlist three surveys for this supplementary analysis: a large administrative snapshot of French unemployment entrants, a large German panel household survey with rich covariates,
and a second German survey that we link to administrative employment biographies from social security data.

**GSOEP Household Panel Survey**  The German Socioeconomic Panel (GSOEP) is a long household panel survey. It also elicits reservation wages from unemployed respondents. The reservation wage question is asked at a given survey date. We also have detailed labor market and other characteristics from this rich panel survey. Our potential wage proxy for this data is the last job’s wage.

**PASS Household Survey**  The Panel Study Labour Market and Social Security (PASS) of the German Employment Research Institute (IAB) is another household panel survey, designed by IAB to answer questions about the dynamics of households receiving welfare benefits.

Unlike GSOEP, PASS asks respondents about their *expected* wage, providing a potentially more precise potential-wage measure rather than the lagged wages (whereas disutility of labor, preferred hours or the worker’s productivity may have changed leading to or following the separation). Moreover, the pairing of wage expectations and reservation wages about a hypothetical future job offer is more likely to hold the particular job constant (e.g., amenities, hours,...).

It also asks the questions of a broader set of households, including employed workers (about their most recent search). Among the nonemployed, it asks the current searchers (unemployed) as well as those not searching but who state they previously did search. For consistency, we restrict our PASS sample to the nonemployed, but for sample size we pool the unemployed (active searchers) with the out of the labor force (who are still asked about the reservation wages if they ever searched).

**PASS–ABIAB Record Linkage to Administrative Matched Employer-Employee Social Security Records**  We also use a linkage of the PASS survey households to administrative social security records covering pre- and post-interview employment biographies, 1975 through 2014, from the Institute for Employment Research (IAB) (described in detail in Antoni and Bethmann, 2019). The spell data are day-specific, include information on unemployment and other benefit receipts, and therefore permit us to track even small interruptions in employment. We translate the day-specific spell data into monthly frequency, where we count as employment any job spell associated with positive earnings in that month. A limitation is that the IAB data only cover jobs subject to social security payroll taxes, and hence exclude the self-employed and the civil servants (*Beamte*) not subject to these payroll taxes. To limit concerns from such mismeasurement for this analysis in the merged sample, we use the occupation indicator in the PASS survey data to drop all observations where the previous labor market status indicated civil service or self employment. Our employment measure is a snapshot one, where by check the calendar date of the survey, and then forward and revert
the year while keeping the month fixed when studying the employment status.

**Administrative Data from UI Agency** To benchmark the reservation raise distributions for unemployed job seekers, we exploit within-worker ratios of micro data collected by the French UI administration (government employment agency) Pôle emploi. The data are binned histograms; we therefore include this data set in the distributional analysis yet cannot provide a covariate analysis. The data cover all UI claimants in France, a context of high UI take-up, and elicit reservation wages at UI claim entry. Our potential wage proxy for this data is the last job’s wage (and so the reservation raise is the worker-level ratio of reservation wage to lagged wage ratio).

**Proxied Reservation Raise Distributions from the Supplementary Surveys of the Unemployed** We present histograms of the empirical reservation raises from Pole Emploi, PASS and GSOEP in Appendix Figure A.5, and summary statistics in Appendix Table A.1. In both datasets, the distribution of reservation raises exhibit a spike at one, where the individual’s reported reservation wage is equal to the lagged wage (Pole Emploi and GSOEP) and expected wage (PASS).

---

40 We thank Le Barbanchon, Rathelot, and Roulet (2019) for sharing the binned data on administrative reservation wage distributions of French UI recipients.

41 For GSOEP and Pole Emploi, the spike may reflect anchoring in the surveys to the previous wage, or sticky reservation wages as in Krueger and Mueller (2016); DellaVigna, Lindner, Reizer, and Schmieder (2017). In the GSOEP, the mass of unemployed workers whose reservation raise is equal to one accounts for about 6.2% of workers for whom we calculate reservation raises. By contrast, only 0.2% report a reservation raise between 0.99 and 1.01 that is not equal to 1. In PASS, the bunching at 1 arises from the structure of the survey question: the survey first asks about the expected wage, and then asks whether or not the worker would also take lower offers. Only those responding yes will be asked to specify the reservation wage. For Pole Emploi and GSOEP, a significant amount of workers have a reservation raise above 1. This is likely the consequence of measurement error as we use past way for the potential wage, as unemployed job seekers should have a reservation raise lower than one (otherwise should not be searching).
Additional Figures: Empirical Reservation Raises, Including the Proxies Constructed from Reservation Wages and the Supplementary Data

