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The relative income effect and labor supply

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ABSTRACT

In the presence of relative income concerns, labor supply response is predicted to be smaller for individual wage change than for global wage change. This difference arises from the relative income effect, which in the case of global wage change is offset by changes in income distribution. We relate the predicted difference in labor supply response to the controversy about differences in micro and macro labor supply elasticities. The relative income effect can also account for a variety of empirical patterns of labor supply elasticity that could not be previously addressed within a single framework.

1. Introduction

In this paper, we study the relative income effect of wage change on labor supply. The relative income effect arises when workers value their earned income not only in absolute terms but also in comparison to others (Duesenberry, 1949). The relevance of social comparisons implies that a positional change in income distribution has implications for individual utility and, in turn, for labor supply. Under the assumption of loss aversion in social comparisons (Tversky and Kahneman, 1991; Fehr and Schmidt, 1999), we study the properties of the relative income effect and demonstrate that many empirical findings about labor supply elasticity previously considered controversial become consistent with the most commonly used labor supply model extended with relative income concerns.

The empirical estimates and patterns of labor supply elasticity vastly diverge across studies. Most notably, there is a controversy about micro and macro labor supply elasticities that renders economists' answer to the question about the effect of a 1 percent wage change on the supply of labor notoriously "two-handed". On the one hand, microeconometric studies report labor supply elasticities of at most 0.5. On the other hand, macroeconomic studies imply labor supply elasticities well above 1.[1] Further controversy is added by the findings of negative elasticity values for specific groups of workers like taxi drivers (Camerer et al., 1997). Given the policy relevance of the question, all this controversy attracts much attention in the profession. To account for different elasticity estimates, the study of labor supply is extended along different dimensions

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[1] See Keane and Rogerson (2012) and Chetty et al. (2013) for discussion. Related literature and evidence are discussed in more detail below.

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including workers' intertemporal substitution, extensive participation, and reference dependence with loss aversion, but consensus views are yet to be reached. Empirical studies also find elasticity to vary non-monotonically in income, with low and high earners responding to wage changes by more than average earners (Gruber and Saez, 2002; Mertens and Montiel Olea, 2018), further adding toward the eclecticism of labor supply modeling (e.g., Chetty, 2012). This paper demonstrates how the aforementioned empirical patterns about labor supply elasticity can be explained by the relative income effect and, thus, reconciled within the same model of labor supply.

We consider a heterogeneous population of workers who supply labor to earn income. Workers value income in absolute and relative terms. We model relative income concerns in the form of loss aversion in reference to other workers' levels of income. In particular, a worker's preferences over income are extended with a "gain-loss" term as in Köszegi and Rabin (2006), which is proportional to the average of differences between own income and others' income with negative differences (losses) increased by a loss aversion factor. In our analysis of labor supply elasticity, we distinguish between two types of wage change, individual and global. The individual type of wage change applies only to an individual worker with the wages of other workers held fixed. The global type of wage change applies to all workers with their relative income position unaffected.

In contrast to related studies on labor supply with loss aversion and reference dependence where the reference point takes a single value (e.g., Farber, 2005; Fehr and Goette, 2007; Card et al., 2012), in our model the reference point is a distributional variable defined by the population distribution of income. Such specification creates a smooth variation in relative income concerns across workers instead of a commonly considered piecewise-linear variation with a kink. A similar preference specification with a stochastic reference point is also considered by Thakral and Tô (2021) in their empirical study of taxi drivers' supply of labor, upon which we draw for the numerical estimates of underlying model parameters.

An implication of loss aversion with a stochastic reference point is that income distribution matters for labor supply decisions because a worker's utility of labor earnings depends on the population shares of workers who are money-wise behind and ahead of the worker. Consequently, a shift in the worker's position in income distribution can create a relative income effect, thus, reinforcing the income effect of individual wage change on labor supply. The outcome of a stronger income effect is the subdued responsiveness of labor supply. With global wage change, however, there is no relative income effect on labor supply as there are no positional shifts in income distribution for workers. Defining micro and macro labor supply elasticity from individual and global wage change, respectively, we obtain that relative income concerns imply micro elasticity lower than macro elasticity. Using the numerical estimates of the model parameters reported by Thakral and Tô (2021) and the empirical properties of the US income distribution, we demonstrate that the magnitude of micro and macro elasticities and their difference predicted by our model are also quantitatively consistent with empirical studies.

