The Aggregate Labor Supply Curve at the Extensive Margin:
A Reservation Wedge Approach*

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Abstract

We present a theoretically robust and empirically tractable representation of the aggregate labor supply curve at the extensive (employment) margin. The core concept we define is the individual-level reservation (labor) wedge: the tax-like gap between an individual’s potential earnings and her marginal rate of substitution. This micro wedge is a sufficient statistic that collapses rich multi-dimensional heterogeneity in, e.g., tastes for leisure, marginal utilities of consumption, hours constraints, and worker-specific wages. The CDF of the reservation wedges is the aggregate labor supply curve. In a model meta-analysis, we demonstrate how the reservation wedge serves as a bridge between diverse models including those in which an aggregate labor supply curve is otherwise difficult to characterize and interrelate. The wedges are also empirically tractable: we measure them in a customized household survey for a representative sample of the U.S. population – and thereby map out the complete empirical aggregate labor supply curve at the extensive margin for the U.S. We also study micro covariates (and predictive content for realized employment) of the wedges vis-à-vis model-specific drivers of heterogeneity. For small deviations, the empirical curve exhibits locally large Frisch elasticities above 3 (according with business cycles). Yet, the curve features important non-constant arc elasticities: they shrink for larger deviations in either direction, yet asymmetrically so upward (implying elasticities around 0.5, consistent with quasi-experimental evidence. Treating the empirical curve as a calibration target for labor supply blocks of macro models, we propose one (representative-agent) specification that precisely matches the full curve. This labor supply block implies relatively smooth labor wedges over U.S. business cycles.

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1 Introduction

The aggregate labor supply curve – the sum of individuals’ desired labor supply as a function of homogeneous shifts in the wage – is a core feature of macroeconomic models. In market-clearing equilibrium models, in which individuals are always on their labor supply curve, it forms the iron link between wages and employment. In New Keynesian models with nominal frictions, it shapes the slope of the Phillips curve, the trade-off between the aggregate labor input and wage inflation pressure. In models of wage bargaining or wage posting, the curve shapes workers’ reservation wages. The curve also enters the assessment potential welfare costs of employment adjustment, and scales the amplitude of cyclical labor wedges.

Despite its theoretical centrality, labor supply blocks in macroeconomic models commonly rely on ad-hoc abstractions, for instance conventional intensive-margin hours choices (hours worked conditional on working) directed by a fictional utilitarian head of a large representative household with a pooled budget constraint. This simplification stands in tension with empirical adjustment of labor aggregates primarily along the extensive, i.e. employment, margin. Alternatively, aggregate extensive margin labor supply models may appeal to full-insurance households with employment lotteries. By contrast, richer and perhaps empirically more accurate household blocks with atomistic labor supply often lack an extensive margin, or feature an overwhelming degree of interrelated heterogeneity, precluding the tangibly representable and simple-to-parameterize aggregate labor supply curve convenient for calibration and quantitative analysis in macroeconomic models.

We present a theoretically robust yet tractable framework to conceptualize and quantitatively analyze the aggregate labor supply curve at the extensive margin. Individuals make discrete choices over employment, which we summarize in form of a micro reservation (labor) wedge: a tax-like gap \(1 - \tau_i^*\) between the individual’s idiosyncratic potential earnings and the extensive-margin version of her idiosyncratic marginal rate of substitution (such as the value of leisure). Intuitively, the wedge corresponds to a hypothetical mark-up or mark-down on the returns to working that would render individual \(i\) indifferent between employment and nonemployment. Hence the wedge, capturing worker surplus from employment, is a sufficient statistic for each worker’s extensive-margin labor supply behavior, summarizing detailed model-specific features including rich heterogeneity in, e.g., tastes for leisure or disutility from working, marginal utilities of consumption, hours constraints, potential wages, and distributional assumptions, a variety of parameterizations and equilibrium outcomes. While we focus on the Frischian perspective, the curve also accommodates longer-run horizons and wealth effects. It additionally incorporates intensive margin choices, and a variety of frictions and other extensions.

The cumulative distribution function of the micro wedges fully characterizes – is – the aggregate labor supply curve: structurally different models will exhibit the same labor supply behavior if and only if they are isomorphic in their reservation wedge distribution. As its argument, the curve takes a generalized aggregate wage concept: the prevailing aggregate wedge \(1 - T_t\). Shifts in this prevailing wedge, due to aggregate wage growth, linear taxes, labor demand shocks or labor market frictions, sweep up marginal workers – whose reservation wedges are originally around the
prevailing aggregate wedge and who hence drive extensive margin adjustment.

In a model meta-analysis, we show how the reservation wedge distribution serves as a unifying bridge between structurally widely different labor supply blocks, unveiling and visualizing the full aggregate labor supply curves even if otherwise difficult to characterize and interrelate. We first analyze models of representative, full-insurance households with ad-hoc MaCurdy labor supply (Gali, 2015) and fully indivisible labor (Hansen, 1985; Rogerson, 1988). We also integrate an intensive margin choice, and apply this insight to the Rogerson and Wallenius (2008) model of lifecycle choices at both margins. We then introduce an extensive-margin choice into atomistic heterogeneous agent models with borrowing constraints (Bewley, 1986; Huggett, 1993; Aiyagari, 1994; Achdou, Han, Lasry, Lions, and Moll, 2017; Debortoli and Gali, 2017; Kaplan, Moll, and Violante, 2018), with heterogeneity in wages as well as the shadow value of income.

The framework provides a consistent definition as well as direct characterization of the aggregate extensive-margin elasticity: the density of marginal over total employment at a given at $\left(1 - T_t\right)$ (i.e. the reverse hazard rate, $\frac{\left(1-T_t\right)f_t\left(1-T_t\right)}{F_t\left(1-T_t\right)}$). It can be read off the reservation wedge distribution as well as be defined for non-infinitesimal variations. Our framework also clarifies that this elasticity is constant if the reservation wedges are power-distributed – which occurs if any one wedge-relevant component is power-distributed, hence permitting various potential origins of this property. For example, the popular ad-hoc specification of representative households exhibiting intensive-margin-like MaCurdy preferences ("$u(c) - L^{1+1/\epsilon}$", as used in, e.g., Gali, 2015) emerges if the disutility of participation is power-distributed, with homogeneous wages (by assumption) and shadow values of income (generated by the pooled budget constraint).

A desirable property for a given labor market block is that its labor supply curve be consistent with its empirical analogue. The reservation wedge distribution also serves as a bridge between the empirical and the model-implied curves. We construct this empirical analogue by implementing a custom survey eliciting reservation wedges. The survey question presents the wedge exactly as the transitory tax/subsidy rendering a given individual indifferent between nonemployment and employment. Our representative survey covers all labor force groups in the U.S.¹ That is, by constructing the CDF of the wedges, we in fact nonparametrically trace out the full empirical aggregate labor supply curve at the extensive margin.

The empirical histogram of the wedge 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. Inspecting the associated empirical CDF, this concentration of marginal workers implies a large local Frisch elasticity of desired extensive-margin labor supply of around 3. This local mass point mirrors, in an attenuated way, intuitions from models of homogeneity (Hansen, 1985). Despite this, the wedge distribution is widely dispersed, implying that the typical worker is inframarginal in that she derives considerable worker surplus from employment, consistent with models of heterogeneity in job quality (Mortensen and Pissarides, 1994; Jäger, Schoefer, and Zweimüller, 2018).

¹ Pistaferri (2003) measures intensive-margin intertemporal labor supply preferences in a household survey by comparing individual-level wage expectations with hours worked.
and present in lifecycle models Rogerson and Wallenius (2008) or with heterogeneous disutility of labor supply (Gali, 2015; Boppart and Krusell, 2016), but inconsistent with models of homogeneity (e.g. Hansen, 1985; Rogerson, 1988), as well as textbook DMP models without heterogeneity.

Interestingly, the high local Frisch elasticity is close to calibrations of macroeconomic models, but an order of magnitude larger than quasi-experimental estimates of realized employment adjustment to short-run net-wage changes (see, e.g., Chetty et al., 2012). However, the shape of the empirical curve implies arc elasticities that are far from constant – and become much smaller falling below 1.0 – away from the local infinitesimal perturbation towards larger wedge (e.g. tax) changes. This non-constancy of the elasticity raises the possibility that very large shifts, such as tax holidays (Bianchi, Gudmundsson, and Zoega, 2001; Martinez, Saez, and Siegenthaler, 2018; Sigurdsson, 2018), may imply small Frisch arc elasticities – while the same underlying empirical labor supply curve may still exhibit large more local Frisch elasticities (masked by a large tax change) – unless the structural elasticity were constant. This insight implies a trade-off for empirical work estimating structural labor supply preferences and elasticities, which relies on large tax changes to obtain statistical power and overcome adjustment costs (e.g., Chetty, 2012), but perhaps at the expense of accurately measuring local elasticities for small changes.

Business cycle fluctuations suggest small average changes in the return to working, and hence local elasticities determine the labor supply behavior of the model economy. Here, the empirical curve features high local elasticities of around 2.0 to 3.0, and moreover features asymmetries implying smaller upward than downward responsiveness, further attenuating upward employment responses.

Comparing model curves to the data, we find that the empirical wedges are distributed in a way not easily described by labor supply blocks of existing macro models. We therefore next treat them as a calibration target for labor supply blocks of macro models, using the reservation wedge framework to go from empirics to theory. We illustrate one specification we construct to precisely match the full curve: a representative-agent full-insurance household with its members heterogeneous in labor disutility. We also fit and provide a ready-to-use parametric polynomial of the disutility of labor that delivers a close approximation, a naturally increasing and convex function of the employment rate.

To assess the macroeconomic consequences of the data-consistent flexible labor supply curve, we close with an exercise comparing the performance of a benchmark business cycle model with the aforementioned data-consistent curve, to standard constant-elasticity labor supply specifications. Our performance measure is the labor wedge (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009), the gap between the marginal product of labor and the imputed marginal rate of substitution, going from a frictionless general equilibrium and a representative full-insurance household model.\(^2\) We find that the data-consistent labor supply curve implies that the labor market is closer to equilibrium during recessions, essentially acting as a high-constant-elasticity model in that region.

\(^2\)An ongoing debate studies the incidence of this market-level wedge the MRS and the wage, and the wage and the MPL (Karabarbounis, 2014; Bils, Klenow, and Malin, 2018; Mui and Schoefer, 2018).
of small employment deviations. We caution that this exercise stands on the assumption – or rather assesses its capacity to generate realistic simulated time series – of labor market clearing.

We reiterate that the reservation wedges trace out desired spot-market labor supply, i.e. underlying preferences over employment and nonemployment. Our framework is therefore decidedly agnostic and prior to potential real-world frictions such as search or wage rigidities, which may detach desired from actual employment allocations. Hence, our focus on (stated) preferences contrasts with, e.g., an empirical investigation of the realized employment effects of tax changes (e.g. Chetty, Guren, Manoli, and Weber, 2012; Martinez, Saez, and Siegenthaler, 2018; Sigurdsson, 2018), which in the presence of frictions need neither perfectly reveal preferences nor solely reflect micro choices. To us, the distinction implies that those estimates provide calibration targets for the entire labor market structure of a given model "net of frictions", whereas our contribution helps guide the deeper structural parameters guiding labor supply preferences, a necessary model ingredient to generate behavioral responses perhaps prior to market structure.3

To assess the degree and incidence of such rationed labor supply implied by the wedge measures, we close with an empirical exercise comparing an individual’s reservation wedge with her realized employment outcomes. We use a panel dimension of our custom survey, and supplement our analysis for existing panel surveys of unemployed job seekers in Germany, France, and the United States, for whom we show we can generate wedge proxy in form of the ratio of an individual’s reservation wage to the actual/potential wage. We also link one survey to German administrative social security data covering their pre- and post-interview labor market biographies. Here we find considerable evidence that realized employment fluctuations are far from closely aligned with Frischian labor supply preferences, either suggesting measurement error in the wedges or limited room for short-run labor adjustment as would arise from a variety of labor market frictions and features missed in the spot market benchmark.

Outline In Section 2, we provide the general labor supply framework, define the individual-level reservation wedge, and derive the aggregate labor supply curve. Our meta-analysis of models in Section 3 applies this framework to existing supply blocks. In Section 4 we construct the empirical counterparts of the wedge distribution for the US in a custom survey. In Section 5, we compare the model-implied distributions with the empirical one, and show how a standard model can be transparently calibrated to precisely match this calibration target. In Section 6, we conduct a worker-level analysis of covariates, and the micro-relationship between the wedge-implied desired labor supply and realized employment allocations. We also review additional related literature below.

Additional Related Literature We contribute to a large existing literature on the aggregate labor supply curve as well as extensive-margin choices presenting and estimating distinct parametric models. Broadly, we add to this prior work by building a general unifying framework that is nonparametric and delivers an empirically tractable as well as model-independent sufficient-
statistics, capable of interrelating various models as well as data.

First, on the macroeconomic side, our paper shares one intermediate step, namely to explicitly think of aggregate extensive margin employment adjustment to be driven by marginal workers in a distribution of reservation wages (Chang and Kim, 2006, 2007; Gourio and Noual, 2009; Park, 2017). Unlike our paper, these papers each present one specific model of aggregate labor supply with heterogeneity, and provide parametric estimations of the calibrated model relying on model-specific as well as distributional assumptions. By contrast, our goal is to provide a nonparametric and hence generalized sufficient statistics in form of the reservation wedge and its distribution, which we show is more model-independent and moreover can be directly measured in survey as a single response. Directly tracing out desired labor supply, our empirical implementation does not require the assumption of Walrasian labor market clearing (otherwise needed to to infer preferences from prevailing employment allocations. Finally, our framework then also facilitates calibration of model curves to the empirical wedge distribution.

The second literature to which our paper connects is the structural estimation of rich micro labor supply models (e.g., Blundell, Pistaferri, and Saporta-Eksten, 2016). Attanasio, Levell, Low, and Sánchez-Marcos (2018) and Beffy, Blundell, Bozio, Laroque, and To (2018) estimate a structural model for female labor supply behavior at the micro level including an extensive margin; the former authors then also include a simulation-based computation of extensive-margin Frisch elasticities for women. Our paper instead provides a sufficient-statistics approach to labor supply preferences for the Frischian extensive margin in various models and a custom survey.

Third, our method complements the nascent literature studying reduced-form Frisch elasticities using quasi-experimental tax changes (Bianchi, Gudmundsson, and Zoega, 2001; Chetty, Guren, Manoli, and Weber, 2012; Martinez, Saez, and Siegenthaler, 2018; Sigurdsson, 2018).

2 Framework: Micro Reservation Wedges and Aggregate Labor Supply

We micro-found the extensive-margin aggregate labor supply curve from discrete choices between employment and nonemployment by individual households. We summarize these micro-employment choices in the form of an allocative sufficient statistic: the individual reservation (labor) wedge, which is the transitory labor tax that would render an individual indifferent between employment and nonemployment. This statistic collapses a variety of sources of heterogeneity and is theoretically robust across model classes. The aggregate labor supply curve is the CDF of the reservation wedge distribution. It traces out the fraction of households desiring to work as a function of the prevailing aggregate wedge – which in turn is a generalized notion of an aggregate

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4 For example, Park (2017) assumes homogeneous labor supply disutility and uses measured consumption with imputed wages and distributional assumptions to back out empirical reservation wage levels. Gourio and Noual (2009) consider an empirical setting specified to normal distributions and derives estimating equations based on a social planner’s large-household allocation.

5 Erosa, Fuster, and Kambourov (2016), who do not derive reservation wages, permit matching frictions, worker flows and exogenous separation shocks.

6 Compositional differences between group-specific Frisch elasticities are highlighted and estimated in reduced form in Fiorito and Zanella (2012) and Peterman (2016). Keane and Rogerson (2012) and Keane and Rogerson (2015) review mechanisms by which aggregate extensive-margin Frisch elasticities may be larger than implied micro Frisch elasticities.
wage.

2.1 Micro Labor Supply

Household’s Problem Consider an individual $i$ with time-separable utility $u_i(c_i, h_i)$ from consumption $c_i$ and hours worked $h_i$, with budget Lagrange multiplier $\lambda_{it}$:

$$\max_{a_{it}, h_{it}, c_{it}} \mathbb{E}_t \sum_t \beta^t u_i(h_{it}, c_{it})$$

s.t. $a_{it} + c_{it} \leq a_{i,t-1}(1 + r_{t-1}) + (1 - T_t) y_{it}(h_{it}) + T_{it}(\cdot)$

For now labor is indivisible, such that $h_{it} \in \{0, \tilde{h}_{it}\}$; we permit intensive-margin hours choices below. Her potential earnings are $y_{it} = w_{it} \tilde{h}_{it}$, at labor disutility $v_{it} = u_i(c^{e=1, \lambda_{it}}_{it}, \tilde{h}) - u_i(c^{e=0, \lambda_{it}}_{it}, 0)$. Besides standard hours disutility, $v_{it}$ may also include fixed participation costs (Cogan, 1981; Attanasio, Levell, Low, and Sánchez-Marcos, 2018; Beffy, Blundell, Bozio, Laroque, and To, 2018). We will put concrete structures on these terms below and by reviewing particular models in Section 3. $T_{it}(\cdot)$ denotes other taxes and transfers (unrelated to labor income and employment status).

The prevailing aggregate wage labor wedge $1 - T_t$ is a homogeneous shifter of the monetary return to working. This shifter could capture wage growth or changes in labor taxes to which individual-level wages $w_{it}$ are proportionate. $1 - T_t$ generalizes the standard homogeneous aggregate wage to our setting with potential heterogeneity in idiosyncratic wages. Aggregate labor supply denotes desired total as a function of this shifter.