Figure A.5: Distribution of Reservation Raises from Three Reservation Wage Surveys of Unemployed Job Seekers: Pôle Emploi Administrative Survey, GSOEP Household Survey, PASS-IAB Admin-Linked Household Survey

Note: The figure plots histograms of reservation proxies from surveys of (unemployed) job seekers (constructed as the ratio of reservation wages to a proxy for a potential wage (e.g., the previous wage for GSOEP and Pole Emploi and expected wage for PASS), with the construction and correspondence to the reservation raise concept described in Appendix B). Associated summary statistics are reported in Table A.1. PASS reservation net of raise rates less than 0.5 and greater than 1 are grouped in the left-most and right-most bars, due to data disclosure requirements. PASS includes unemployed and out of the labor force individuals reported to have ever searched (rather than current searchers only). Sources: German Socio-Economic Panel (GSOEP); PASS-IAB linked data; Pole Emploi French UI Agency data (provided by Le Barbanchon, Rathelot, and Roulet, 2019).
Figure A.6: Distribution of Reservation Raises

(a) U.S. Survey: Distribution by Gender

(b) GSOEP: Distribution by Gender

(c) PASS: Distribution by Gender

(d) Reservation Raises by Age

(e) GSOEP: Reservation Raises by Education

Note: The figure plots additional properties of the empirical reservation raise distributions discussed in Section 3. Panels (a)-(c) plot histograms by gender for three surveys: U.S. population (NORC, authors’ survey), GSOEP and PASS. Panel (d) is a binned scatter plot of the log reservation raise against age bins (three-year averages for NORC; one-year for GSOEP; and unweighted three-year averages for PASS). Data for ages 66+ in NORC are combined. PASS reservation raises are coefficients from a Tobit regression of the log reservation raise on a saturated set of age dummies (age 18 omitted). Panel (e) plots, in the GSOEP, the gradients of employment rates and the mean raise against education. The construction of the reservation raise proxies are detailed in the main text for NORC, and in Appendix Section B for GSOEP and PASS. reservation raises and reservation raise proxies for the NORC and GSOEP data are truncated at 2.0. Reservation raises for the PASS data are by construction truncated at 1.0 due to the survey question.
C Empirical Relationship Between Micro Labor Supply Outcomes and Reservation Raises

We now assess the micro-empirical relationship between an individual respondent’s reservation raise and her idiosyncratic realized employment outcomes in previous and future periods. We in part draw on the supplementary data from Appendix Section B, where we show the correspondence between reservation wages divided by potential wages, and the reservation raises.

The degree to which desired labor supply is allocative for employment outcomes depends on market structure and potential labor market frictions. One extreme, the Walrasian, frictionless market-clearing model, implies that at the given wage, all workers with positive surplus from employment – with reservation raises below the prevailing one – will be at work. Away from this benchmark, frictions such as wage rigidity or search frictions can detach the reservation-raise-implied desired labor supply from prevailing employment allocations, due to search frictions, rationing from labor demand, or misperceptions about potential wages.

The reservation raise measure at the micro level may provide an empirical handle and diagnostic tool for micro-level rationed labor supply, a notoriously challenging task to assess empirically (for analyses of the efficiency of employment adjustment at the group-level cyclical dimension and the separation margin, see respectively Bils, Chang, and Kim, 2012; Jäger, Schoefer, and Zweimüller, 2019).

To investigate the empirical consequences of such rationed labor supply (conversely, the allocative consequences of desired labor supply), we compare respondents’ realized employment outcomes past, present and future (using the panel structure in the surveys and administrative data) with their stated reservation raises, which determines her rank in the aggregate labor supply curve.