Optimal labor supply assigns each individual $i$ her hours $h_{it} \in \{\tilde{h}_{it}, 0\}$ following a cutoff rule:

$$h_{it}^* = \begin{cases} 0 & \text{if } (1 - T_t) w_{it} \tilde{h}_{it} \lambda_{it} < v_{it} \\ \tilde{h}_{it} & \text{if } (1 - T_t) w_{it} \tilde{h}_{it} \lambda_{it} \geq v_{it} \end{cases}$$

That is, her discrete choice selects employment if the benefits, $(1 - T_t) y_{it} \lambda_{it}$, outweigh the cost, $v_{it}$ (such the net of wedge earnings exceed the extensive-margin MRS). For marginal workers, who are indifferent between working and not, the condition holds with equality. Equivalently, due to labor indivisibility, the discrete choice determines her employment status $e_{it} \in \{0, 1\}$:

$$e_{it}^* = \begin{cases} 0 & \text{if } (1 - T_t) y_{it} \lambda_{it} < v_{it} \\ 1 & \text{if } (1 - T_t) y_{it} \lambda_{it} \geq v_{it} \end{cases}$$

Micro Reservation (Labor) Wedges We summarize the individual’s extensive-margin labor supply behavior by defining as a micro sufficient statistic her idiosyncratic reservation wedge $1 - \tau_{it}^*$: the hypothetical aggregate wedge $1 - T_{it}$ that would, if prevailing transitorily, render her marginal – i.e. indifferent between working and not working in a Frischian ($\lambda$-constant) setting:

$$1 - \tau_{it}^* = \frac{v_{it}}{y_{it} \lambda_{it}}$$
2.2 Aggregation

The Aggregate Labor Supply Curve The distribution of reservation wedges in period $t$, given by CDF $F_t(1 - \tau^*)$, in turn fully characterizes the aggregate short-run labor supply curve as a function of transitory shifts in $1 - \tau_t$ (hence Frischian, $\lambda$-constant variation). Aggregate desired employment rate $E_t$ equals the fraction of workers with $1 - \tau^*_t \leq 1 - \tau_t$; i.e. the mass of employed households (defined by $i$ and having density $g(i)$) up until the marginal worker:

$$E_t(1 - \tau_t) = \int e^*_t g_t(i) di = \int_{-\infty}^{\infty} 1 (1 - \tau^* \leq 1 - \tau_t) dF_t(1 - \tau^*)$$

$$= F_t(1 - \tau_t)$$  \hspace{1cm} (6)

Different microfoundations that generate the same reservation wedge distribution $F$ also generate the same labor supply curve. The reservation wedge subsumes arbitrarily rich heterogeneity in potential wages, budget multipliers, and the labor disutility of workers. These three components in turn capture rich model-specific sources of heterogeneity, such as lifetime wealth, borrowing constraints, worker-specific skills, hours requirements, job amenities, time endowments, or tastes for leisure.

Desired employment adjustment occurs along this supply curve. For example, suppose an increase in aggregate wedge from $(1 - \tau_t)$ to $(1 - \tau'_t)$. The employment response is driven by the mass of nearly-marginal workers, $F_t(1 - \tau'_t) - F_t(1 - \tau_t)$: those workers nonemployed in regime $1 - \tau_t$ but employed under $1 - \tau'_t > 1 - \tau_t$, i.e. those marginal workers with reservation wedges $1 - \tau'_t < 1 - \tau^*_t \leq 1 - \tau_t$.

2.3 The Extensive-Margin Elasticity

The extensive-margin elasticity – one local property of the curve – can be defined in the wedge framework.

Definition The labor supply elasticity for discrete wedge changes is:

$$\epsilon_{E_t,(1-\tau_t)\rightarrow(1-\tau'_t)} = \frac{F_t \left(1 - \tau'_t\right) - F_t \left(1 - \tau_t\right)}{F_t \left(1 - \tau_t\right) \left(\left(1 - \tau'_t\right) - (1 - \tau_t)\right)}$$ \hspace{1cm} (8)

For infinitesimal changes in $(1 - \tau_t)$, the extensive margin elasticity is:

$$\epsilon_{E_t,1-\tau_t} = \frac{(1 - \tau_t)}{E_t} \frac{\partial E_t}{\partial (1 - \tau_t)} = \frac{(1 - \tau_t) f_t(1 - \tau_t)}{F_t(1 - \tau_t)}$$ \hspace{1cm} (9)

For a preexisting wedge normalized to $1 - \tau_t = 1$, the elasticity is the reverse hazard rate at threshold 1, i.e. $f_t(1)/F_t(1)$ (any tax system can be subsumed in redefining initial wages $w_{it}$ as net wages without loss of generality).

Conditions for a Constant Extensive Margin Frisch Elasticity We now clarify the general distributional conditions for a constant extensive-margin Frisch elasticity, a convenient property for
calibration often assumed in ad-hoc specifications, two of which we include in our meta-analysis of models in Section 3. A power-law-like distributed wedge exhibits this property. Suppose $1 - \tau^*$ follows a distribution

$$G_{1-\tau^*}(1 - \tau^*) = \left(\frac{1 - \tau^*}{(1 - \tau^*)_{\text{max}}}\right)^{\alpha_{1-\tau^*}}$$

with shape parameter $\alpha_{1-\tau^*}$ with maximum $(1 - \tau^*)_{\text{max}}$. That distribution delivers an elasticity equal to $\alpha_{1-\tau^*}$:

$$\epsilon_{E,1-\tau^*} = \left(\frac{1 - \tau^*}{(1 - \tau^*)_{\text{max}}}\right)^{-1}$$

Specifically, the distributional assumptions for the property in power-law terms specify a standard power law distribution $F(X) = P(x < X) = a \cdot \left(\frac{x}{X_{\text{max}}}\right)^{-\gamma+1}$ with shape parameter $\gamma > 0$. A comparison with our wedge-based power-law-like distribution (10) and a rearrangement clarify that we require the inverse of our wedge to follow a power distribution:

$$G_{1-\tau^*}(1 - \tau^*) = P(X < 1 - \tau^*) = \left(\frac{1 - \tau^*}{(1 - \tau^*)_{\text{max}}}\right)^{\alpha_{1-\tau^*}}$$

$$\Leftrightarrow P\left(\frac{1}{1 - \tau^*} < \frac{1}{X}\right) = \left(\frac{1 - \tau^*}{(1 - \tau^*)_{\text{max}}}\right)^{\alpha_{1-\tau^*}}$$

which is a power-law distribution of $\frac{1}{1 - \tau^*}$ with minimum $\frac{1}{(1 - \tau^*)_{\text{max}}}$, and shape parameter $\gamma = \alpha_{1-\tau^*} + 1$.

Another useful property is that such a power-like wedge distribution can emerge as long as any one of wedge components $(v_{it}, 1/\lambda_{it}, 1/y_{it})$ is power-distributed conditional on the other two. For example, let $v_{it}$ follow a power distribution with maximum $v_{\text{max}}$ and shape parameter $\alpha_{v_{it}}$ independent from $g(y, \lambda)$, the joint distribution of $y_{it}$ and $\lambda_{it}$. The distribution of $1 - \tau_{it}^*$ is then:

$$F_{t}(1 - \tau_{t}) = P\left(1 - \tau_{it}^* \leq 1 - \tau_{t}\right) = P\left(\frac{v_{it}}{y_{it}\lambda_{it}} \leq 1 - \tau_{t}\right) = P\left(v_{it} < (1 - \tau_{t})y_{it}\lambda_{it}\right)$$

$$= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \min\left\{\left(\frac{(1 - \tau_{t})y_{it}\lambda_{it}}{v_{\text{max}}}\right)^{\alpha_{v_{it}}}, 1\right\} g(y, \lambda)dyd\lambda$$

A powerful case is $\left(\frac{(1 - \tau_{t})y_{it}\lambda_{it}}{v_{\text{max}}}\right)^{\alpha_{v_{it}}} < 1$ for each $(y, \lambda)$-"type". Economically, this distributional assumption implies positive nonemployment in each $(y, \lambda)$-type at $1 - \tau_{it}$. Then the distribution
becomes "cleanly" power-like:

\[
\Rightarrow F_t(1 - \mathcal{T}_t) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \left(1 - \mathcal{T}_t \frac{w\lambda}{\nu_{\text{max}}}\right) \alpha_v g_t(y, \lambda) dy d\lambda
\]

\[
= \left(1 - \mathcal{T}_t\right)^{\alpha_v} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (\frac{y\lambda}{\nu_{\text{max}}})^{\alpha_v} g_t(y, \lambda) dy d\lambda
\]  

(16)

which itself is a power distribution with shape parameter \(\alpha_v\) and maximum

\[
1 - \tau_{\text{min}}^\nu = \left[\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} (y\lambda)^\alpha g_t(y, \lambda) dy d\lambda\right]^{1/\alpha_v}. \quad \text{That is, we have indexed the population by} \ (y, \lambda). \ \text{Within each} \ (y, \lambda)-\text{type, the reservation wedge is power-distributed since } v_{it} \text{ is. So each } (y, \lambda)-\text{type exhibits a constant elasticity } \alpha_v. \ \text{The aggregate elasticity – the weighted average of } (y, \lambda)-\text{types’ elasticities } \alpha_v – \text{ is hence also } \alpha_v. \ \text{By contrast, if } \mathcal{T}_t \text{ or } \tau_{\text{min}}^\nu \text{ is low enough for full employment in some types, these types’ labor supply will be locally inelastic, so the aggregate elasticity will be smaller than } \alpha_v, \ \text{at } \alpha_v \cdot P((1 - \mathcal{T}_t)y\lambda < \nu_{\text{max}}).
\]

### 2.4 Extensions Within the Spot Labor Market Benchmark

#### Net vs. Gross Earnings, and Leisure Subsidies

In our baseline model, the household trades off the benefit of working (earnings valued at the shadow value of income) with the costs, which were in terms of disutility of labor or amenities and hence of non-monetary nature. By contrast, real-world labor markets feature monetary opportunity costs of working, such as various welfare programs or perhaps home production (for measurement of these average costs in the context of a representative household, across countries and the U.S. business cycle, see Prescott, 2004; Chodorow-Reich and Karabarbounis, 2016). We now refer to such non-disutility, monetary opportunity costs as \(b_{it}\), again permitting them to be idiosyncratic and time-varying.\(^7\)

A key distinction is whether or not such non-disutility, monetary opportunity costs are subject to the prevailing wedge. If they are subject to the wedge – which would be expected for components such as home production that may be assumed to inherit, for example, shifts in TFP, then we can simply define a richer concept of net potential earnings, as the difference of gross potential earnings \(y_{it} = \tilde{y}_{it} - b_{it}\) and a wedge-sensitive monetary opportunity cost of working \(b_{it}\). The associated wedge is then:

\[
1 - \tau_{it}^* = \frac{v_{it}}{(\tilde{y}_{it} - b_{it}) \lambda_{it}} = \frac{v_{it}}{\tilde{y}_{it} (1 - \frac{b_{it}}{\tilde{y}_{it}}) \lambda_{it}} = \frac{v_{it}}{y_{it} \lambda_{it}} \]

(18)

where \(\frac{b_{it}}{\tilde{y}_{it}}\) can be thought of us the "replacement rate" akin to a tax wedge. The expression clarifies that the logic of the distribution goes through. For example, homogeneous shifts in \(b_{it}\) such as through nonemployment subsidies in UI simply shift the reservation wedge distribution to the left. The elasticity implications depend on the local distribution around the new marginal worker.

By contrast, if \(b_{it}\) is not marked up by the wedge (for example, nonemployment subsidies that
are constant of the business cycle), then \( b_{it} \), marked up by \( \lambda_{it} \), folds into the disutility of labor \( v_{it} = v_{it} + b_{it} \lambda_{it} \):

\[
1 - \tau^*_i = \frac{v_{it} + b_{it} \lambda_{it}}{\gamma_{it} \lambda_{it}} = \frac{v_{it}}{y_{it} \lambda_{it}} - \frac{b_{it}}{y_{it} \lambda_{it}} = \frac{\delta_{it}}{y_{it} \lambda_{it}}
\]  

(19)

where \( \frac{b_{it}}{y_{it}} \) can be thought of as a "net-to-gross" replacement rate.

**Non-Wage Job Amenities** Non-wage job amenities (Mas and Pallais, 2017; Hall and Mueller, 2018) can simply be folded into the now net disutility of work \( v_{ij} \) for each job \( j \), then encompassing all non-monetary flow benefits from the job entering directly the utility function.

**Intensive Margin Hours Choices and Job Menus** Even with intensive margin hours choices, the reservation wedge continues to encode the extensive-margin labor supply curve. Rather than \( \tilde{h}_{it} \in \{\tilde{h}_{it}, 0\} \), labor supply is a choice \( j \) from a menu of jobs \( J_{it} = \{(y_{it,j}, v_{it,j})\} \), each permitted to differ in its earnings, and disutility (or amenities) \( (y_{it,j}, v_{it,j}) \). This general setting nests heterogeneity in hours \( \tilde{h}_{it}^j \), for example, i.e. the standard intensive margin, e.g. a sparse set of discrete hours options (e.g. 0, 20, or 40), or nearly continuous hours choices. But the setting is more general in that permits the worker to choose along general job attributes, nonparametrically nesting nonconvexities in payoff \( y \) or costs \( v \).

Our solution proceeds in two steps. First in the "inner loop", for any given wedge \( 1 - T_i \), we can define the household’s intensive-margin job choice – at which stage we therefore intentionally and explicitly ignore the participation constraint i.e. the extensive-margin choice:

\[
\max_{a_{it}, j_{it} \in J_{it}, c_{it}} \mathbb{E}_t \sum_{t} \beta^t u(j, c_{it}) \tag{20}
\]

\[
\text{s.t. } a_{it} + c_{it} \leq a_{i,t-1}(1 + r_{i-1}) + (1 - T_i)y_{it,j} + T_{it}(.) \tag{21}
\]

where optimal job choice is defined as a discrete choice, maximizing the utility (anticipating subsequent optimization of other variables). This “inner loop” essentially asks: conditional on working (at all), what is the individual’s best option? We denote that best option as:

\[
\text{argmax}_{j \in J_{it}} \{ \text{(20)} \text{ s.t. (21)} \} \tag{22}
\]

Second, in the "outer loop", optimal extensive-margin labor supply is given by an augmented cutoff rule conditioning on the job choice respectively optimal at the given prevailing wedge \( 1 - T_i \):

\[
\Rightarrow e^*_i = \begin{cases} 
0 & \text{if } (1 - T_i)y_{it}^j(1 - T_i) \lambda_{it} < v_{it} \\
1 & \text{if } (1 - T_i)y_{it}^j(1 - T_i) \lambda_{it} \geq v_{it}
\end{cases} \tag{23}
\]

Here, the extensive-margin reservation wedge is an implicitly defined fixed point, rendering the individual indifferent between working and not working, conditional on having (re-)optimized job
choice with respect to this to-be-determined reservation wedge:

\[ 1 - \tau_{it}^* = \frac{y_{it}^{j(1-\tau_{it}^*)}}{y_{it}^{j(1-\tau_{it}^*)} \lambda_{it}} \]  

(24)

These results also formally clarify that the job/hours choice under a prevailing wedge \(1 - \mathcal{T}_t\) hence need not be the relevant hours choice to pin down the reservation tax for employment, if job switching and hours reoptimization may occur towards the marginal job \(j^*(1 - \tau_{it}^*)\).

For instance, consider the specific case in which jobs differ by hours only, and potential income is \(y_{it} = h_{it} w_{it}\). With perfectly unrestricted hours choice and no nonconvexities, such as with standard MaCurdy (1981) utility specifications, we have \(h_{it}^{*1/\eta} = (1 - \mathcal{T}_t) \lambda_{it} w_{it}\). Hence, the reservation wedge \(1 - \tau_{it}^* = 1 - \mathcal{T}_t\) trivially tracks the prevailing wedge. That is, \(h_{it}^{j(1-\tau_{it}^*)} = 0\), which intuitively holds as the first infinitesimal fraction of an hour yields no first-order disutility of work but a first-order consumption gain – precluding a meaningful extensive margin. A version of this consideration will emerge in the Rogerson and Wallenius (2008) model we include in our model meta-analysis in Section 3.

**Non-Frischian Variation: Long-Run Changes or Hand-to-Mouth Consumers** The framework can also be generalized to study extensive-margin labor supply in response to non-Frischian shifts in taxes or wages, in response to which \(\lambda\) need not remain constant. Let \(1 - \mathcal{T}_{t,t+\Delta}\) denote a wedge perturbation lasting for duration \(\Delta\) (e.g. a discrete amount of periods, with \(\Delta = 0\) denoting a one-period deviation). Special cases are the one-period (or in continuous time, instantaneous perfectly transitory) shift \(1 - \mathcal{T}_{t,t}\), and a permanent wedge \(1 - \mathcal{T}_{t,t+\infty}\). Consider settings in which at least for the time interval of the perturbation \(\Delta\), the other parameters are stable. \(\lambda_{it}(1 - \mathcal{T}_{t,t+\Delta})\) denotes the budget multiplier, which in this non-Frischian context may be \((1 - \mathcal{T}_{t,t+\Delta})\)-dependent. The decision rule for period-\(t\) employment then is:

\[
\begin{align*}
\varepsilon_{it}^* &= \begin{cases} 
0 & \text{if } (1 - \mathcal{T}_{t,t+\Delta}) y_{it} \lambda_{it}(1 - \mathcal{T}_{t,t+\Delta}) < v_{it} \\
1 & \text{if } (1 - \mathcal{T}_{t,t+\Delta}) y_{it} \lambda_{it}(1 - \mathcal{T}_{t,t+\Delta}) \geq v_{it}
\end{cases}
\end{align*}
\]

(25)

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

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

(26)

Non-Frischian wedges \(1 - \mathcal{T}_{t,t+\Delta}\) with \(\Delta > 0\) capture two effects. First, the substitution effect going along the the reservation wedge distribution holding \(\lambda\) constant. This is the Frischian setting we have so far studied by assuming the period \(\Delta\) to be infinitesimal (or alternatively permitting the
lump-sum tax \( T \) to offset any wealth effects). Second, a wealth effect may also shift \( \lambda_{it}(1 - T_{it,t+\Delta}) \), generally working into the other direction.

Consider an application of our framework to the canonical example of balanced-growth (with \( \sigma = 1 \)) preferences separable and isoelastic in consumption \( u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} + v(h) \), and labor income as the only source of income, and with amortized (hence smoothed as consumption) present value of income \( Y_{it} \), for an infinitely-lasting wedge \( 1 - T_{it,t+\infty} \):

\[
e^{*}_{it} = \begin{cases} 
0 & \text{if } (1 - T_{it,t+\infty})y_{it}(1 - T_{it,t+\infty})^{-\sigma} \cdot Y_{it}^{-\sigma} < v_{it} \\
1 & \text{if } (1 - T_{it,t+\infty})y_{it}(1 - T_{it,t+\infty})^{-\sigma} \cdot Y_{it}^{-\sigma} \geq v_{it}
\end{cases}
\] (27)

For \( \sigma = 1 \), the employment policy is independent of the wedge: the substitution effect, movement along the aggregate labor supply curve, is perfectly offset by the wealth effect, which shifts the curve towards the original employment level, generating the extensive-margin analogue of constant inelastic long-run labor supply. The rest of the paper focuses on the short-run labor supply curve and Frischian variation.

Another application of this setting is the reservation wedge of households with borrowing constraints binding and hence hand-to-mouth consuming their (labor) income – i.e. incurring maximal wealth effects. This population essentially exhibits static labor supply (although a Frischian experiment can still be induced by leaving income constant due to a lump sum tax transfer \( T \)). Still, even then a Frischian variation can arise from leaving income constant, e.g., through an offsetting lump sum tax transfer \( T \).

### 2.5 Beyond the Spot Labor Market Benchmark

So far we have characterized desired labor supply in form of reservation wedges from the perspective of a spot labor market as well as "gross-of-frictions". Deviations from this benchmark will enter the micro wedges if the spot model is taken to labor market data that is in fact generated by non-spot or frictional labor markets – essentially a micro version of the aggregate wedge results presented in business cycle accounting (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009).

The framework accommodates these richer considerations. Broadly, we can capture such non-spot features and frictions in terms of an additional term – here at the example of \( \mu_{it} \) we place on the incentive side of labor supply – and then review specific examples below:

\[
e^{*}_{it} = \begin{cases} 
0 & \text{if } (1 - T_{it})y_{it} \lambda_{it} + \mu_{it}^{j} < v_{it} \\
1 & \text{if } (1 - T_{it})y_{it} \lambda_{it} + \mu_{it}^{j} \geq v_{it}
\end{cases}
\] (28)

The distinction between features and frictions is not clear-cut. For example, the skill loss models of Ljungqvist and Sargent (2006, 2008) act as adjustment costs from the perspective of a worker considering temporary nonemployment. Institutional arrangements limiting arbitrarily long and timed "vacations" out of long-term jobs act as adjustment cost. In our Frischian context, particularly when zooming into short periods, adjustment frictions may play a role in labor supply behavior.
In fact, as in our discussion in Section 2.4, intensive-margin adjustment frictions may explain the presence of indivisible labor and the extensive margin itself.

**Long-Term Jobs** The long-term nature of jobs may generate dynamic considerations in committing to a job. For example, Mui and Schoefer (2018) develop a framework of otherwise standard labor supply in which jobs are long-lasting and exogenously separating with probability $\delta$, building on matching models. The authors show that the wage concept can be cast as a standard spot condition augmented to reflect market-timing considerations, overall resulting in a "user cost of labor" (akin to Kudlyak (2014) for labor demand in a matching model setting). Reformulated in terms of wedges, the relevant term augmenting the benefit of the job is the continuation term for a worker considering committing to a long-term job today – of job type $y_{ts}^t$ (i.e. job index $j = t$) rather than waiting one period to take a job of type $y_{ts}^{t+1}$ (i.e. job index $j = t + 1$), where for simplification we assume that wages are fixed within a job:

$$
\mu_{it}^{\text{Long-Term Jobs}} = \mathbb{E}_t \sum_{s=t+1}^{\infty} \beta^{s-t} \lambda_{is}(1 - \delta)^{s-t}(1 - \tau_s) \left[ y_{it} - y_{is}^{t+1} \right]
$$

(29)

An analogous term could likely be constructed for the separation decision.

**Human Capital Accumulation** The model can also accommodate incentives to accumulate human capital on the job, as in Imai and Keane (2004) and relatedly in the skill-loss perspective of Ljungqvist and Sargent (2006, 2008). Now we adjust let a period’s potential earnings $y_{it} \left( \sum_{d=t-1}^{t-1} e_{id} \right)$ depend on the sum of employment in the last $T$ periods. As a result, the spot condition for labor supply includes an $\mu_{it}$ term that captures the forward-looking investment incentive for labor supply today.\(^8\)

$$
\mu_{it}^{\text{Human Capital}} = \mathbb{E}_t \sum_{s=t+1}^{t+T} (1 - \tau_s) \left[ y_{is} \left( \sum_{d=s-1}^{s} e_{id}^* + 1 \right) - y_{is} \left( \sum_{d=s-1}^{s-1} e_{id}^* \right) \right] e_{is} \lambda_{it}
$$

(30)

The extensive-margin choice and hence reservation wedge definition then follow the general logic.

**Frictional vs. Desired Labor Supply: Adjustment Costs and Frictions** So for we have characterized desired labor supply in form of "gross-of-frictions" reservation wedges from the perspective of a spot labor market.

One can alternatively define a "frictional" labor supply curve, i.e. a "net-of-frictions" reservation wedge distribution that takes into account market structures, such as for the labor market or other markets. Naturally, a definition respecting these frictions will yield different reservation wedges than one ignoring those frictions.

---

\(^8\)The original setting of Imai and Keane (2004) presents an hours-based rather than extensive-margin setting, and moreover consider a lifecycle setting. This specific intensive-margin setting could be again be featured with an hours-job choice set (yet would require some nonconvexities to generate an extensive margin, as discussed previously in the intensive-margin discussion).
To fix ideas, consider the discrete choice setup in which these costs are monetary as an ad-hoc adjustment lump-sum cost \( \lambda_{it} \cdot c_{it} \cdot \mathbb{1} (e_{it} \neq e_{i,t-1}) \), which may be time- and cross-sectionally varying, or alternatively enter the utility function directly. For a given transitory shift in the wedge, the presence of such a cost will shrink the set of individuals adjusting, and specifically generate policies – reservation wedges – that differ by previous employment status. As a result, a given employed worker may – gross of frictions – prefer to take off a month for a vacation in response to small wage changes. However, net of the adjustment costs required for transition in and out of nonemployment, the worker may in practice not act on this preference.

3 Meta-Analysis of Models Recast in the Reservation Wedge Framework

The behavior of aggregate labor supply at the extensive margin in any given model is fully characterized by the reservation wedge distribution. Models will exhibit the same labor supply behavior if and only if they are isomorphic in their reservation wedge distribution. We now present a meta-analysis in which we apply the reservation-wedge approach as a unifying bridge between structurally widely different labor supply blocks, proceeding in three steps:

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

M2 Compute its equilibrium distribution \( F_t(1 - \tau_{it}^*) \), and plot the implied aggregate labor supply curve.

M3 Compute the extensive margin labor supply elasticity at \( 1 - \tau_t \) as \( \left(\frac{1 - \tau_t}{F_t(1 - \tau_t)}\right)^2 \).

In each of our modeling exercises, we parameterize the model so that the steady state employment rate (the employment to population ratio) is \( F_t(1 - \tau_t) = 60.7\% \), an empirical target that reflects the U.S. 16+ civilian employment population ratio in February 2019 from the BLS (FRED series EMRATIO). The relevant parameters for our calibrated models in this meta-analysis are in Table 1.

We plot the associated labor supply curves in summary Figures 3 (zoomed out) and 4 (zoomed into the local behavior), and the implied arc elasticities in Figure 5, the central figures of this paper. We report descriptive statistics of the global labor supply curves in Table 2. In Table 3, we report local arc elasticities for various intervals around the prevailing aggregate wedge. (We normalize the prevailing aggregate wedge around 1 without loss of generality, to harmonize with our empirical wedge normalization. This implies that any prevailing taxes in the model are included in the reservation wedge measure, and the relevant wage in the reservation wedge is the after-tax wage.) We additionally plot model-specific reservation wedge distributions and supplementary items in Figure 1.

---

9 Rather than restricting to prime working age population, we target a fuller population definition because our models include explicit lifecycle perspectives such as labor force entry or retirement (Rogerson and Wallenius, 2008). Accordingly, our custom survey targets workers 18 and older without an upper age limit.
3.1 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 here explicitly index by $i \in [0, 1]$. The large household has a pooled budget constraint. 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 utilitarian household head assigns consumption levels and employment statuses to its individual members:

$$\max_{\{c_{it}, e_{it}\}, A_t} \sum_{t=0}^{\infty} \int_{0}^{1} \left[ u_i(c_{it}) - e_{it}v_{it} \right] g(i)di$$

s.t. $A_t + \int_{0}^{1} c_{it}g(i)di \leq A_{t-1}(1 + r_{t-1}) + \int_{0}^{1} (1 - \tau_i) y_{it}e_{it}g(i)di + T_t$

Full "insurance" implies that the marginal utility of consumption is optimally set homogeneous across households, equal to the multiplier on the pooled budget constraint:

$$\bar{\lambda}_t = \frac{\partial u_i(c_{it})}{\partial c_{it}} \forall i$$

hence eliminating $\lambda_{it}$ as a source of wedge heterogeneity even with heterogeneity in consumption utility $u_i(\cdot)$. Due to the spot nature of jobs, expectations and intertemporal aspects are fully subsumed in $\bar{\lambda}_t$.

First, we define the allocative micro reservation wedge in this large-household structure, here rendering the household head indifferent between sending member $i$ to employment rather than nonemployment (where we can index an individual $i$ by her disutility-earnings type $v_y(i)$):

$$1 - \tau_{it}^* = \frac{v_{it}}{\bar{\lambda}_t y_{it}}$$

$$= 1 - \tau_{v_y}^*$$

Optimal labor supply assigns each $i$ her employment status $e_{it} = e_{v_y}^* \in \{0, 1\}$ following the wedge cutoff:

$$e_{v_y}^* = \begin{cases} 
0 & \text{if } 1 - \tau_{v_y}^* > 1 - T_t \\
1 & \text{if } 1 - \tau_{v_y}^* \leq 1 - T_t 
\end{cases}$$

Second, we trace out the aggregate labor supply curve from the distribution of the reservation wedge, which in turn subsumes the detailed potential heterogeneity in wages and labor supply

---

10 We take a perspective, akin to Gali (2015), that the household head directly determines employment allocations. In Hansen (1985) and Rogerson (1988), employment can be assigned incentive-compatible lotteries. The set-up is equivalent to a representative household with utility function $U(c_t, E_t) = \log(c_t) - \pi E_t$, with intratemporal first-order condition $\bar{\lambda} \bar{w} = \pi$. 
disutilities. Employment $E_t$ is equal to the mass of workers with $1 - \tau^*_it \leq 1 - T_t$:

$$E_t = F_t(1 - T_t) = P(1 - \tau^*_it \leq 1 - T_t) = P\left(\frac{v_{it}}{y_{it}\lambda_t} \leq 1 - T_t\right) = P\left(\frac{v_{it}}{y_{it}} \leq (1 - T_t)\lambda_t\right)$$

$$= \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \mathbf{1}\left[\frac{v}{y} \leq (1 - T_t)\lambda_t\right] dG_t(v, y)$$

(37)

where $G_t(v, y)$ is the CDF of the joint distribution of $v$ and $y$. Below we review specific cases of this general class of labor supply block.

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

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

$$1 - \tau^*_it = 1 - \bar{\tau}_i = \frac{\bar{v}}{\lambda_t\bar{y}_t}$$

(39)

Second, the wedge distribution, which we plot in Figure 1 (a), is degenerate.

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

**Heterogeneity Only in Disutility of Labor** We now shut off heterogeneity in wages and only allow heterogeneity in the disutility of labor $v$ distributed according to CDF $G^v_t(v)$. First, each individual $i$ is now characterized by their type $v(i)$. Now, the household maximizes:

$$\max_{\{c_{vt}, e_{vt}\}, A_t} E_v \sum_{t=0}^{\infty} \int \left[ u(c_{vt}) - e_{vt}v_{vt} \right] g(v)dv$$

s.t. $A_t + \int e_{vt}g(v)dv \leq A_{t-1}(1 + r_{t-1}) + (1 - T_t)y_t \int e_{vt}g(v)dv + T_t$

(41)

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

$$1 - \tau^*_it = \frac{v_{it}}{y_{it}\lambda_t}$$

$$= 1 - \tau^*_vt$$

(42)

(43)

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

$$E_t = F_t(1 - T_t) = P(1 - \tau^*_it \leq 1 - T_t) = P\left(\frac{v_{it}}{y_{it}\lambda_t} \leq 1 - T_t\right) = G^p_t\left(1 - T_t\right)$$

(44)
Alternatively, pointwise optimization would lead to a disutility cutoff rule $v_{it}^* = (1 - \tau_t)\bar{y}_t \bar{\lambda}_t$: $v_{it} \geq v_{it}^*$ types work, $v_{it} < v_{it}^*$ types stay at home.

Third, the elasticity is given by
\[
\left(1 - \tau_t\right) g_i^v \left(\frac{1 - \tau_t}{\bar{y}_t \bar{\lambda}_t}\right) \left[1 - G_i^v \left(\frac{1 - \tau_t}{\bar{y}_t \bar{\lambda}_t}\right)\right].
\]

MacCurdy (1981) Preferences: Ad-Hoc Constant Frisch Elasticity A common representative household setup (pooled budget constraint and homogeneous wages) applies the familiar isoelastic intensive-margin MacCurdy (1981) preferences to the extensive margin:
\[
\frac{C_i^1 - \sigma}{1 - \sigma} - \Psi \frac{F_i^{1 + 1/\eta}}{1 + 1/\eta}
\] (45)

We now reverse-engineer a distribution of disutility $G_i^v(v)$ that delivers this labor supply specification. The micro wedge is again given by (42). Suppose $v$ follows a power distribution $G_i^v(v) = \left(\frac{v}{v_{\text{max}}}\right)^{\alpha_v}$ with shape parameter $\alpha_v$ over support $[0, v_{\text{max}}]$. Then, aggregate employment is (where, building on Section 2, assuming positive nonemployment by all types):
\[
E_t = F_t(1 - \tau_t) = P\left(\frac{v_{it}}{\bar{y}_t \bar{\lambda}_t} \leq 1 - \tau_t\right) = G_i^v \left(1 - \tau_t\right) \bar{y}_t \bar{\lambda}_t = \left(\frac{1 - \tau_t}{\bar{y}_t \bar{\lambda}_t} \frac{v_{\text{max}}}{v_{\text{max}}^\alpha_v}\right)
\] (46)

The wedge distribution then too is a power distribution inheriting shape parameter $\alpha_v$—giving the constant extensive margin Frisch elasticity:
\[
\epsilon_{E_t,1-\eta} = \frac{(1 - \tau_t)F_t(1 - \tau_t)}{F_t(1 - \tau_t)} = (1 - \tau_t)^{\alpha_v} \left(\frac{1 - \tau_t}{\bar{y}_t \bar{\lambda}_t} \frac{v_{\text{max}}}{v_{\text{max}}^\alpha_v}\right)^{\alpha_v} = \alpha_v
\] (47)

To show that this household can be written as a representative household with a MacCurdy preference structure, consider a rearrangement the aggregate labor supply curve (46):
\[
v_{\text{max}} E_t^{1/\alpha_v} = (1 - \tau_t) \bar{y}_t \bar{\lambda}_t
\] (48)

which is the first order condition of objective function (45) for $\eta = \alpha_v$ and $\Psi = v_{\text{max}}$.

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 $E_t = G^v(\mu(E_t)) = \left(\frac{\mu(E_t)}{v_{\text{max}}^{\alpha_v}}\right)^{\alpha_v}$, which gives quantile function $\mu(E_t) = v_{\text{max}} E_t^{1/\alpha_v}$, and hence:
\[
V(E_t) = \int_0^{\mu(E_t)} v dG^v_i(v) = \frac{\alpha_v}{v_{\text{max}}^{\alpha_v}} \int_0^{\mu(E_t)} (v)^{\alpha_v} dv = \frac{\alpha_v}{v_{\text{max}}^{\alpha_v}} \frac{\alpha_v}{1 + \alpha_v} \left[\mu(E_t)\right]_0^{\mu(E_t)} = v_{\text{max}} E_t^{1 + 1/\alpha_v}
\] (49)
which again mirrors MaCurdy utility function (45) for \( \eta = \alpha_v \) and \( \Psi = \bar{\lambda} \).

In Figure 1 (b), we plot the density of reservation wedges for a MaCurdy model with potential earnings \( \bar{y} \) and marginal utility of consumption \( \bar{\lambda} \) are normalized to one, and the Frisch elasticity is 0.32. The maximum micro labor supply disutility is set to 0.607\(^{-1/0.32} \) to set the equilibrium employment rate at 60.7%.

**Heterogeneous (Sticky) Wages and MaCurdy: Gali (2015)** The New Keynesian model of Gali (2015) additionally features wage heterogeneity. Individuals are a unit square indexed by \((l, s) \in [0, 1] \times [0, 1] \). \( l \) denotes the type of labor, paid wage \( y_{lt} \), which may diverge across types due to wage stickiness. \( s \) indexes labor disutility, \( s^{1/\eta} \). The household head maximizes:

\[
\max_{c_t, \{E_{lt}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^{-t} \left( \frac{c_t^{1-\sigma} - 1}{1 - \sigma} - \Psi \int_0^1 \int_0^{E_{lt}} s^{1/\eta} \ ds \ dl \right)
\]

s.t. \( A_t + \int_0^1 c_{lt} \ dl \leq A_{t-1}(1 + r_{t-1}) + (1 - T_t) y_{lt} E_{lt} + T_t \)

where the \( l \)-specific employment rate is \( E_{lt} = \int_0^1 e_{lt} \ dl \).