Formally, our empirical design investigates the discrete choice of desired labor supply $e^*_it \in \{0, 1\}$ following the raise cutoff:

$$e^*_it = \begin{cases} 
0 & \text{if } 1 + \xi^*_it > 1 + \Xi_t \\
1 & \text{if } 1 + \xi^*_it \leq 1 + \Xi_t.
\end{cases} \quad \text{(C5)}$$

Specifically, we plot the empirical employment rates $P(e_{it+s}|1 + \xi^*_it)$ by continuous reservation raises at various horizons $s$ relative to the survey year and for our various surveys. Appendix Figure A.7 presents the results using the PASS and GSOEP (household panels) and from our survey of U.S. households (where we included forward- and backward-looking employment
Below we show our approximations in three data sets.

**U.S. Survey Data**  In our survey, we ask three variants for study the intertemporal dimension in our cross section of respondents:

1. Thinking back to the last two years, how many months were you not working (not counting vacations)?

2. Consider your future plans and expectations regarding your work situation. How many months out of the next two years do you think you will likely not be working?

3. What do you believe is the probability you will be working in a job exactly two years from now? We are looking for a percentage number. For example, a 50% probability means that it is just as likely that you will be working as not. A 100% probability means that you are sure that you will be working. 0% means that you are sure that you will not be working exactly two years from now. You can give any percentage number between 0% and 100%.

Appendix Figure A.7 Panels (a) and (b) present the results for the representative cross-section of the U.S. population. Observations above 1 are out of the labor force, below 1 are unemployed searchers or the employed by construction. Panel (a) presents the raw data, and Panel (b) after residualizing with labor force status fixed effects to remove the mechanical jump at 1 (hence tracing out within-labor-force-status variation). The data reveal a compelling downward-sloping pattern for all groups, validating the measure. However, the slope is far from clear-cut.

**Unemployed Job Seekers**  Appendix Figure A.7 Panel (c) presents the evidence for unemployed job seekers in GSOEP. We exploit the panel structure of the survey and plot employment rates by event time around the survey, where importantly the reservation wage question underlying our reservation raise proxy is only asked for unemployed job seekers (and so employment should be zero at survey time \( t = 0 \) and is hence not plotted).

Before the survey year, there is a clear pecking order: high-reservation-raise workers are substantially less likely to be employed (40% five years before, less than 60% the year before) compared to low-reservation-raise workers (more than 60% five years before, and nearly 80% in the pre-survey year). The picture is somewhat noisier less pronounced after the survey, although the ranking is stable. Perhaps the event that selects the GSOEP respondent into the reservation wage question – unemployment – is associated with a reshuffling of potential earnings introducing measurement error going forward.
Appendix Figure A.7 Panel (d) plots the corresponding results for PASS, where we use the stated subjective expected reemployment wages (again for workers sampled during nonemployment episodes), and link the data with administrative employment biographies to track workers nearly over their entire life cycle. Here a binary distinction between workers declaring themselves willing to work at a lower wage and not, would yield a clear picture before and after the nonemployment spell and interview date. (Our employment outcomes are of administrative quality due to our linkage with social security records for the survey respondents, so do not perfectly square with the survey measure, and so at the interview date some workers are employed. Moreover, since we pool the unemployed job seekers and out of the labor force that previously searched, the pre and post interview employment rates are much lower than for GSOEP, for example, where we see only active searchers.) Yet separating the workers who report that the reservation wage is strictly below the potential wage yields no clear ranking within that group, perhaps due to selection for this questionnaire (where the continuous response of the reservation wage is only possible when one declares to be willing to take a wage below the expected one).

**Interpretation**

There are three sources of potential discrepancies between realized and desired i.e. reservation-raise-implied employment status: measurement error in the original reservation raises, idiosyncratic shocks (limited persistence) in the reservation raise, or frictions that detach realized and desired employment allocations.