First, we define the micro reservation wedge. An individual \( i \) is fully characterized by her type \((ls)(i)\):

\[
1 - \tau^{*}_{slt} = \frac{\Psi^{s^{1/\eta}}}{y_{lt} \bar{\lambda}_t}
\]

Second, the distribution of \( 1 - \tau^{*}_{slt} \) is (building on Section 2, assuming some nonemployment within each wage-type \( l \)):

\[
F_l(1 - T_t) = P \left( \frac{\Psi^{s^{1/\eta}}}{y_{lt} \bar{\lambda}_t} \leq 1 - T_t \right) = \int_0^1 \left( \frac{(1 - T_t) y_{lt} \bar{\lambda}_t}{1/\eta} \right)^{\eta} \ dl = \frac{(1 - T_t)}{\Psi \left( \int_0^1 y_{lt}^{\eta} \ dl \right)^{1/\eta} \bar{\lambda}_t}^{\eta}
\]

which is a power distribution with maximum \( \Psi \left( \int_0^1 y_{lt}^{\eta} \ dl \right)^{1/\eta} \bar{\lambda}_t \) and shape parameter \( \eta \).

Third, again as in Section 2 the elasticity is again precisely \( \eta \).\(^{11}\)
3.2 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 individual budget constraints potentially facing incomplete markets. In these class of models, heterogeneity in productivity/skills, asset endowments or tastes can generate heterogeneity in $\lambda_{it}$.

A useful classification of heterogeneity, for a given object, is whether it is permanent or transitory.

3.2.1 Permanent Heterogeneity

We start with a note showing that permanent heterogeneity can generate trivial reservation wedge dispersion (doing so in continuous time for a continuous lifecycle labor supply choice derived below). Consider a household that may differ in disutility $v_i$, initial endowments $a_{0i}$, or wages $w_i$ (or consumption tastes $u_i(c_{it})$), with stable interest rates $r = \rho$ and no borrowing constraint, such that we obtain a simple lifecycle budget constraint:

$$\max_{c_{it}, e_{it}, a_{it}} \mathbb{E}_0 \int_{t=0}^{\infty} e^{-\rho t} \left[ u_i(c_{it}) - v_i e_{it} \right] dt$$

s.t. $\dot{a}_{it} = (1 - T_t)y_i e_{it} + ra_{it} - c_{it} + 1(t = 0) \cdot a_{0i} \forall t$ (56)

$$\Leftrightarrow \int_{t=0}^{\infty} e^{-\rho t} c_{it} dt = \int_{t=0}^{\infty} e^{-\rho t} (1 - T_t)y_i e_{it} dt + a_{0i}$$

First, this household’s labor supply choice is an employment policy $e_{it}^*$ characterized by a constant reservation wedge:

$$1 - \tau_{it}^* = \frac{v_i}{\lambda_i y_i}$$

$$= 1 - \tau_i^*$$

Second, we move to the distribution of the wedges (labor supply curve):

$$F(1 - T_t) = \int_i 1[1 - \tau_i^* \leq 1 - T_t] g(i) di$$

(60)

The constant wedge structure implies that for a given prevailing wedge $1 - T_t$, there are three wedge regions. Two inframarginal regions denote workers that do not work even for (small) wedge increases, as well as those that always work even for small wedge 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 wedge declines, and all move into employment for small wedge increases. (curve) is:

$$F_i(1 - T_t) = P \left( s \leq \left( \frac{(1 - T_t) y_i \lambda_i}{\Psi} \right)^\eta \right) = \int_0^1 \min \left\{ \left( \frac{(1 - T_t) y_i \lambda_i}{\Psi} \right)^\eta, 1 \right\} dl$$

mirroring the expression in Equation (15).
Hence, if there is a mass point of these marginal individuals at the prevailing wedge, the labor supply curve will exhibit an infinite Frisch elasticity at the extensive margin.

Interestingly, with atomistic agents with separate budget constraints, a mass point of marginal set of workers endogenously emerges for a large set of the workforce (mirroring intuitions from labor indivisibility with homogeneity (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. $\int_0^\infty \phi_{it} \, dt = l_i$, following the time-averaging approach of Ljungqvist and Sargent (2006).

Permanent heterogeneity in tastes, endowments or wages affects the average probability, yet at each given point in time, these "interior" households are exactly on the margin. A natural question is how large this local mass of marginal actors is. The model implies that it makes up one minus the fraction of households that either never or always work – implying that this class of model is an empirically uninteresting case given the effectively infinite Frisch elasticity.

We therefore move to more realistic models with time-varying heterogeneity below, starting with the stochastic wages case in Section 3.2.2, and then moving to deterministically evolving age profiles in wages in Section 3.3.

### 3.2.2 Time-Varying Heterogeneity: Stochastic Wages (Huggett, 1993)

Below, we consider the popular case where the deep heterogeneity between households arises from uninsured stochastic shocks to labor market income in the form of productivity. Households can only borrow and save in one asset, and face a borrowing constraint. Incomplete financial markets mean that idiosyncratic productivity realizations pass through into the model agents’ individual budget constraints, and therefore into heterogeneity in consumption/savings policies, assets, consumption, and $\lambda_{it}$.

Specifically, we introduce indivisible labor into the model of Huggett (1993). There is a continuum of infinitely lived individuals, in discrete time. Assets held by any given individual $i$, which are denoted by $a_{it}$, earn interest (or incur debt, in the case of $a_{it} < 0$) at rate $r_{it}$. In each period, an individual chooses consumption $c_{it}$ and labor supply $e_{it}$. The individual’s labor supply choice is between working and not working; that is, $e_{it} \in \{0, 1\}$. If the individual chooses to work, she receives potential earnings $y_{it}$, following an exogenous Markov process. If the individual does not work, they receive an unemployment benefit level $b$ for that period. The household maximizes separable preferences, subject to budget constraint and borrowing limit $a < 0$, with discount factor $\beta \leq 1$:

$$\begin{align*}
\max_{c_{it}, e_{it}, a_{it}} & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[ c_{it}^{1-\sigma} \frac{1-\sigma}{1-\sigma} - \bar{v} e_{it} \right] \\
\text{s.t.} & a_{i,t+1} = (1 - T_i) y_{it} e_{it} + (1 + r_i) a_{it} - c_{it} \quad (62) \\
& a_{it} \geq a \quad (63)
\end{align*}$$

For the purposes of demonstrating our framework, we ignore general equilibrium and solve for the consumption and labor supply rules, as well as the joint distribution of assets and productivity...
states for a given interest rate $r$.

We calculate each individual’s reservation wedge, our first step. Since individuals of the same asset and productivity types face the same optimization problem, we can index individuals by asset and productivity:

$$1 - \tau_{ay}^* = \frac{\bar{v}}{\lambda_{ay}y}$$

(64)

Second, we can calculate the distribution of the reservation wedges from the joint distribution of assets and productivity levels. The CDF of the reservation wedges yields our labor supply curve:

$$F(1 - T) = \sum_{y \in Y} \int_{a_2}^{\infty} 1[1 - \tau_{ay}^* \leq 1 - T] g(a, y) da$$

(65)

where $g(a, y)$ is the equilibrium density of individuals with asset level $a$ and potential wage $y$.

**Two-State Income Process** We start with a two-level 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 twofold, first to illustrate that the aggregate extensive margin labor dynamics quickly become complex already with only two wage states – and how our framework can help make sense of an otherwise obscure labor supply curve—and second to demonstrate the intuition behind the shape of the labor supply curve in this type of model. The parameters are not picked to match any empirical moments, except that the equilibrium employment rate is equal to 60.7% when $1 - T_t = 1$.\(^{12}\)

We plot the distribution of the wedges in Figure 1 (c).

Figure 1 Panel (a) plots the reservation wedge as a function of assets, separately by wage. For both wage levels, $1 - \tau_{ay}^*$ is increasing in assets, since $\lambda_{ay} = c^{a-y}$ is decreasing in assets. As expected, $1 - \tau_{a,y_2}^* < 1 - \tau_{a,y_1}^*$ for any given asset level $a$, since higher wages raise consumption and the opportunity cost of not working. For $1 - T_t = 1$, all high earners work, regardless of their asset holdings ($1 - \tau_{a,y_2}^* < 1 \forall a \geq \bar{a}$). Low earners work if assets (and consumption) are low, but above an asset threshold $a_{y_1}^*$, s.t. $1 - \tau_{a,y_1}^* = 1$ prefer nonemployment.

The implied labor supply curve is plotted in Figure 1 Panel (b), and exhibits complex behavior even with only two wage types, due to the asset distribution. When the labor wedge is at $1 - T_t = 1$, the marginal worker is a low-wage worker with a relatively high asset level. As $1 - T_t$ 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 (echoing a logic in (Hansen, 1985; Rogerson, 1988)) at that point. As $1 - T_t$ falls further, all low-wage individuals become nonemployed, and the marginal worker is now a high-income earner.

\(^{12}\)For this example, $r = 0.03$, $a = 2$, $\rho = 0.05$, $\lambda_{12} = 0.1$, and $\lambda_{21} = 0.2$ with earnings levels 0.15 and 0.0797, $\bar{v} = 3.0$, $b = 0.06$ (a nonemployment subsidy we feature in this toy example only), and the asset space is -0.02 and 0.75.
**Realistic Income Process** We now choose a realistic discrete Markovian income process, specifically to follow the income process used in Kaplan, Moll, and Violante (2018). The computational details are again described in Appendix Section C.2, and the parameters are in Table 1.

As the histogram and the summary statistics show, the distribution of the reservation wedges in the heterogeneous agent model with a borrowing constraint and a realistic earnings process generates a small local Frisch elasticity. For a 0.01 wedge perturbation, the arc elasticity is 0.72 on the high side for reductions in the return to working, but much smaller increases for increases (0.18). For large perturbations towards 0.10, the elasticities quickly settle in below 0.5. These Frischian properties, as is made obvious in the reservation wedge formulation, inherits the joint distribution of $\lambda$ and $y$. The implied labor supply curve of course dramatically differs from the two-state model, and hence is connected to the earnings process (and the associated consumption/savings behavior). Next, we decompose the heterogeneous agent labor supply curve into these two components by shutting off the heterogeneous in $\lambda$.

**The Role of Incomplete Financial Markets** The model features heterogeneity in $\lambda$ arising from the idiosyncratic evolution of wages and hence wealth. That link crucially relies on incomplete markets: if (risk-averse) agents could hedge their income risk by trading income-state contingent claims, they would neutralize the effects of stochastic evolution of productivity on $\lambda$, generating homogeneity in $\lambda$. The resulting reservation wedges, and hence the aggregate labor supply curve, of heterogeneous agent economies with complete markets then mimic those of the large representative full-insurance household setup.

We illustrate the consequences of incomplete markets for aggregate labor supply in Figure 1 Panel (g) (but for scale reasons not in the full Figures 3–5), where we additionally trace out the reservation wedge distribution that shuts off heterogeneity in $\lambda$ as in a complete-markets setting. We set $\lambda_t$ to generate the same initial employment rate, and hence the distribution of the wedge reflects solely heterogeneity in potential earnings $y$:  

$$1 - \tau_y = \frac{\bar{\sigma}}{\lambda y}$$  

The (log) wedge distribution inherits the stationary (log) earnings distribution arising from the discrete Markov process, and hence is choppier than the incomplete-markets setting. The scarce

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13 We follow a two-step process for choosing the income levels and the transition probabilities. In the first step, we simulate the (potential) earnings process $y_t$ from Kaplan, Moll, and Violante (2018), which is:  

$$y_t = y_{1t} + y_{2t}$$  

where each component $y_t$ follows a "jump-drift" process; that is:  

$$dy_{jt} = -\beta_j y_{jt} dt + dJ_{jt}$$  

where $dJ_{jt}$ captures "jumps" that arrive at Poisson rate $\lambda_j$ and are drawn from a mean-zero normal distribution. This process is set in continuous time; we discretize it by simulating 2,000 quarters worth of 100,000 samples of this earnings process using the parameters in Kaplan, Moll, and Violante (2018). In the second step, we use the extended Tauchen process described in Civale, Diez-Catalan, and Fazilet (2016) to choose the levels and the associated transition probabilities of the income process. We use 10 income states, which we find matches the income moments well.
income state space around the marginal wedge also prohibits us from plotting this curve into our full Figures Figures 3–5. (A continuous time approach may similarly smooth out the earnings and hence wedge distribution.)

The comparison highlights the stabilizing role of incomplete markets in shaping extensive-margin labor supply behavior at micro and macro levels. The curve with homogeneous $\lambda$ is dramatically steeper in the low end of the distribution. This is because the joint distribution of $\lambda$ and $y$ in the incomplete markets setup implied a negative covariance between the two: agents in low productivity states have high shadow value of income, and hence are (more) desperate to work than their better-earning peers. Absent this negative covariance between productivity and the shadow value of income, as with full insurance, the aggregate labor supply curve is dramatically more elastic. This intuition is specific to the extensive margin and would not be present with setups featuring only intensive margin choices (e.g., Domeij and Floden, 2006; Kaplan, Moll, and Violante, 2018). The reservation wedge framework may offer a useful diagnostic tool to uncover and study macro labor-supply implications through the resulting joint distribution of $\lambda$ with the income process, entailed (perhaps otherwise inadvertently) by richer setups of financial markets, such as variation in the liquidity of assets (e.g., as in Kaplan, Moll, and Violante, 2018).

3.3 Intensive and Extensive Margins, and Lifecycle Dynamics

Rogerson and Wallenius (2008) As laid out in the general case in Section 2, allowing for intensive margin hours choices preserves the reservation wedge framework. A leading model that incorporates both an intensive margin choice and delivers extensive margin movements is Rogerson and Wallenius (2008) (RW), which also features rich lifecycle patterns. We discuss our solution to the Rogerson and Wallenius (2008) model and our choice of parameters in Appendix Section C.1. The calibration process mostly follows Chetty, Guren, Manoli, and Weber (2012), except that we calibrate the equilibrium employment rate to be 60.7%.

The overlapping generations economy has a unit mass of individuals born at every instant, who live between age $a \in [0, 1]$. Wages $w_a$ are age-specific, generating lifecycle aspects. (In the Rogerson and Wallenius (2008) model, the wage will be a triangular, single-peaked function of age.) Individuals choose consumption, whether to work, and the numbers of work hours:

$$\max_{c_a, h_a} \int_{a=0}^{1} e^{-\rho a} \left[ u(c_a) - v(h_a) \right] da$$

s.t. $$\int_{a=0}^{1} e^{-\rho a} c_a = \int_{0}^{1} e^{-\rho a} y_a(h) da$$

Disutility is MaCurdy at the intensive margin, with $v(h_a) = \frac{h_a^{1+1/\gamma}}{1+1/\gamma}$. The extensive margin choice in this model arises from a nonconvexity in form of fixed hours cost, such that only labor hours above $h$ are productive and earn wage $w_a$:

$$y_a(h_a) = w_a \max\{ h_a - h, 0 \}$$
In the absence of this fixed cost, the marginal disutility from working at $h = 0$ hours is zero, and so all individuals would work strictly positive hours, regardless of age as long as wages are positive – eliminating the extensive margin as in the intensive-margin job choice in Section 2.4.

First, we define the individual-level reservation wedge, here specified for an individual at age $a$, implicitly defined as a fixed point, as in our general job-choice case in Section 2.4. In RW, the discount rate is zero and individuals can save and borrow at zero interest rate, implying $\lambda_a = \bar{\lambda} \forall a$. In what follows in the main text, we normalize $\lambda$ to 1, a simplification inconsequential for our Frischian experiments. In our simulation, the consumption part of the utility function is CRRA. $h^*_a(1 - T)$, the intensive margin choice at age $a$ given wedge $1 - T$, is given by $(1 - T) w_a = \Gamma h^*_a 1/\gamma$.

In the Rogerson and Wallenius (2008) model, we can then solve for the age-specific reservation wedge explicitly:

$$1 - \tau^*_a = \frac{\nu(h^*_a(1 - \tau^*_a))}{\lambda_a y_a(h^*_a(1 - \tau^*_a))} = \frac{\nu\left(\frac{(1-\tau_a)w_a}{1-\tau_a}\right)^\gamma}{w_a \left(\frac{(1-\tau_a)w_a}{1-\tau_a} - h\right)} = \frac{\Gamma \left(h(1/\gamma + 1)\right)^{1/\gamma}}{w_a} \tag{72}$$

The only heterogeneous element of the wedge is the wage: individuals work when the (hourly) wage is above threshold $w^*$. Also, setting $h = 0$ nests the MaCurdy intensive-margin-only setting, with $1 - \tau^*_a = 0$ for all workers and ages.

Second, in Figure 1 (e) and (f), we again compute the distribution of reservation wedges, thereby tracing out the aggregate labor supply curve:

$$F(1 - T) = P\left(\frac{\Gamma \left(h(1/\gamma + 1)\right)^{1/\gamma}}{w_a} \leq 1 - T\right) = P\left(\frac{1}{w_a} \leq \frac{1 - T}{\Gamma \left(h(1/\gamma + 1)\right)^{1/\gamma}}\right) \tag{73}$$

clarifying that here the wedge distribution inherits that of $1/w_a$, a feature we discuss in detail below. (For example, if $1/w_a$ were power-distributed, the Rogerson and Wallenius (2008) model would again exhibit a constant Frisch elasticity, an application of our constant elasticity cases from Section 3.) In the Rogerson and Wallenius (2008) model, $w_a$ is piece-wise linear (a single-peaked triangle in age), so the wage distribution is given by the age distribution.

Third, we compute the aggregate extensive-margin elasticity. We then numerically approximate the local density using the simulated discretized distribution of $1 - \tau^*_a$ (details in Appendix C.1), from which we calculate the Frisch elasticity, which is 2.87 in this particular calibration. In principle, the reservation wedge distribution could permit us to obtain the elasticity analytically.\(^\text{14}\)

\(^\text{14}\) Our method complements the construction of the Rogerson and Wallenius (2008) model’s Frisch elasticity by Chetty, Guren, Manoli, and Weber (2012), who simulate a small, short-lived once percentage-point tax change in the calibrated model. (They then compare the model output to empirical Frisch-like quasi-experiments (an income tax holiday (studied in Bianchi, Gudmundsson, and Zoega, 2001) and targeted tax incentives to work (Meyer, 2010; Card and Hyslop, 2005).) While a short-lived tax change may affect consumption, our method isolates a strict Frisch elasticity. Besides permitting visualization and characterization of the full curve, it is perhaps also much simpler to numerically approximate the wedge distribution than to simulate a temporary tax change, which requires repeatedly solving the
The Role of the Intensive Margin  Figure 1 (f) additionally plots as a dashed line the labor supply curve of a variant in which the hours choice is held fixed at (optimally chosen) pre-experiment levels – hence isolating the extensive margin. The solid line plots the RW extensive-margin labor supply curve that additionally permits intensive margin reoptimization in response to wedge changes. This curve "envelopes" the fixed-hours one: for non-infinitesimal wedge shifts, extensive margin adjustment is attenuated. Intuitively, intensive margin reoptimization weakly raises the return of work. As a result, the flexible-hours extensive employment curve always exceeds the fixed-hours analogue.