Assessing the role of frictions in employment allocations is beyond the scope of our paper. Instead, we close with an attempt a suggestive hint asking whether higher unemployment, the canonical symptom of rationed labor and labor market frictions, may cause, or reflect, more severe allocational frictions inducing less-efficient rationing. In Appendix Figure A.7 Panel (e) we revisit the German GSOEP sample, and split the survey waves in half: a high-unemployment time before 2006 (steadily around 10%), and after 2006 when unemployment sharply declined to 7% and in the later years even lower. The employment–reservation raise gradient does indeed appear somewhat flatter during high-unemployment period.
Figure A.7: The Empirical Relationship Between Individual-Level Realized Employment Dynamics and Reservation Raises

Notes: The figure shows individual-level realized or expected employment rates for individuals grouped by their reservation raise proxy elicited at a given survey date. The construction of the proxies for PASS and GSOEP are described in Appendix B, along with interpretation of all panels. Panels (a) and (b) are binned scatter plots of the U.S. survey, plotting on the y-axis three outcomes (survey questions printed in Appendix Section C) denoting (i) the share of months worked over the past 24 months, (ii) over the next 24 months, and (iii) the probability assessment of employment two years post-survey. On the x-axis, the graph bins respondents into quantiles by their reservation raise, so that the y-axis reports the mean value of the given reservation raise bin. Panel (a) plots the raw data; the discontinuity at one reflects the switch from (un-)employed to out of the labor force. Panel (b) residualizes both axes by a fixed effect for labor force status. Panel (c) plots the probability (share) of employment pre and post survey year using the panel survey. Since in GSOEP, reservation wages are only elicited for the unemployed, it is (and hence omitted) in the survey year (0). Panel (d) uses a merged version of the PASS survey and the IAB social security panel data to plot employment rates (an admin. snapshot at the survey date, and the same dates in the other years). Due to disclosure requirements and sample sizes, PASS respondents are split by quartiles of the reservation raise proxy, with a separate group for those whose wage is not lower than their expected wage (as only then is the reservation wage elicited in the survey). The PASS sample includes the unemployed and out of the labor force reported to have ever searched (rather than current searchers only), explaining why pre and post employment is below GSOEP; positive employment at the survey date reflects admin.-data-based employment. Panel (e), based on GSOEP, plots the one-year-ahead outcome but splits up the sample by the national unemployment rate, tentatively suggesting that the slope between employment and reservation raises appears steeper in tighter labor markets, perhaps reflecting more efficient rationing. (We split the survey waves in half: a high-unemployment time before 2006 (steadily around 10%), and after 2006 when unemployment sharply declined to 7% and lower.) Sources: GSOEP; PASS-IAB matched data set; authors’ U.S. custom (NORC) survey.
### Table A.4: GSOEP Covariate Analysis: (Log) Reservation Raise for German Job Seekers

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**Note:** The table reports coefficients from a regression of individual-level empirical reservation wage proxies on survey covariates for unemployed job seekers (constructed as the ratio of reservation wages to a proxy for a potential wage (e.g., the previous wage), with the construction and correspondence to the reservation raise concept described in Appendix Section B). ∗: p < 0.10, ∗∗: p < 0.05, ∗∗∗: p < 0.01. Robust standard errors in parentheses. Source: German Socio-Economic Panel (GSOEP).
Table A.5: PASS Covariate Analysis: Tobit Regression of (Log) Reservation Raise Proxy for German Nonemployed (Right-Censored at 0 (Log(1))

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<td></td>
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</tr>
<tr>
<td>Home Satisfaction (Medium)</td>
<td>-0.007</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.013)</td>
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<tr>
<td>Home Satisfaction (High)</td>
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<tr>
<td></td>
<td>-0.016</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>(0.015)</td>
<td></td>
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<tr>
<td>Health Issues</td>
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<tr>
<td></td>
<td>0.034</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(0.123)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.269***</td>
<td>-0.271***</td>
<td>-0.278***</td>
<td>-0.018***</td>
<td>-0.258***</td>
<td>-0.271***</td>
<td>-0.288***</td>
</tr>
<tr>
<td></td>
<td>(0.055)</td>
<td>(0.022)</td>
<td>(0.056)</td>
<td>(0.088)</td>
<td>(0.056)</td>
<td>(0.058)</td>
<td>(0.091)</td>
</tr>
</tbody>
</table>

N 25,964 25,964 25,964 25,915 25,955 25,964 25,899

Note: The table reports coefficients from a regression of individual-level empirical reservation wage proxies on survey covariates for unemployed job seekers (constructed as the ratio of reservation wages to a proxy for a potential wage (e.g., the previous wage), with the construction and correspondence to the reservation raise concept described in Appendix Section B). ∗: \( p < 0.10 \), ∗∗: \( p < 0.05 \), ∗∗∗: \( p < 0.01 \). Robust standard errors in parentheses. \( R^2 \) is omitted for the Tobit regressions. Source: Panel Study Labour Market and Social Security (PASS) survey from the Institute for Employment Research (IAB).
D Technical Details: Polynomial Approximation of Representative Household Aggregate Employment Disutility $V(E)$ to Empirical Reservation Raise Distribution

In this section we describe how we choose the polynomial approximation of $V(E)$ (in fact by means of fitting $V'(E)$) from the survey data. Our empirical observations, indexed by $x = \{1, \ldots, X\}$, come as a combination of reservation raise level and employment rate $((1 + \xi_x), E_x)$. Given a polynomial degree $d$, the goal is to choose the polynomial $p^*(E)$ such that

$$p^*(E) = \arg \min_{p(E) \in P_d(E)} \sum_{x=1}^{X} \omega_i \left(p(E_x) - (1 + \xi_x)\right)^2$$

subject to $p''(E) \geq 0 \forall E \in [0, 1]$,

where $P_d(E)$ is the set of polynomials of degree $d$. We select the polynomial degree by informal visual experimentation. Weights are of the form $\omega_x = \left[(1 + \xi_x) - 1\right] + 0.01)^{-2}$, hence assigning more weight to local raise (and hence employment) deviations e.g., relevant to business cycle fluctuations.

In lieu of the actual nonnegativity constraint on the derivative of $p^*(E)$ for the full and continuous support, we approximate this constraint as follows:

$$p^*(E_j) \geq 0 \ \forall E_j \in \{E_1, E_2, \cdots, E_J\},$$

where $E_1, E_2, \cdots, E_J$ are a set of $J$ points in $[0, 1]$. In other words, we check that the derivative is positive at many points in the interval. This is computationally simple to implement. For a candidate polynomial $p(E) = p_0 + p_1 E + p_2 E^2 + \cdots + p_d E^d$, the constraints can be written as:

$$p_1 + 2p_2 E_j + 3p_3 E_j^2 + \cdots + d p_d E_j^{d-1} \geq 0 \ \forall E_j \in \{E_1, E_2, \cdots, E_J\}$$

which is a linear restriction in the polynomial coefficients $[p_0, p_1, \cdots, p_d]$. One can similarly write restriction $p^*(E) \geq 0$ as a linear restriction on the coefficients of the polynomial. This problem can then be passed to an appropriate solver, where we use the ECOS solver through
Julia’s Convex.jl package (Udell, Mohan, Zeng, Hong, Diamond, and Boyd, 2014). We check the constraint with \( J = 100,000 \) equally spaced points in \([0, 1]\). Here, the constrained polynomial fits the data almost as well as that of an unconstrained polynomial of the same degree; in fact, the derivative of the polynomial chosen with unconstrained weighted least squares is positive over much of the domain. The weighted \( R^2 \)s of the unconstrained and constrained regressions are 0.9802 and 0.9800.

Table A.6: Fitted Representative Household Labor Supply Disutility \( V(E) \), \( V'(E) \) and \( V''(E) \) as a Function of the Aggregate Employment Rate \( E \in [0, 1] \): Coefficients of Polynomial Approximation