The Role of the Wage-Age Profile  Equation (73) clarifies that the labor supply curve derives its shape from the wage-age profile, since the reservation wedge for an individual of age $a$ depends on the age-specific wage $w(a)$. The marginal individuals are just young (or old) enough for their productivity to warrant "entering the labor force" (or "retiring"). Since the age distribution is uniform, the slope of $e(a)$ around the cutoff ages then determined the extensive-margin Frisch elasticities, with a steeper (flatter) $e(a)$ at those points yielding a lower (higher) elasticity of labor supply.

Chetty, Guren, Manoli, and Weber (2012) used the Rogerson and Wallenius (2008) model as an example of a macroeconomic model with indivisible labor featuring inherently large labor supply elasticities. The labor supply elasticity depends on the shape of the wage-age profile at the cutoff ages. Our framework suggests the possibility that the particular wage-age profile imposed may underlie this result. At least locally, one could reverse-engineer any particular extensive margin Frisch elasticity by retaining the calibrated productivity profile $e(a)$, but tilting the shape of $e(a)$ in an arbitrarily small region around the cutoff ages. This modification would largely preserve the labor supply choices of the individual except for that region around the cutoff points, and would still hit the lifetime calibration targets.

To demonstrate the flexibility of the Rogerson and Wallenius (2008) model, we conduct another exercise in which we also change the level of peak lifetime productivity, while targeting a lower extensive margin Frisch elasticity. The parameter choices and targets are in Table 1, and we plot the labor supply curves of both calibrations in Figure 1. We can target a lower Frisch elasticity in the model by allowing a higher level of peak lifetime productivity and a steeper slope of the wage-age productivity gradient. This change means that the density of individuals with a reservation wedge in a given neighborhood around 1.0 is lower, and so the local Frisch elasticity of extensive margin labor supply is lower. Quantitatively, the calibration implies a local Frisch elasticity (using an arc from 0.995 1.005) of only 1.6 – cutting the baseline model’s Frisch elasticity of 2.9 by nearly half. Here we have limited the functional form of the wage-age function to piecewise linear, but one could also choose different functional forms of the productivity process and calibrate a Rogerson-Wallenius model to lower Frisch elasticities.

model for each generation.
4 Empirical Reservation Wedges

Having robustly formulated the theoretical extensive-margin aggregate labor supply curves as the reservation wedge distribution, the natural next object of interest is the shape of the empirical analogue. We next show that the reservation wedge can be directly measured in household survey data, permitting us to construct the empirical curve. We implement this reservation wedge elicitation by running a custom survey in the United States. We thereby follow the empirical analogues of our three model steps:

**E1** Elicit the individual-level reservation wedge \(1 - \hat{\tau}^*_it\).

**E2** Construct and plot CDF \(F_t(1 - \hat{\tau}^*)\), the aggregate labor supply curve.

**E3** Back out the extensive margin labor supply elasticities from the CDF.

4.1 Measuring the Wedges

Our primary data set is a custom survey of U.S. households comprising all labor force segments, of which we ask a tailored question eliciting directly their idiosyncratic reservation wedges.

**Ideal Measure of the Reservation Wedge** To fix ideas, we start with the ideal measure, and then clarify how we implement this question in the survey. The ideal survey question closely mirrors its formal theoretical definition, for the employed [nonemployed] worker and hence abstracts from potential frictions in such choices to elicit desired labor supply:

You are currently [non-]employed. Suppose the following thought experiment: you (and only you) receive a 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 between not working for this period and working (at whichever job would be your best choice at that given tax [subsidy] rate)?

By invoking an additional tax on top of a potentially prevailing one \((1 - \hat{\tau}^*_it)(1 - T_t)\), the answer would also automatically target \(1 - \hat{\tau}^*_it = 1\) as the cutoff for the marginal worker (i.e. is centered around one), and hence does not require a stance on empirical prevailing wedges \(T_t\):

\[
(1 - \hat{\tau}^*_it)(1 - T_t)y_{it} \lambda_{it} = v_{it} \tag{74}
\]

\[
\Leftrightarrow 1 - \hat{\tau}^*_it = \frac{v_{it}}{(1 - T_t)y_{it} \lambda_{it}} \tag{75}
\]

\[
= \frac{1 - \tau^*_it}{1 - T_t} \tag{76}
\]

Our design differs from the reservation wage questions that have long been asked to *unemployed* searchers. First, one innovation of our question is to elict it from all three labor force segments of the population. Second, we ask what percentage shift in the wage would render an individual
marginal. Third, we explicitly focus on a Frischian neoclassical setting rather than a sequential search model with long-term jobs. Fourth, the ideal question permits job switching and reoptimization (see Section 2.4).

4.1.1 Custom Survey of U.S. Households

Survey Implementation In practice, we translate the aforementioned ideal question into three variants, routed by labor force status. Given that we are to our knowledge the first to elicit the reservation wage/wedge off non-job-searchers, we present our three questions below. These questions are results of prolonged piloting and iterations with survey administrators, leading us to formulate rather concrete scenarios. Throughout, we keep the frequency of the Frischian wage change constant at one month. Feedback from our pilots also led us to present a "job-constant" perspective (at the prevailing wage), rather than explicitly alluding to the possibility of job switching or hours adjustments.

Data: Custom Reservation Wedge Survey We implement this approach with a tailored survey question 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 program, and aimed to cover a representative cross-section of U.S. households. We also obtain additional demographic variables permitting us to study the covariates of the wedges and to conduct subsample analyses.

Question for the Employed The question presents the employed worker with a scenario forcing her to trade off the level of reduced earnings with an indifferent point of employment vs. nonemployment. To keep the scenario sufficiently realistic, we allude to a vacation. 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 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.

\[ \lambda_{it} \equiv v_{it,1-T_i}, \]

\[ 1-T_i \]

\[ \lambda_{it} \equiv v_{it,1-T_i}, \]

\[ 1-T_i \]

\[ \lambda_{it} \equiv v_{it,1-T_i}, \]

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\[ \lambda_{it} \equiv v_{it,1-T_i}, \]

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\[ \lambda_{it} \equiv v_{it,1-T_i}, \]

\[ 1-T_i \]

\[ \lambda_{it} \equiv v_{it,1-T_i}, \]
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**  For the unemployed, while reservation wedge questions have a long history in empirical research, our challenge was to keep the answer comparable to the Frischian perspective presented to the other respondents. We therefore induce the scenario at 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:

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.

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. They are the ones least likely to consider a scenario of taking up employment, in some cases perhaps containing the disabled or those without possibility of employment. Yet of course there are marginal workers in this set, given the fluctuations in the labor force participation rate as well as individual-level transitions in and out of this state. Ex ante we naturally do not know how many and who of the out of the labor force are at the margin, hence we ask the question of all out of the labor force, while explicitly warning this sample about the hypothetical nature of the experiment. We also highlight the possibility to respond with a very high number if the respondent finds an employment scenario unappealing even at a high wage. Another distinction is that we here require a subsidy since by declaration 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. We implement this scenario with the most concrete and plausible real-world 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 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
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.

4.2 Results: The Empirical Aggregate Labor Supply Curve

Distribution of the Reservation Wedge We present histograms of the empirical reservation wedges from the reported reservation wedges in the NORC survey data in the histogram in Figure 2 Panel (a), where gray (white) [black] bars denote observations from the sample that are employed (unemployed) [out of the labor force]. Table 2 reports the summary statistics of the distribution of the log reservation wedge. Table 3 clarifies (left column, entries for "U.S. data") the share of the population in a given distance from the cutoff for indifference between employment and nonemployment (a wedge value of 1, such that the log of the wedge is zero).

The empirical histogram of the wedge distribution exhibits a spike around one – where the reservation wage is close to the individual’s actual wage i.e. the location of marginal workers. Yet, the distribution is widely dispersed, implying that the typical worker is inframarginal in that she derives considerable worker surplus from employment and with tremendous heterogeneity in worker surplus.

Aggregate Labor Supply Curves As in the model meta-analysis, we aggregate the micro wedges into a cumulative distribution function. Figure 2 Panel (b) plots the CDF of the empirical distribution of the empirical reservation wedges from the NORC survey data, with the cumulative distribution function $F(1 - \tau^*)$ on the x-axis, and the log of the wedge on the x-axis $1 - \tau^*$. To facilitate visual inspection with regards to implied elasticities, we take logs of both axes, thereby plotting desired log($E^*$) against log($1 - T$).

Implied Arc Elasticities Complementing this interpretation, in Table 3, we additionally report local arc elasticities of the empirical labor supply curve given by Equation (8) defined in Section 2.3:

$$
\varepsilon_{E,(1-T)\rightarrow(1-T')} = \frac{F(1 - \tau') - F(1 - \tau)}{F(1 - \tau)} \left[ \frac{(1 - \tau') - (1 - \tau)}{1 - \tau} \right]
$$

To detect potential non-constant elasticities or asymmetries, we construct a set of arc elasticities using varying sizes of wedge deviations (upwards, downwards, and equally spaced around zero).

Inspecting the empirical CDF, we find a local Frisch elasticity of desired extensive-margin labor supply of around 3. This result is due to the concentration of marginal workers, mirroring, in an attenuated way, intuitions from models of homogeneity (Hansen, 1985).

Nonconstancy and Asymmetries in the Arc Elasticities However, going away from the local context, large changes in the return to working imply dramatically different – lower – arc elasticities.
That is, while locally an increase of the return to working crowds in nearly 2.26 percent of the employment rate around a 1% change in the wedge (implying an elasticity of \( \frac{\Delta \text{Emp}}{\Delta \text{Pop}} = 0.01 = \frac{2.26}{0.01} = 3.72 \)), the implied elasticity falls to 0.96 when considering a larger increase in the return to working of around 10%. The reduction in the return to working implies the same nonconstancy of the arc elasticity, falling from 5.66 for the 1% interval to 1.68 for the 10% drop in the return to working.

In Figure 5, we illustrate the non-constant elasticities by plotting the data points underlying yet dividing each implied desired employment deviation by the associated wedge deviation. The curve clarifies that elasticities are largest around the baseline prevailing wedge, and decrease in either direction of the curve.

Taking the empirical benchmark at face value, Figure 5 suggests that constant extensive margin elasticities do not provide a realistic description of the real-world aggregate labor supply curve.\(^{18}\)

In Figure 5 has two potential implications. First, for researchers aiming to use constant-elasticity setups nevertheless, one insight may be that no single existing model fits the empirical curve globally. For small perturbations in the incentives to work (as implied by marginal labor product shifts in business cycle models with the labor market clearing), setting a rather high elasticity may be more warranted than when aiming to make predictions about temporary work subsidies the the labor-supply effects of large real-wage devaluations.

Second, a potential methodological implication is that the extrapolation from arc elasticities identified off large binary variation in the return to working to a global constant elasticity may mask large local elasticities guiding labor supply to small shocks around steady state. To illustrate this point, we discuss one particularly compelling quasi-experimental settings that changed the net of tax rates from which Chetty, Guren, Manoli, and Weber (2012) infer arc elasticites at the extensive margin. The variations in the net-of-tax rate, comparable to our prevailing aggregate labor wedge \( 1 - \tau \), is fairly transitory, hence plausibly yielding Frischian labor supply behavior. The changes also yielded increases in the return to working, hence in the area where the asymmetric empirical curve is most insightful. Specifically, the Icelandic income tax holidays, studied by Bianchi, Gudmundsson, and Zoega (2001), raised average net of tax rate (in our model: \( 1 - T \)) from 0.855 to 1.000 for one year (and then 0.92 for another year), in response to which positive employment effects implied an elasticity of 0.42. The Self Sufficiency Program in Canada, studied by Card and Hyslop (2005), 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. Yet, fitting these large variations

\[^{18}\] We also could in principle formally estimate which constant elasticity would be implied by the data, imposing the power function derived in Section 2, where the shape parameter \( \alpha \) represents that elasticity. The best-fit \( \hat{\alpha} \) can be obtained from the MLE estimator for shape parameter \( \gamma > 0 \) of power law distribution \( F(X) = P(x < X) = a \left( \frac{x}{x_{\text{min}}} \right)^{-\gamma + 1} \), and hence for iso-elasticity parameter \( \alpha = \gamma - 1 \), is given by \( \hat{\gamma} = 1 + n \left[ \sum_i^n \ln \left( \frac{P_T}{1 - \tau_{\text{max}}} \right) \right]^{-1} \Rightarrow \hat{\alpha} = n \left[ \sum_i^n \ln \left( \frac{P_T}{1 - \tau_{\text{max}}} \right) \right]^{-1} \), where \( n \) is the number of observations, \( i \leq n \) indexes our data points. The standard error of \( \hat{\gamma} \) is given by \( SE_{\gamma} = \frac{\hat{\gamma} - 1}{\sqrt{n}} \), hence the standard error of the iso-elasticity parameter is \( SE_{\alpha} = \frac{\hat{\alpha}}{\sqrt{n}} \).
in our curve, the experiments would occupy points far on the right, where the nonconstancy of the reservation wedge distribution implies smaller elasticities well below 1.00. The nonconstancy and asymmetry of the empirical labor supply curve may therefore make the extrapolation of arc elasticities from large to small variations even more challenging. Our empirical benchmark, taken at face value, raises the possibility that these estimates of small elasticities from large variation can, and in our empirical curve do, mask very large local elasticities.\footnote{To some degree, the nonconstant elasticity is of course expected, as the employment rate cannot exceed 1.00. Conversely, the large macro elasticity benchmarks of around 2.5 cited by\textsuperscript{\textcopyright} Chetty, Guren, Manoli, and Weber (2012) would, out of a baseline employment rate of 0.65, imply rates exceeding 100\% for some of the case studies the authors discussed. By contrast, Martinez, Saez, and Siegenthaler (2018) also study a large tax holiday, in Switzerland, and find no treatment effects on employment rates, and therefore implying small elasticities across all intermediate arcs.} We illustrate how the nonconstancy may play out for macroeconomic (business cycle) contexts below.

5 \hspace{1em} Macroeconomic Implications

We compare the empirical curve with the model-implied labor supply curves. We then provide one illustration of how to exactly calibrate a given model economy’s curves by matching the reservation wedge distribution in the context of a representative household full-insurance setting with heterogeneous disutility of labor (our free parameters). We then assess the performance of the benchmark model against U.S. business cycles, by conducting a labor wedge analysis (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009).

5.1 \hspace{1em} Existing Models vs. Data

The reservation wedge distribution can serve not only as a unifying framework not only between labor supply blocks of various models, but also as a bridge between the empirical as well as the model-implied aggregate labor supply curves at the extensive margin. In extensive margin models, the reservation wedge distribution arises from complex distributional assumptions and parametric choices that are difficult to synthesize without the reservation wedge bridge.

Overall, since the empirical arc elasticities are far from constant, we find that the empirical curve is distributed in a way not easily described by a parametric distribution, suggesting that no single model provides a fully accurate description of extensive-margin employment preferences both local and global.

In Figure 3 we plot the wedge distributions as aggregate labor supply curves for the models from Section 3, against the empirical curve from our custom survey for the U.S. population. We here have again normalized the prevailing aggregate wedge around 1 without loss of generality. This implies that any prevailing taxes in the model are included in the reservation wedge measure, and the relevant wage in the reservation wedge is the after-tax wage. At the normalized-to-one original aggregate prevailing wedge, all curves overlap. This is because in each of our modeling exercises, we parameterize the model so that the 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 empirical survey.\footnote{Rather than restricting to prime working age population, we target a fuller population definition because our models include explicit lifecycle perspectives such as labor force entry or retirement (Rogerson and Wallenius, 2008).}
We additionally report descriptive statistics of the global labor supply curves in Table 2. In Table 3, we report local arc elasticities for various intervals around the prevailing aggregate wedge. (We normalize the prevailing aggregate wedge around 1 without loss of generality. This implies that any prevailing taxes in the model are included in the reservation wedge measure, and the relevant wage in the reservation wedge is the after-tax wage.) Lastly, Figure 5 plots the arc elasticities as a function of the deviation from the baseline prevailing wedge.

**Homogeneity Hansen (1985)** Qualitatively, the empirical wedge 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 wedge, generating the large local elasticities. However, as is evident from the histogram of reservation wedges in Figure 2 Panel (a), the data clarify tremendous heterogeneity in the "willingness to pay" of workers for jobs, consistent with models of heterogeneity in job surplus (Mortensen and Pissarides, 1994; Bils, Chang, and Kim, 2012; Jäger, Schoefer, and Zweimüller, 2018) and present in lifecycle models Rogerson and Wallenius (2008) or with heterogeneous disutility of labor supply (Gali, 2015; Boppart and Krusell, 2016), or incomes (as in the heterogeneous agent model). We now discuss the detailed shapes of these models in detail.

**Isoelasticities MaCurdy (1981)** We include the 0.32 and 2.5 isoelasticity setups we present and microfound in Section 3. We follow (Chetty, Guren, Manoli, and Weber, 2012) in declaring the 0.32 case to correspond to the yet an quasi-experimental estimates of realized employment adjustment to short-run and large net-wage changes (Chetty, Guren, Manoli, and Weber, 2012), 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 wedge, 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 pertubations, the data exhibit smaller arc elasticities below 1.00, towards 0.50.

**Rogerson and Wallenius (2008)** During our analytical discussion of the Rogerson and Wallenius (2008) model, we clarified that the age distribution and the productivity distribution jointly determine the wedge distribution. The model generates a high local elasticity. In the upwards direction, it generates a nearly constant elasticity, mirroring the 2.5 isoelasticity line. Interesting, 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 return-to-work shifts, where the empirical benchmark implies elasticities below one and towards 0.5, whereas the model-implied elasticities remain above 2.²²

Accordingly, our custom survey targets workers 18 and older without an upper age limit.