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>( f(E, \beta) = \sum_{i=0}^{\tilde{i}} \beta_i E^i ) = ...</th>
<th>( V'(E) ) (fitted, ( \tilde{i} = 8 ))</th>
<th>( V(E) ) (analytical from ( V'(E) ))</th>
<th>( V''(E) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_0^j )</td>
<td>1.03 ( \cdot 10^{-5} )</td>
<td>0*</td>
<td>13.88</td>
<td></td>
</tr>
<tr>
<td>( \beta_1^j )</td>
<td>13.88</td>
<td>1.03 ( \cdot 10^{-5} )</td>
<td>-478.41</td>
<td></td>
</tr>
<tr>
<td>( \beta_2^j )</td>
<td>-239.20</td>
<td>6.94</td>
<td>5889.42</td>
<td></td>
</tr>
<tr>
<td>( \beta_3^j )</td>
<td>1963.14</td>
<td>-79.74</td>
<td>-32581.88</td>
<td></td>
</tr>
<tr>
<td>( \beta_4^j )</td>
<td>-8145.47</td>
<td>490.79</td>
<td>93474.10</td>
<td></td>
</tr>
<tr>
<td>( \beta_5^j )</td>
<td>18694.82</td>
<td>-1629.09</td>
<td>-144600.69</td>
<td></td>
</tr>
<tr>
<td>( \beta_6^j )</td>
<td>-24100.11</td>
<td>3115.80</td>
<td>114099.61</td>
<td></td>
</tr>
<tr>
<td>( \beta_7^j )</td>
<td>16299.95</td>
<td>-3442.87</td>
<td>-35816.04</td>
<td></td>
</tr>
<tr>
<td>( \beta_8^j )</td>
<td>-4477.00</td>
<td>2037.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \beta_9^j )</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Note: The table reports the coefficients of the polynomial function fitted to match the empirical extensive-margin aggregate labor supply curve measured and discussed in Section 3. The function fitted here corresponds to a representative household’s aggregate disutility of employment \( V(E) \). We describe the fitting procedure in Section 4.2 with further details in Appendix Section D. \( V'(E) \) is the eighth-degree polynomial fitted to the empirical labor supply curve, with \( E \in [0, 1] \) denoting the employment rate. The microfoundation is a full-insurance representative household in which household members are heterogeneous in the disutility of working, which acts as a fixed cost due to indivisible labor. As a result \( V'(E) \) denotes the disutility of labor of the marginal household member at employment rate \( E \). We obtain \( V(E) \) as the analytical antiderivative of \( V'(E) \) (with its constant, denoted by \*), normalized s.t. \( V(0) = 0 \). \( V''(E) \) is the analytical derivative of \( V'(E) \). The properties of the functions in the range of interest \( E \in [0, 1] \) are \( V(E) \geq 0, V'(E) > 0 \) and \( V''(E) > 0 \). Along with raw empirical data points, these functions are plotted in Appendix Figure A.8, and included in Figure 2 and Figure 3.
Figure A.8: Visualizing the Fitted Polynomial Approximation and Empirical Labor Supply Curve: Representative Household Labor Supply Disutility $V'(E)$, $V(E)$ and $V''(E)$ as a Function of Employment Rate $E \in [0, 1]$:

(a) Fit and Target of Marginal Aggregate Disutility $V'(E) = v$
(Marginal Worker’s Micro Disutility)

(b) Aggregate Disutility $V(E)$: Antiderivative of $V'(E)$

(c) Second Derivative: $V''(E)$

Note: The figures plots the empirical labor supply curve (hollow circles) and fitted lines of the extensive-margin labor supply curves implied by reservation raises. Panel (a) plots our fitted polynomial approximation (solid continuous line) against the empirically recovered disutilities $V'(E) = v$ (hollow circles). Panel (b) displays the analytical antiderivative against the numerical integral, and finally Panel (c) confirms that the second derivative of $V(E)$ is positive over the support. We summarize the fitting procedure in Section 4.2 and detail it in Appendix Section D. The micro-foundation is a full-insurance representative household with aggregate disutility of employment $V(E)$ capturing household members’ heterogeneous disutility of working with indivisible labor. As a result, $V'(E)$ denotes the disutility of labor of the marginal household member at employment rate $E$. $V'(E)$ is the eighth-degree polynomial $f(E, \beta) = \sum_{i=0}^{8} \beta_i E^i$ fitted to the empirical labor supply curve, with $E \in [0, 1]$ denoting the employment rate. Going from the fitted function for $V'(E)$ (plotted in Panel (a)), we obtain $V(E)$ (plotted in Panel (b)) as the analytical antiderivative (with its constant normalized s.t. $V(0) \approx 0$). $V''(E)$ (plotted in Panel (c)) is the analytical derivative of $V'(E)$. The properties of the functions in the range of interest $E \in [0, 1]$ are $V(E) \geq 0$, $V'(E) > 0$ and $V''(E) > 0$. As in Appendix Figure 1, we do not include reservation net of raise rate observations above 2.0, which make up around 10% of our sample (and so our employment rate does not go to 100%). Due to large values towards an employment rate of 100%, we also cut off the plots at different points on the right to maintain readable y-axis ranges. Appendix Table A.6 reports the coefficients, and the resulting fitted curve is included in Figure 2 and Figure 3.