²¹The histogram also exhibits some likely spurious mass points at 0.5 and 1.5, likely due to rounding.

²²Consistent with our global clarification, Chetty et al. (2012), who simulate large empirical wage increases in the model, find it to exhibit large Frisch elasticities.
**Heterogeneous Agent Model**  The microfoundations of the shape of the extensive-margin labor supply curve are substantially less transparent in models with heterogeneous agents and stochastic income processes, since individuals in these models are often heterogeneous across multiple dimensions, and distributions reflect in equilibrium outcomes. The reservation wedges, at the micro level, clarify the sources of heterogeneity in labor supply preferences, and plotting and analyzing their distribution reveals the overall Frischian behavior of the labor supply block.

The heterogeneous agent model generates very small local labor supply elasticities (0.12–.31) upward, but exhibits larger (up to 0.72) elasticities downward, albeit only briefly. 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 of elasticities throughout, except perhaps for very large positive changes in the return to working about 20%.

Interestingly, the model then generates fairly stable elasticities for larger perturbations, asymptotes quite tightly towards the 0.32 benchmark corresponding to the Chetty, Guren, Manoli, and Weber (2012) quasi-experimental estimates.

In conclusion, no model accurately matches the global empirical curve. While we treat our empirical benchmark with caution, we next propose a theoretical mode that precisely matches the empirical curve, at the very least serving as a proof of concept.

### 5.2 One Theoretical Functional Form Precisely Delivering the Calibration Target

A researcher may even want to calibrate a given model’s implied wedge distribution to match the empirical target for labor supply blocks of macro models. This process requires formulating the reservation wedges in the model, setting them equal to the empirical distribution, and backing out a model-given distribution of the detailed underlying sources of heterogeneity to generate a wedge distribution congruent with the empirical distribution.

To illustrate this process, we provide one particular example, which we engineer to be nearly perfectly consistent with (i.e. meet as a calibration target) the empirical curve. The easiest process takes a setting with only one dimension of heterogeneity in the wedge-relevant components $\lambda$, $y$ and $v$. We therefore discuss the case of a representative full-insurance household whose individual members are heterogeneous in labor disutility and face homogeneous wages. Disutility of labor $v$ is distributed according to CDF $G^v_t(v)$. As in Section 3.1, the household maximizes:

$$\max_{\bar{c}_t, \{e_{vt}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \left[ u(\bar{c}_t) - \int e_{vt} v dG^v_t(v) \right]$$

s.t. $A_t + \bar{c}_t \leq A_{t-1}(1 + r_{t-1}) + (1 - T_t)y_t \int e_{vt} dG^v_t(v) + T_t$.

The empirical wedge, $1 - \hat{\tau}_{vt}$, corresponds to the theoretical wedge of a type $v$ household member.
as follows:

\[ 1 - \hat{\tau}_{vt} = \frac{1 - \tau_{vt}}{1 - \gamma_t} = \frac{v}{(1 - \gamma_t)\bar{\gamma}_t \bar{\lambda}_t} \]  
\[ \Leftrightarrow v = (1 - \hat{\tau}_{vt}) \cdot \frac{1}{(1 - \gamma_t)\bar{\gamma}_t \bar{\lambda}_t}, \]  

for some calibrated values of \( \bar{\gamma}_t \) and \( \bar{\lambda}_t \). To perfectly match the calibration target of the empirical distribution of \( 1 - \hat{\tau}_{vt} \), the distribution of \( v \) is disciplined to match the distribution corresponding to the empirical wedge adjusted by \( (1 - \gamma_t)\bar{\gamma}_t \bar{\lambda}_t \). Let \( \hat{f}(\cdot) \) denote the empirical density distribution of \( 1 - \hat{\tau}_{vt} \). Because the multiplication \( (1 - \gamma_t)\bar{\gamma}_t \bar{\lambda}_t \) is a positive monotone transformation, the density distribution of \( v \), denoted as \( g(v) \), can be written as a function of \( \hat{f}(\cdot) \):

\[ g(v) = \hat{f} \left( \frac{v}{(1 - \gamma_t)\bar{\gamma}_t \bar{\lambda}_t} \right) \frac{1}{(1 - \gamma_t)\bar{\gamma}_t \bar{\lambda}_t}. \]

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

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

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

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

In consequence, the popular representative household with full insurance can be easily made consistent with the (any) empirical aggregate labor supply curve at the extensive margin (without resorting to a MaCurdy isoelasticity assumption), as follows:

\[ \max_{\{\bar{\gamma}_t, E_t\}, A_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \left[ u(\bar{\epsilon}_t) - V(E) \right] \]
\[ \text{s.t. } A_t + u(\bar{\epsilon}_t) \leq A_{t-1}(1 + r_{t-1}) + (1 - \gamma_t)\bar{\gamma}_t E_t + \gamma_t. \]

While this model may exhibit behavior particular to e.g. representative household assumption, its short-run extensive-margin labor supply curve will **precisely** match the empirical curve by construction. Below we detail its properties and its construction as a smooth function.

**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 a given employment level, whom the household adds into employment. Due to optimal rationing, it is increasing \( V'(E) > 0 \) – and also convex \( V''(E) > 0 \), as the marginal worker has higher disutility of labor than its predecessor.
already and inframarginally 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.

**Analytical Approximation to \( V(E) \): Fitted Polynomial** We now construct the a continuous and differentiable analytical function \( V(E) \) by fitting a polynomial to the empirical curve, which naturally discrete (and has gaps). This procedures essentially smooth out and interpolates the discrete empirical distribution to permit fine-grained labor supply levels in the model, such that we can pin down optimal labor supply, marginal rates of substitution and other properties for any given model or empirically prevailing employment level.

Our procedure ultimately approximates the inverse empirical cumulative distribution function of the reservation wedges for intuitive reasons. The procedure starts by exploiting the aforementioned property of \( V(E) \) that its derivative — \( V'(E) = \mu(E) = v \) — is the disutility of the marginal person at the verge of (non-)employment at a given \( E \). In turn, using the correspondence between model and empirical wedge, we recover that disutility \( v \) of each worker marginal at a given \( E \) from the empirical wedge \( 1 - \bar{\tau} \) (times a homogeneous factor \( \bar{A}(1 - \bar{T}) \)). Having associated disutility \( V'(E) = v \) with a given employment rate \( E \), we apply a polynomial approximation to \( V'(E) = v \) over the support of \( E \), the employment rate (rather than \( V(E) \) directly).\(^{23}\) Due to the polynomial approximation procedure, we can then analytically antiderivative and recover \( V(E) \) (and \( V''(E) \)).

We implement the polynomial approximation using a seventh degree polynomial approximation to the inverse empirical cumulative distribution function of the disutility distribution (corresponding to employment rate \( E \)), using a simple weighting structure to ensures we capture both its particularly interesting local curvature and also global asymmetries.\(^{24}\) The coefficients from the polynomial approximation for \( V'(E) \) are displayed in Table 4, along with the corresponding antiderivative for \( V(E) \) and the derivative \( V''(E) \).

In Figure 6 Panel (a), we plot our polynomial approximation against the empirically recovered disutilities \( V'(E) = v \), where the solid continuous line denotes the fitted curve, and the hollow circles represent the empirical observations. To further confirm the quality of the approximation, in Panel (b) we also display the analytical antiderivative against the numerical integral, and finally Panel (c) confirms that the second derivative of \( V(E) \) is positive over the support.

### 5.3 Application: The Cyclical Labor Wedge Revisited

We illustrate the macroeconomic implications of the empirical labor supply curve by comparing the performance of a benchmark business cycle model with standard constant-elasticity labor supply

\(^{23}\)Fitting \( V'(E) \) rather than \( V(E) \) (e.g., through taking conditional expectations of \( v \) by \( E \) in the data) is appealing because \( V(E) \) would nature be smooth and easily fitted, but its curvature determines elasticities, making \( V'(E) \) a more informative target for our purposes.

\(^{24}\)We select the order by informal visual experimentation. The weighting is performed through a weighted polynomial regression of the disutility \( v \) on polynomials of the employment rate (or the quantiles of each associated \( v \)). The weight assigned to the regression is of the form \( w = (E - \bar{\theta})^{-2} \), for some calibrated steady state employment rate \( \bar{\theta} \), hence assigning more weight to disutility observations that are around the magnitude of business cycle fluctuations.
specifications, with a variant in which we specify and calibrate the labor supply block to exactly match our labor supply curve. Our performance measure is the labor wedge (Chari, Kehoe, and McGrattan, 2007; Shimer, 2009), the gap between the marginal product of labor and the imputed marginal rate of substitution, going from a frictionless general equilibrium and a representative full-insurance household model. This exercise demonstrates the role of the high local elasticities (and the limited role of distant arc elasticities). Moreover, the exercise will also formalize that fact that the asymmetric curve implies smaller upward than downward responsiveness, and assess the implications for business cycles.

Figure 7 presents results as time series and binned scatter plot for U.S. business cycles, based on quarterly data, with all time series detrended using an HP filter with a smoothing parameter of 1,600.

Representative Household Disutility

We posit separable balanced growth preferences for the representative household, with log consumption utility:

\[ \ln C_t - V(E_t). \] (83)

We consider three variants for the disutility of labor term \( V(E_t) \). The first two variants are benchmarks standard isoelastic curves \( \Gamma E^{1+1/\eta}/(1 + 1/\eta) \), such that \( \eta \) again denotes the constant Frisch elasticity, for \( \eta \in \{0.32, 2.5\} \). Our third variant constructs \( V(E_t) \) to match the empirical extensive margin labor supply curve as described in the previous section. Therefore, the only difference between the economies arises from the disutility of labor component of the marginal rate of substitution.

Fluctuations in the Marginal Disutility of Labor

Panels (a) and (b) of Figure 7 present the detrended log deviations of \( V'(E) \), the marginal disutility of labor (i.e. the employment disutility of the marginal worker at a given aggregate employment rate). Since empirical employment fluctuations have low amplitudes, this time series is tightly centered around the area in which our empirical supply curve \( V(E) \) exhibits high local elasticities. As a result, the empirically consistent \( V(E) \) we construct is more consistent with the high isoelasticity benchmark than the low isoelasticity benchmark at business cycle frequencies.

The Labor Market Wedge

A useful summary measure of labor market disequilibrium is the labor wedge between these two sides of the market, in form of a tax-like gap between the marginal

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25An ongoing debate studies the incidence of this market-level wedge the MRS and the wage, and the wage and the MPL (Karabarbounis, 2014; Bils, Klenow, and Malin, 2018; Mui and Schoefer, 2018).

26Specifically, the U.S. time series we use are real personal consumption experience per capita, quarterly and seasonally adjusted (FRED series A794RXQ048SBEA), the employment to population ratio for all persons aged 15 and over, seasonally adjusted and quarterly (LREMTTTSUSQ156S), and the nonfarm business sector’s real output per hour of all persons quarterly and seasonally adjusted (OPHNFB). We start our time series in 1960. We have obtained similar results with other age groups, real output per person, and with alternative consumption proxies including service flows from durables.
product of labor and the marginal rate of substitution:

\[(1 - \theta_t)F_L(L_t, K_{t-1}) = \frac{-U_L(C_t, E_t)}{U_C(C_t, L_t)} \] (84)

A frictionless spot labor market equilibrium would fulfill this condition with representative firm and household.

The labor wedge exercise imposes particular forms for the utility and production functions, and then feeds in empirical time series for \(C_t, E_t\) and a proxy for the marginal product of labor, to then back out the time series of the labor wedge \((1 - \theta_t)\) that would lead the condition to hold precisely at each point in the empirical data. Any deviations that may arise in form of a nonzero labor wedge, reflect omitted frictions, taxes, model misspecification or measurement error; Chari, Kehoe, and McGrattan (2007) and Shimer (2009) describe specific frictions and alternative models that manifest themselves as labor wedges from the perspective of the benchmark economy. We follow Shimer (2009) and pick Cobb-Douglas productivity, such that the marginal product of labor, once logged and detrended with an HP filter, inherits the movement of average real output per hour. (While focus is on the extensive-margin when backing out \(V'(E)\), we obtain similar wedges with average real output per worker rather than hour.)

We plot the labor wedge time series in Figure 7, for all three variants of \(V(E)\). As is well known, calibrating labor supply to a small Frisch elasticity in this exercise 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 market wedge is on firms (Bils, Klenow, and Malin, 2018; Mui and Schoefer, 2018). Clearly, even for a large Frisch elasticity, the qualitative wedge remains, yet the amplitude is reduced compared to the low Frisch elasticity setting.

Setting \(V(E)\) to the empirically consistent labor supply curve generates a low-amplitude labor wedge that is strikingly similar to the high-isoleasticity case. The binned scatter plots illustrate this property. Panels (e) and (f) also present the labor wedge that set \(\lambda_t\) counterfactually to be acyclical and hence present a “Frischian” labor market wedge. The amplitudes shrink very little, clarifying that the wedge is largely due to the fluctuations in \(V'(E)\) in the MRS rather than \(\lambda_t\).

**Inducing Non-Local Variation** In Appendix Figure A1, we replicate Figure 7 but artificially amplify the cyclical fluctuations in \(E_t\) only in the calculation of the marginal disutility of labor, while constructing \(\lambda_t\) and the marginal product of labor using the actual time series. With such large fluctuations in employment, the data-consistent non-isolastic labor supply curve finally generates a labor wedge that is in between the two 0.25 and 2.5 benchmarks, particularly moving towards the low elasticity during upswings, but during recessions still tightly hugging the low elasticity case.

This asymmetry follows directly from the asymmetry in the labor supply arc elasticities previously discussed: the curve exhibits – only for large pertubations – fairly low arc elasticities, but remains quite elastic downwards. However, the figure confirms that these asymmetries are not
reached by the average U.S. business cycle, at least on average and if taking our empirical attempt to measure the curve at face value.

In conclusion, the empirical labor supply curve from our survey of U.S. households, if taken at face value, implies relatively smooth labor wedges closer to a high elastic labor supply curve, and acting much like a high isoelasticity setting (although the isoelastic assumption would, unlike our nonconstant elasticity, not be able to rationalize relatively small arc elasticities to, e.g., large tax holidays.

6 Microempirical Analysis: Covariates of Individual-Level Wedges

We next present a covariate analysis of the empirical reservation wedges. The first purpose is to validate the use of our reservation wedge proxy. The second is to shed light on the covariates of marginal and inframarginal workers, and what the distribution of worker surplus is by subsample.\(^{27}\) Third, one could assess the empirical against theoretical covariates model-by-model. Finally, we assess the micro-empirical relationship between an individual respondent’s reservation wedge and her idiosyncratic realized employment outcomes in previous and future periods.

To enlarge our sample size for a covariate analysis 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 wedge) questions can be constructed into wedge proxies.

6.1 Supplementary Data: Proxies from Reservation Wage Household Surveys

Additional Proxy: Reservation/Potential Wage Ratios  We complement our tailored survey with a wedge 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-\(T\) reservation wage (earnings) \(y'_{it}\) (for indifference between employment and nonemployment for a short period of time, all else equal), by:

\[
(1 - T_t) y'_{it, 1-T_t} x_{it} = \frac{\nu_{it, 1-T_t}}{(1 - T_t) y_{it}} \quad (85)
\]

\[
\Leftrightarrow y'_{it, 1-T_t} = \frac{\nu_{it, 1-T_t}}{(1 - T_t) y_{it}} \quad (86)
\]

This route requires characterizing the worker’s actual or potential earnings \(y_{it, 1-T_t}\). We can write the reservation wedge as reservation-to-actual/potential-wage ratio, again centered around one and hence mirroring the \((1 - \hat{\tau}_{it})(1 - T_t)\) analogue of the model object as in the aforementioned

\(^{27}\) Our analysis of covariates of marginal workers complements revealed-preference identification by Jäger, Schoefer, and Zweimüller (2018), who study complier-separators in response to UI benefit extensions, and isolate their attributes.
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.

**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 IAB (described in detail in Antoni and Bethmann, 2018). 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 and drop all observations where the previous labor
market status indicated civil service or self employment.

**Administrative Data from UI Agency** To benchmark the reservation wedge distributions for
unemployed job seekers, have 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 besides
eliciting reservation wages at UI claim entry. Our potential wage proxy for this data is the last job’s
wage (specifically the data set comes as the worker-level reservation to lagged wage ratio).

**Proxied Wedge Distributions from the Supplementary Surveys of the Unemployed** We present
histograms of the empirical reservation wedges from Pole Emploi, PASS and GSOEP in Appendix
Figure A2, respectively, and key summary statistics in Appendix Table A1. In both datasets,
the distribution of reservation wedges 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).

### 6.2 Covariates of the Reservation Wedges

Next, we ask which micro covariates are associated with between-worker variation in reservation
wedges, and to the degree possible aim to relate our empirical findings to the predictions from
the models we discussed in Section 3. We regress the logged reservation wedge on various
covariates in Table 6 (our U.S. survey), and then Table 7 (German GSOEP) and Table 8 (PASS) for
the unemployed. We conduct covariate-by-covariate regressions (incl. baseline controls) and
then one kitchen-sink multivariate regression in the last column.

In Appendix Figure A3, we aditionally portray some results graphically in histograms of
subgroups and age gradients.

**Age** The Rogerson and Wallenius (2008) model implies that marginal workers arise predomi-
nantly from the extremes of the age distribution, due to the triangle-shaped productivity profile
and the resulting cutoff ages for labor force participation. We therefore plot the GSOEP data age

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28 We thank the authors of Le Barbanchon, Rathelet, and Roulet (2017) for providing us with the binned data.
29 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 wedge is equal to one accounts for about 6.2% of workers for whom we
calculate reservation wedges. By contrast, only 0.2% report a wedge 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 for those responding yes will be asked to
specify the reservation wage. For Pole Emploi and GSOEP, a significant amount of workers have a reservation wedge
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 wedge lower than one (otherwise should not be searching).
30 For our custom survey, the regression sample shrinks by around a quarter (see observation count compared to the
full survey sample of 2,000) largely due to incomplete coverage of covariates, some of which are taken from previous
panel waves and merged onto our waves.
profile of the reservation wedge in Appendix Figure A3 (e). The average reservation wedge proxy of younger workers (aged 20 to 25) is higher than that of older workers, consistent with these workers having lower productivity (as in the Rogerson and Wallenius (2008) model) or having higher-valued non-work outside options such as schooling. Interestingly, older workers’ reservation wedge proxies are nearly flat and finally falls – inconsistent with the RW prediction. We repeat this with our smaller U.S. survey in Appendix Figure A3 (f), binning ages to the nearest multiple of five. Here we aim to capture the entire population. Before age 60, the relationship is flat, but then reservation wedges increase after age 60. This is almost entirely due to the change in labor force status after age 60, when more of the sample leaves the labor force, and so their reservation wedges are naturally (and, by construction in the survey) higher than either the employed or unemployed, which dominate the under-60 sample. Perhaps therefore absence of the higher wedge among the younger reflects the endogeneity of human capital through training on the job, as in Imai and Keane (2004) and not captured in the Rogerson and Wallenius (2008) model.

**Sex** Reservation wedges of male and female workers are very similar among GSOEP respondents, with mean male reservation wedges of 0.845 and mean female reservation wedges of 0.850. That statistic masks interesting differences in other moments, as the histogram of wedges by sex in Figure A3 (a) reveals. Specifically, female workers have a larger mass of “very inframarginal” workers on the employment side (left of 1), somewhat shifted from the mass right below 1.

Our U.S. survey does not clearly echo this result in the associated histogram in Panel (b), perhaps because the GSOEP survey relies on the unemployed. However, the regression analysis reveals a noisily estimated 10% higher reservation wage among the female population on average.

**Household Structure** We compare reservation wedges of GSOEP respondents by partnership status. A larger households may smooth consumption, but members at home may raise the opportunity cost of working. Appendix Figure A3 (c) presents the histograms of the reservation wedge proxy, by partnership status. Partnered individuals exhibit lower reservation wedges in GSOEP (a shift to the left), consistent with a 7-10% decline in the wedge in the regression analysis, but less of a clear effect in the U.S. survey.

According to the regression results in Table 7 columns 2 and 7, having children leads to somewhat lower reservation wedges, even controlling for other covariates, perhaps implying that the marginal utility of consumption is increased even more than the value of time spent at home.

**The Opportunity Cost of Working** The labor disutility term in the reservation wedge formulation represents any utility cost of employment. While we cannot observe this measure directly in the data, the GSOEP asks respondents to rate their satisfaction of housework and leisure on a zero to ten scale. Higher levels of satisfaction with housework and leisure are associated with lower reservation wedges. One way to rationalize this pattern is that “high satisfaction” may not imply marginal satisfaction but “satiation”, lowering the disutility of labor and hence the wedge.

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31 We split these into three bins, with “low” satisfaction comprising responses 0-4, “medium” satisfaction comprising responses 5-7, and “high” satisfaction comprising responses 8-10.
Wealth, Borrowing Constraints, and Financial Stability  The GSOEP core sample provides little direct data on the finances of respondents (other than income in the current and previous year), the survey does about satisfaction with one’s household’s income (on a 0 to 10 scale, which we again bin into low, medium, and high concern) and level of concern with one’s financial situation (little concern, somewhat concerned, or very concerned). Perhaps counterintuitively, satisfaction with income is negatively associated with the reservation wedge, while concern about ones’ finances is positively associated with the reservation wedge. This may be due to the sample of unemployed individuals.

By contrast, in the U.S. survey, high net and gross asset to income ratio individuals (perhaps with a high $\lambda$ and low $y$) do have higher reservation wedges. By contrast, though noisily estimated, the credit card debt bins provided (our survey does not provide continuous amounts) leads to lower wedges, entirely consistent with these values indicating higher $\lambda$ as in heterogeneous agent models where workers may be close to the borrowing constraint.

Education Basic theories of human capital enhancing market productivity would predict worker surplus to increase in education (e.g., Oi, 1962). In Appendix Figure A2 Panel (f), we plot average reservation wedges and employment rates, by education level for GSOEP (the survey with the richest education information). As would be consistent with educated individuals having job options with higher wages, 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 on the wedge of years of education. For the U.S. survey, we do find a largely noisily estimated but negative throughout effect of college education on the wedge (omitted category: less than high school diploma).

6.3 Micro Labor Supply Outcomes

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 wedges below the prevailing one – will be at work. Away from this benchmark, frictions such as wage rigidity or search frictions can detach the wedge-implied desired labor supply from prevailing employment allocations, due to search frictions, rationing from labor demand, or misperceptions about potential wages.

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 wedges, which determines her rank in the aggregate labor supply curve.

Formally, our empirical design investigates the discrete choice of desired labor supply $e_{it}^*$ ∈
\{0, 1\} following the wedge cutoff:

\[
e_{it}^* = \begin{cases} 
0 & \text{if } 1 - \tau_{it}^* > 1 - T_t \\
1 & \text{if } 1 - \tau_{it}^* \leq 1 - T_t
\end{cases}
\] (89)

Specifically, we plot the empirical employment rates \(P(e_{it+s}^*|1 - \tau_{it}^*)\) by \textit{continuous} reservation wedges at various horizons \(s\) relative to the survey year and for our various surveys. Figure 8 presents the results using the GSOEP (a large and long household panel) and from our survey of U.S. households (where we included forward- and backward-looking employment questions).

\textbf{Unemployed Job Seekers}  Figure 8 Panel (a) 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 we note that importantly the reservation wage question underlying our wedge proxy is only asked for unemployed job seekers.

Before the survey year, there is a clear pecking order: high-wedge workers are substantially less likely to be employed (40% five years before, less than 60% the year before) compared to low-wedge workers (more than 60% five years before, and nearly 80% in the pre-survey year). The picture is somewhat noisier less pronounced \textit{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.

Figure 8 Panel (e) plots the corresponding results for PASS, where we can use the stated subjective \textit{expected} reemployment wages (again for workers sampled during unemployment episodes), and link the data with administrative employment biographies to track workers nearly over their entire life cycle. Here we focus on the binary distinction between workers declaring themselves willing to work at a lower wage and not, finding a clear consequences of this distinction before and after the unemployment spell and interview date. Our employment outcomes are of administrative quality due to our linkage with social security records for the survey respondents. We relegate the continuous version to the Appendix, noting that these results did not result in clear patterns, perhaps because of failure of the survey to elicit reservation wages from everyone rather than only for workers declaring themselves willing to work below the expected wage before (and only if yes) stating the reservation wage.

\textbf{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 \underline{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%.

Figure 8 Panels (c) and (d) present the results for the cross-section of the U.S. population from our representative sample. Observations above 1 are out of the labor force, below 1 are unemployed searchers or the employed by construction. Panel (c) presents the raw data, and Panel (d) 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-sliping pattern for all groups, validating the measure. However, the slope is far from clear-cut.

There are three potential sources of potential discrepancies: measurement error in the original wedges, idiosyncratic shocks (limited persistence) in the wedge, 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, higher allocational frictions inducing less-efficient rationing. In Figure 8 Panel (b) 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 recently even lower. The employment–wedge gradient appears somewhat flatter during high-unemployment area. The reservation wedge 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 an analysis for the efficiency of employment adjustment at the separation margin, see Jäger, Schoefer, and Zweimüller, 2018).

7 Conclusion

We have provided a tractable and robust framework that formulates and then aggregates individual-level employment decisions into an aggregate extensive-margin labor supply curve. The framework accommodates rich individual-level heterogeneity. The micro decisions are summarized by a sufficient statistic we call the reservation (labor) wedge: the tax-like gap between the extensive-margin version of the marginal rate of substitution and the actual or potential wage. The wedge is a direct measure of worker surplus as a fraction of potential earnings. The aggregate labor supply curve is the cumulative distribution function of that micro wedge. Its argument is a hypothetical average shifter in wages, i.e. a "prevailing wedge" marking up potentially heterogeneous idiosyncratic wages. This framework can serve as a bridge between disparate labor supply blocks of popular macroeconomic models, including those where the aggregate labor supply curve would otherwise remain hard to characterize and compare across very different models.

The framework is also empirically tractable. We measure it directly in a custom U.S. household survey.\textsuperscript{32} Aggregating to the distribution, we trace out the full aggregate labor supply curve at the

\textsuperscript{32}In ongoing and separate work, the authors of this paper are implementing a similar survey in a large and long
This empirical short-run labor supply curve may serve as an empirical calibration target for labor supply blocks in macroeconomic models that feature the, empirically dominant, extensive margin. Via the reservation wedge, we illustrate how a standard representative household can provide precisely the empirical labor supply curve we measured. Calibrating an equilibrium business cycle model to match this global empirical aggregate supply curve target, we find that the labor wedge (a measure of disequilibrium in the labor market including rationed labor supply) is considerably less procyclical.

Yet, our paper does not answer the long-standing core question of macroeconomics about the degree to which empirical employment adjustment occurs along households’ desired labor supply curve (see, e.g., Lucas and Rapping, 1969; Hall, 2009; Schmitt-Grohé and Uribe, 2016; Krusell, Mukoyama, Rogerson, and Şahin, 2017; Mui and Schoefer, 2018; Jäger, Schoefer, and Zweimüller, 2018). We close by reiterating that our framework and empirical implementation trace out desired spot-market labor supply, i.e. underlying preferences. Our framework is therefore decidedly agnostic and prior to potential real-world frictions such as search or wage rigidities, which may detach desired from actual employment allocations.33

representative household panel survey, the German Socioeconomic Panel.

33Hence, our focus on (stated) preferences contrasts with, e.g., an empirical investigation of the realized employment effects of tax changes (e.g. Chetty, Guren, Manoli, and Weber, 2012; Martinez, Saez, and Siegenthaler, 2018; Sigurdsson, 2018), which in the presence of frictions need neither perfectly reveal preferences nor solely reflect micro choices. At the micro-empirical level, we find quite mixed evidence that the rank of an individual in the aggregate labor supply curve – the reservation wedge proxy – tightly determines realized employment allocation.
References


Tables

Table 1: Parameters of Models of Aggregate Labor Supply at the Extensive Margin

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value (by Variant)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Hansen (Indivisible Labor)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ext. Margin Labor supply disutility</td>
<td>$\tilde{v}$</td>
<td>1.0</td>
</tr>
<tr>
<td>Wage</td>
<td>$\tilde{y}$</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 B: MaCurdy (Isolesticity)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Frisch (0.32)</td>
<td>High Frisch (2.50)</td>
<td></td>
</tr>
<tr>
<td>CRRA consumption parameter</td>
<td>$\sigma$</td>
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</tr>
<tr>
<td>Wage</td>
<td>$\tilde{y}$</td>
<td>1.00</td>
</tr>
<tr>
<td>Shape parameter of labor disutility dist.</td>
<td>$\alpha_v$</td>
<td>0.32</td>
</tr>
<tr>
<td>Max. labor disutility</td>
<td>$\nu_{\text{max}}$</td>
<td>4.759</td>
</tr>
<tr>
<td><strong>Panel C: Heterogeneous Agent Model</strong></td>
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<td></td>
</tr>
<tr>
<td>CRRA consumption parameter</td>
<td>$\gamma$</td>
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</tr>
<tr>
<td>Interest rate</td>
<td>$r$</td>
<td>0.03</td>
</tr>
<tr>
<td>Discount rate</td>
<td>$\beta$</td>
<td>0.97</td>
</tr>
<tr>
<td>Labor disutility</td>
<td>$\sigma$</td>
<td>$2.083 \times 10^{-5}$</td>
</tr>
<tr>
<td>Min. assets</td>
<td>$a_{\text{min}}$</td>
<td>-1.775</td>
</tr>
<tr>
<td>Max. assets</td>
<td>$a_{\text{max}}$</td>
<td>5,000,000</td>
</tr>
<tr>
<td><strong>Panel D: Rogerson-Wallenius</strong></td>
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<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>Low-Frisch Variant</td>
<td></td>
</tr>
<tr>
<td>Interest rate</td>
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<td>0.0</td>
</tr>
<tr>
<td>CRRA consumption parameter</td>
<td>$\gamma$</td>
<td>1.0</td>
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<tr>
<td>Labor disutility shifter</td>
<td>$\alpha$</td>
<td>42.492</td>
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<td>Minimum hours</td>
<td>$\bar{h}$</td>
<td>0.258</td>
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<tr>
<td>Maximum labor productivity</td>
<td>$e_0$</td>
<td>1.000</td>
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<tr>
<td>Slope of labor productivity</td>
<td>$e_1$</td>
<td>0.851</td>
</tr>
<tr>
<td>Intensive margin Frisch elasticity</td>
<td>$\eta$</td>
<td>0.5</td>
</tr>
<tr>
<td>Tax rate</td>
<td>$t$</td>
<td>26.0%</td>
</tr>
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Table 2: Reservation Wedge Distributions: Descriptive Statistics from Theoretical Models and U.S. Data

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Rogerson</th>
<th>Heterogeneous</th>
<th>MaCurdy (0.32)</th>
<th>MaCurdy (2.5)</th>
<th>Hansen (Indiv. Labor)</th>
<th>Data: U.S. Pop (Authors’ Survey)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.96</td>
<td>1.02</td>
<td>1.16</td>
<td>0.87</td>
<td>1.00</td>
<td>1.06</td>
</tr>
<tr>
<td>Median</td>
<td>0.94</td>
<td>0.95</td>
<td>0.56</td>
<td>0.93</td>
<td>1.00</td>
<td>0.95</td>
</tr>
<tr>
<td>25 Pctile.</td>
<td>0.83</td>
<td>0.56</td>
<td>0.07</td>
<td>0.70</td>
<td>1.00</td>
<td>0.65</td>
</tr>
<tr>
<td>75 Pctile.</td>
<td>1.09</td>
<td>1.30</td>
<td>1.95</td>
<td>1.09</td>
<td>1.00</td>
<td>1.50</td>
</tr>
<tr>
<td>Pct. &lt; 1</td>
<td>60.7%</td>
<td>60.7%</td>
<td>60.5%</td>
<td>60.7%</td>
<td>0.0%</td>
<td>65.1%</td>
</tr>
<tr>
<td>Pct. &gt; 1</td>
<td>39.3%</td>
<td>39.3%</td>
<td>39.5%</td>
<td>39.3%</td>
<td>0.0%</td>
<td>34.9%</td>
</tr>
<tr>
<td>Pct. &gt; 2</td>
<td>0.0%</td>
<td>4.8%</td>
<td>24.4%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>10.6%</td>
</tr>
<tr>
<td>Variance</td>
<td>0.024</td>
<td>0.25</td>
<td>1.80</td>
<td>0.07</td>
<td>0.00</td>
<td>0.349</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.387</td>
<td>0.69</td>
<td>1.10</td>
<td>-0.73</td>
<td>-</td>
<td>0.415</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-1.014</td>
<td>3.06</td>
<td>3.00</td>
<td>2.76</td>
<td>-</td>
<td>5.139</td>
</tr>
</tbody>
</table>

Note: For the surveys, variance, skewness, and kurtosis were calculated according to Rimoldini (2014), truncating wedges above 2.0.
Table 3: Mass of Marginal Agents and Local Arc Elasticities: Reservation Wedge Distribution

<table>
<thead>
<tr>
<th>Agg. L. S. Curve</th>
<th>( \frac{d\text{Emp}}{\text{Top}} \times 100 )</th>
<th>Elasticity</th>
<th>( \frac{d\text{Emp}}{\text{Top}} \times 100 )</th>
<th>Elasticity</th>
<th>( \frac{d\text{Emp}}{\text{Top}} \times 100 )</th>
<th>Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A: Wedge Interval: 0.01</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hansen</td>
<td>100.0</td>
<td>( \infty )</td>
<td>100.0</td>
<td>( \infty )</td>
<td>100.0</td>
<td>( \infty )</td>
</tr>
<tr>
<td>MaCurdy (0.32)</td>
<td>0.20</td>
<td>0.32</td>
<td>0.20</td>
<td>0.32</td>
<td>0.20</td>
<td>0.32</td>
</tr>
<tr>
<td>MaCurdy (2.5)</td>
<td>1.52</td>
<td>2.50</td>
<td>1.53</td>
<td>2.52</td>
<td>1.51</td>
<td>2.48</td>
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<tr>
<td>Rog.-Wall.</td>
<td>1.74</td>
<td>2.87</td>
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Note: For each model economy and the survey, in the left columns the table presents the mass of marginal agents (those with wedge levels around one) for various intervals around one, symmetrically ("+-", e.g., between 0.995 and 1.005), above one, ("+", e.g., 0.995 and 1.005), 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 only.
Table 4: Fitted Representative Household Labor Supply Disutility $V(E)$, $V'(E)$ and $V''(E)$ as a Function of the Employment Rate $E \in [0,1]$: Coefficients of Polynomial Approximation

<table>
<thead>
<tr>
<th>Coefficient</th>
<th>$f(E, \beta)$ = $\sum_{i=0}^{\tilde{t}} \beta_{i}^f E^{i}$ = ...</th>
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<td></td>
<td>$V'(E)$ (fitted, $\tilde{t} = 7$)</td>
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<tr>
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<tr>
<td>$\beta_3^f$</td>
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<tr>
<td>$\beta_4^f$</td>
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<td>$\beta_5^f$</td>
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</tr>
<tr>
<td>$\beta_6^f$</td>
<td>2108.3930</td>
</tr>
<tr>
<td>$\beta_7^f$</td>
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</tr>
<tr>
<td>$\beta_8^f$</td>
<td>-104.5830</td>
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</tbody>
</table>

Note: $V'(E)$ is the 7th-order 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 feature heterogeneity 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 $E$. Going from the fitted function for $V'(E)$, we obtain $V(E)$ as the analytical antiderivative (with its constant, denoted by ‘∗’, normalized s.t. $V(0) \approx 0$). $V''(E)$ 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 $V''(E) > 0$. The corresponding curves and data points are illustrated in Figure 6.
Table 5: Covariate Analysis: (Log) Reservation Wedge for U.S. Population (Authors’ Survey)

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<td>-0.023*</td>
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**Note:** ****: p < 0.10, **: p < 0.05, *: p < 0.01. Robust standard errors in parentheses. Construction of reservation wedges and sample are described in main text. Source: Authors’ commissioned questionnaire in NORC Amerispeak Omnibus Survey. Also includes a set of region fixed effects (9 regions).
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Note: ***: p < 0.10, **: p < 0.05, *: p < 0.01. Robust standard errors in parentheses. Construction of reservation wedges and sample are described in main text. Source: Authors’ commissioned questionnaire in NORC Amerispeak Omnibus Survey. Also includes a set of region fixed effects (9 regions).
Table 7: Covariate Analysis: (Log) Reservation Wedge for German Job Seekers (GSOEP)

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<td>-3.980***</td>
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<td>(0.463)</td>
<td>(0.459)</td>
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<tr>
<td>(Age / 100)^2</td>
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<td>3.898***</td>
<td>5.038***</td>
<td>4.713***</td>
<td>5.381***</td>
<td>5.171***</td>
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<tr>
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<td>Satis. Income High</td>
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<tr>
<td>Satis. Housework Medium</td>
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<td>-0.066***</td>
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<td>(0.015)</td>
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<td>-0.047***</td>
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Note: ***: p < 0.10, **: p < 0.05, *: p < 0.01. Robust standard errors in parentheses. Construction of reservation wedges and sample are described in main text. Source: German Socio-Economic Panel.
Table 8: Covariate Analysis: Tobit Regression of (Log) Reservation Wedge Proxy for German Non-Employed (PASS, Right-Censored at 0 (Log(1)).)

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<td>25,964</td>
<td>25,964</td>
<td>25,915</td>
<td>25,955</td>
<td>25,964</td>
<td>25,899</td>
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Note: ***: p < 0.10, **: p < 0.05, *: p < 0.01. Robust standard errors in parentheses. Construction of reservation wedges and sample are described in main text. For lack of a goodness-of-fit measure for a Tobit regression using survey data, we do not report any R²-like statistics. Source: German PASS data.
Figures
Figure 1: Model Distributions of Reservation Wedges

(a) Hansen
(b) MaCurdy
(c) Het-Agent: 2-Wage Variant
(d) Het-Agent: 2-Wage Variant
(e) Het-Agent: 33-state Income Process from HANK
(f) Het-Agent Model: Isolating 3/33 Wage States
(g) Het-Agent Model (33 Wages): Het. vs. Homog. λ
(h) Rogerson-Wallenius

Note: In the income-specific asset distribution of the heterogenous agent model, the Low, Medium, and High income levels are 1876.61, 24,489.68, and 117,080.23 respectively. The densities are normalized so that the total density by income level sums to one; however, there is 0.395, 0.164, and 0.033 of density for the low, medium, and high income levels that have reservation wedges above 1.5.
Figure 2: Empirical Distribution of Reservation Wedge Proxy in the United States

(a) Empirical Distribution of Reservation Wedge Proxy in the United States

(b) Aggregate Labor Supply Curve in the United States

Source: author's custom survey (NORC AmeriSpeak/UChicago).
Figure 3: Comparing the Labor Supply Curves: Model-Implied vs. Data

Note: The MacCurdylines refer to Frisch elasticities of 0.32 and 2.5, respectively. The Hansen Indivisible labor is plotted on a employment level axis; all other series are plotted on log deviations from steady state employment (for models) or current employment levels (for the U.S. population, from the authors’ survey).
Figure 4: Zoomed In: Comparing the Complete Labor Supply Curves: Model-Implied vs. Data (+/- 0.05 Log Wedge Change)

Note: The MacCurdy lines refer to Frisch elasticities of 0.32 and 2.5, respectively. The Hansen Indivisible labor is plotted on a employment level axis; all other series are plotted on log deviations from steady state employment (for models) or current employment levels (for the U.S. population, from the authors’ survey).
Figure 5: Arc Elasticities: Model-Implied vs. Data

Note: Arc elasticities are calculated as $\frac{d\text{Emp}}{\text{Emp}} \times 100$, where $\text{Emp}$ is the implied change in employment from a percentage point change in the reservation wedge (on the x-axis), and $\text{Emp}$ is the employment level at a wedge level of 1.0.
Figure 6: Fitted Representative Household Labor Supply Disutility $V(E)$, $V'(E)$ and $V''(E)$ as a Function of the Employment Rate $E \in [0,1]$: Visualizing the Fit Between Polynomial Approximation and Data

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

(b) Antiderivative of $V'(E)$ Giving Total Aggregate Disutility $V(E)$

(c) Second Derivative of Aggregate Disutility $V''(E)$

Note: $V'(E)$ is the 7th-order polynomial $f(E, \beta) = \sum_{i=0}^{7} \beta_i E^i$ fitted to the empirical labor supply curve, with $E \in [0,1]$ denoting the employment rate. The fitted curve are continuous black lines. The data points are hollow circles. The corresponding coefficients are reported in Table 4. The microfoundation is a full-insurance representative household, in which household members feature heterogeneity 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 $E$. Going from the fitted function for $V'(E)$, we obtain $V(E)$ as the analytical antiderivative (with its constant, denoted by $\ast$, 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 $V''(E) > 0$. 

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Figure 7: Cyclical Implications: Marginal Labor Supply Disutility and Labor Market Wedges (Log Deviations From Trend, U.S. Business Cycles, Quarterly Data)

(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 plots model-implied marginal disutilities of labor and implied labor market wedges for U.S. business cycles, for three models: Frisch isoelasticities of 0.32 and 2.50, and the data-consistent disutility curve $V(E)$ we fit and describe in Section 5.2. All time series are quarterly, and log deviations from trend using an HP filter with smoothing parameter of 1600. The graphs are described and interpreted in Section 5.3.
Figure 8: Employment Dynamics, by Reservation Wedges

(a) Employment Dynamics, by Reservation Wedges in GSOEP

(b) Employment Dynamics by Aggregate Labor Market State, by Reservation Wedges in GSOEP

(c) US Survey: Pooling All Labor Force Statuses

(d) US Survey: Controlling for Labor Force Status

(e) Future and Past Employment Rates of PASS Respondents, by Reservation Wedge Proxy: Administrative-Data Employment Outcomes

Notes: The figure shows realized or expected employment rates separated by survey-time reservation wedge proxies. Employment rates are calculate as the proportion of respondents who are employed at various points before and after their survey date (years on the x-axis). Due to data disclosure requirements and sample sizes, reservation wage binning differs by survey source. For example, in PASS, respondents are split by quartiles of the reservation wedge proxy, with a separate group for those whose reservation wage is not lower than their expected wage (above which the wedge proxy is censored). Details for each survey are in the main paper in Section 6 (PASS and GSOEP) and Section 4 (U.S. survey). Data sources: PASS-IAB matched data set, GSOEP, authors’ U.S. custom (NORC) survey.
Appendix of:
The Aggregate Labor Supply Curve at the Extensive Margin: A Reservation Wedge Approach

Preston Mui and Benjamin Schoefer
## Additional Tables

Table A1: Descriptive Statistics of the Reservation Wedge Proxy from Reservation Wage Surveys of Unemployed Job Seekers: GSOEP, PASS and Pole emploi

<table>
<thead>
<tr>
<th>Measure</th>
<th>Empirical Statistic</th>
<th>A. GSOEP</th>
<th>B. PASS</th>
<th>C. Pole Emploi</th>
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<tr>
<td>Mean</td>
<td></td>
<td>1.22</td>
<td>0.75</td>
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<tr>
<td>Median</td>
<td></td>
<td>0.83</td>
<td>0.84</td>
<td>0.93</td>
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<td>25 Pctile.</td>
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<td>0.64</td>
<td>0.75</td>
<td>0.83</td>
</tr>
<tr>
<td>75 Pctile.</td>
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<td>1.2</td>
<td>≥ 1.0</td>
<td>1.01</td>
</tr>
<tr>
<td>Pct. &lt; 1</td>
<td></td>
<td>61.0%</td>
<td>72.8%</td>
<td>70.5%</td>
</tr>
<tr>
<td>Pct. = 1</td>
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<td>6.00%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Pct. &gt; 1</td>
<td></td>
<td>33.0%</td>
<td>27.2%</td>
<td>29.5%</td>
</tr>
<tr>
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<tr>
<td>Variance</td>
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<tr>
<td>Skewness</td>
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<td>6.43</td>
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<tr>
<td>Kurtosis</td>
<td></td>
<td>70.83</td>
<td>5.55</td>
<td>7.44</td>
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<table>
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<tr>
<th>Deviation from 1</th>
<th>+/-</th>
<th>+</th>
<th>-</th>
<th>+/-</th>
<th>+</th>
<th>-</th>
<th>+/-</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. GSOEP</td>
<td>B. PASS</td>
<td>C. Pole Emploi</td>
<td></td>
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<td></td>
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<tr>
<td>0.01</td>
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<td>0.11%</td>
<td>0.07%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>6.23%</td>
<td>3.03%</td>
<td>3.20%</td>
</tr>
<tr>
<td>0.03</td>
<td>6.67%</td>
<td>0.52%</td>
<td>1.09%</td>
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<td>0.1%</td>
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<td>7.48%</td>
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<td>1.41%</td>
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<td>-</td>
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<tr>
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<td>8.50%</td>
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<td>-</td>
<td>-</td>
<td>4.6%</td>
<td>45.6%</td>
<td>16.1%</td>
<td>29.5%</td>
</tr>
</tbody>
</table>

The "+/−" column denotes the fraction of reservation wedges (reservation wage to previous wage) within a band around 1.00 with radius according to the row. The "+" and "−" columns denote the fraction of reservation wedges on the positive or negative side of that band, not including reservation wedges equal to 1. Source: German Socio-Economic Panel (for GSOEP column); PASS-IAB linked data (for PASS columns); Le Barbanchon, Rathelot, and Roulet (2017) for the Pole Emploi columns. Note that PASS entries are empty due to disclosure restriction and/or due to the censoring above 1.00 in the wedge. Associated histograms and implied labor supply curves are presented in Figure A2.
B Additional Figures

Figure A1: Cyclical Implications: Marginal Labor Supply Disutility and Labor Market Wedges Implied By 10-Fold Increases in $E_t$ Deviations from Trend in $E$ Entering $V'(E)$ (Log Deviations From Trend, Quarterly Data)

(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 replicates Figure 7 but scales up the employment deviations $E_t$ from trend 10-fold within each model marginal disutility of $V'(E_t)$ only labor only (while having other wedge elements remain the baseline time series). The graphs are described and interpreted in Section 5.3.
Figure A2: Distribution of Reservation Wedges from Three Reservation Wage Surveys of Unemployed Job Seekers: Pôle Emploi Administrative Survey, GSOEP Household Survey, PASS-IAB Admin-Linked Household Survey

Note: The panels plot histograms of reservation proxies from surveys of (unemployed) job seekers constructed off potential wage proxies and reservation wage ratios, as detailed in Section 6, which also describes and interprets the distributions and data sources. Associated summary statistics are reported in Table A1. Panel (f) presents the wedge by years of education of the respondent.
Figure A3: Distribution of Reservation Wedges from the GSOEP Household Survey and Authors’ Survey of U.S. Population

(a) GSOEP: Distribution by Gender

(b) U.S. Population: Distribution by Gender

(c) GSOEP: Distribution by Partnership Status

(d) U.S. Population: Distribution by Partnership Status

(e) GSOEP: Reservation Wedges and Employment by Age

(e) U.S. Population: Reservation Wedges and Employment by Age
C Computational Details

C.1 Solving Rogerson and Wallenius (2008)

The original Rogerson and Wallenius (2008) distribution of the hourly wage $w_a$ (labor efficiency $e_a$) arises from a uniform age distribution and a triangular wage-age gradient (single-peaked at $a = 1/2$ with $e(1/2) = 1$). 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 parametrize the Rogerson and Wallenius (2008) model, we choose the utility function parameters ($\alpha$, the labor disutility shifter, $\gamma$, the labor supply intensive margin elasticity), effective labor supply parameters ($\bar{h}$, the minimum number of hours worked, and $e_t$, the slope of the wage-age gradient) and the tax rate at which the model equilibrium is calculated.

We set the initial tax 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 paramaterizations. In the first, we choose the remaining three parameters, $\alpha$, $\bar{h}$, and $e_t$, 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 paramaterization sets $\alpha = 42.492$, $\bar{h} = 0.258$, and $e_t = 0.851$.

In the second paramaterization, we also choose the peak of the wage-age profile and target a lower extensive Frisch elasticity. This paramaterization sets $\alpha = 40.000$, $\bar{h} = 0.248$, $e_t = 1.319$, and lifetime peak productivity at 1.110.

For each generation, indexed by $a$, we calculate hours at each age, $h^*(a)$, and then calculate the wedges using

$$1 - \tau_{it}^*(a) = \frac{(1-t)w(a)(h^*(a) - \bar{h})a'(c(a))}{v(h^*(a))}. $$

This formulation of the wedge is "normalized" so that the relevant wage is the after-tax wage, and so the indifferent worker is that of the age $a$ such that $1 - \tau_{it}^*(a) = 1$.

This, combined with the distribution of individuals along the age dimension (uniform), gives the distribution of reservation wedges. We then approximate the local labor supply extensive margin elasticity as $\varepsilon_{E_t, 1-\tau_t}$ by approximating $f(1 - \tau_t)$ as $\sum_{a=0}^{1} 1[1 - \tau_t < 1 - \tau_{it}^*(a) < 1 - \tau_t + 0.001] da$, where $da$ is the distance between generations, and $F_t(1-\tau_t)$ as $\sum_{a=0}^{1} 1[1 - \tau_{it}^*(a) < 1 - \tau_t]$.

C.2 Computational Details of the Heterogeneous Agent Model

C.2.1 Calibrating the Income Process

In our first step, we simulate the earnings process $y_t$ from Kaplan, Moll, and Violante (2018):

$$y_t = y_{1t} + y_{2t}$$

where each component $j \in \{1, 2\}$ follows a "jump-drift" process; that is:

$$dy_{jt} = -\beta_j y_{jt} dt + dF_{jt}$$

Each $dF_{jt}$ captures "jumps" that arrive at Poisson rate $\lambda_j$ and are drawn from a mean-zero normal distribution with standard deviation $\sigma_j$. This process is set in continuous time, but we simulate 1,000 years of data for 100,000 samples of this earnings process. We use the parameters from Kaplan, Moll, and Violante (2018), which are $\lambda_1 = 0.08$, $\lambda_2 = 0.007$, $\beta_1 = 0.761$, $\beta_2 = 0.009$, $\sigma_1 = 1.74$, and $\sigma_2 = 1.53$.

In the second step, we use the extended Tauchen process described in Civale, Diez-Catalan, and Fazilet (2016) to choose the levels and the associated transition probabilities of the income process. For a proposed set of income states, we match the last two periods of simulated data (which are taken as an approximation of the steady state of this income process) to the discrete income states using the nearest-neighbor method. Then, we compute the transition probabilities between the discrete income states using the matched simulated data. This allows us to compute the analogous moments for the discrete income process. We choose the discrete income states to emulate the moments from the continuous income process. We use ten discrete states, which we find matches the moments well.
C.3 Huggett (1993) with extensive margin labor supply

In this section we describe our modification to Huggett (1993) in which individuals make labor supply decisions on the extensive margin only.

Individuals solve

$$\max \sum_{t=0}^{\infty} \beta^t \left[ \frac{c_{i,t}^{1-\sigma}}{1-\sigma} - \bar{c}_{i,t} \right]$$

s.t. $a_{i,t+1} = (1 - \tau_t)y_{i,t}e_{i,t} + b(1 - e_{i,t}) + (1 + r_t)a_{i,t} - c_{i,t}$

where $y_{i,t}$ follows the Markov process described in Section 3.2.2. Households endogenously choose their labor supply $c_{i,t}$, 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 can be written as a function of assets and productivity.

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

$$u_c(c(a,y,t), l(a,y,t)) = V_a(a,y,t)$$

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

$$l(a,w) = \begin{cases} 1 & \text{if } V_a(a,w_t)y_t > \bar{v} \\ 0 & \text{if } V_a(a,w_t)y_t < \bar{v} \end{cases}$$

A similar optimality condition should be used to solve the agent’s problem at the binding constraint $a$:

$$l(a,y,t) = \begin{cases} 1 & \text{if } \frac{(y+a)^{1-\gamma}}{1-\gamma} - v > \frac{(r,a)^{1-\gamma}}{1-\gamma} \\ 0 & \text{otherwise} \end{cases}$$

If $a < 0$, this implies that individuals at the borrowing constraint are always employed.

C.4 Solution algorithm

We solve the model with parameters $\sigma = 2$, $r = 0.03$, $\beta = 0.97$, intensive margin Frisch elasticity $\eta = 0.5$, and unemployment insurance $b = 0$. We set the borrowing constraint at $a = -z_1 r + 0.001$, so that positive consumption is possible at the lowest productivity and asset levels if the individual works. We choose the labor supply disutility shifter $\phi$ to match the equilibrium employment rate 60.7%.

We use a discrete grid of assets $A$ between $a$ and 50000000. We place fifty asset levels equally spaced between $a$ and 0, 450 levels between 0 and 1000000, and 500 levels between 1000000 and 50000000. We solve the consumption and labor supply rules using value function iteration:

$$V^{n+1}(a,y) = \max_{a' \in A, l} \{u(yl + (1 + r)a' - a') + \beta \sum_{y'} T_{y,y'} V(a', y') \}$$

where $T_{y,y'}$ is the transition probability between productivity levels $y$ and $y'$. Implied consumption is given by $c(a,y) = y l^*(a,y) + (1 + r)a - a^*(a,y)$, where $l^*$ and $a^*$ are the solutions to the maximization problem in (A7).

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:

$$g(a,y) = \sum_{\tilde{y}} \sum_{\tilde{a} \text{ s.t. } a^*(a,y) = a} g(\tilde{a}, \tilde{y})$$
With the joint distribution of assets and productivity assets, value functions, and consumption choices, we can solve for the distribution of reservation wedges, and therefore the labor supply curve.