The stochastic reference point implies that micro labor supply elasticity can be variable across workers due to aversion to disadvantageous income inequality. If the worker faces a steeper ascend on the curve of income distribution, then his elasticity is lower, and vice versa. In other words, the more improved from additional income the worker's relative income standing is, the larger the additional amount of labor the worker is ready to supply. The predicted relationship between income distribution and labor supply implies larger values of labor supply elasticity at the low and high (i.e., flat) ends of income distribution. This finding is consistent with the empirical evidence of Gruber and Saez (2002) and Mertens and Montiel Olea (2018). Furthermore, our model demonstrates that loss aversion and reference dependence can be consistent with negative elasticity values (Camerer et al., 1997) and positive values, which suggests that positive values may not be unequivocally interpreted as evidence in favor of the neoclassical model of labor supply (Farber, 2005; 2015).

Interesting empirical implications follow from the relaxation of the assumption of constant sensitivity of the loss aversion term. With diminishing sensitivity, i.e., with the marginal impact of income change diminishing with the distance from a reference point, we can obtain non-zero cross-wage/tax elasticities of labor supply. For instance, a change in the top income tax rate can affect the labor supply of workers in lower income groups because of relative income effects. Hence, if the labor supply of such workers is used as a control variable for unobserved changes in earnings, then we can argue that the labor supply elasticity of top earners can be overestimated in the empirical analysis of tax reform of the top income tax rate.

Related Literature. The consensus view emerging from microeconometric labor studies is that compensated labor supply elasticity is small, lying in the range between 0 and 0.5; see MaCurdy (1981), Altonji (1986), Gruber and Saez (2002), Giertz (2010), and Chetty (2012) for empirical evidence and Saez et al. (2012) for its review. A recent exception from this literature is (Mertens and Montiel Olea, 2018) who report labor supply elasticity at 1.2. At the same time, the macroeconomic empirical literature studying the aggregate effects of tax reforms on labor supply implies elasticities in the range between 1 and 3; see Romer and Romer (2010), Barro and Redlick (2011), Mertens and Ravn (2013), and Zidar (2019). This controversy is comprehensively addressed by Keane and Rogerson (2012) and Chetty et al. (2013), who argue that micro and macro labor supply elasticities may not be directly comparable. Because of the use of cross-sectional variation in wages or reform-based variation in tax rates for a subpopulation of workers, microeconometric studies do not capture intertemporal substitution effects, which are important in the macroeconomic analysis of, e.g., life-cycle patterns of work. Similarly, a failure to account for extensive margin responses can also result in the observed discrepancy between micro and macro labor supply elasticities. However, these explanations do not find support in the recent studies of Blundell et al. (2016) and Martínez et al. (2021) to the extent needed to explain the difference between micro and macro labor supply elasticities.[2]

[2] The early microeconometric studies of MaCurdy (1981) and Altonji (1986) did not find any sizable intertemporal substitution effects either.

In the present paper, we show that even for the case of underlying quasi-linear preferences, which would imply the equality of Frisch (intertemporal), Hicksian (compensated), and Marshallian (uncompensated) elasticities, we can obtain different elasticity measures that can be related to the empirically observed difference in micro and macro elasticities.

In the literature started with Camerer et al. (1997), a common test for the role of loss aversion and reference dependence for labor supply is the negative wage elasticity of labor supply. While many studies find strong support for this role as in Fehr and Goette (2007), Abeler et al. (2011), Crawford and Meng (2011), Dupas et al. (2020), and Thakral and Tô (2021), other studies find only limited support or none as in Oettinger (1999), Farber (2005, 2008, 2015), Stafford (2015), and Giné et al. (2017). An important aspect of this literature, which distinguishes it from the microeconometric studies cited above, is its usage of high-frequency data from specific professions such as daily earnings of taxi drivers, fishermen, or bicycle messengers. The transitory nature of wage changes in these professions may give rise to positive intertemporal substitution effects on labor supply, thus, offsetting the negative effect of reference dependence and, in turn, confounding the interpretation of reasons for labor supply response. In relationship to this literature, our model shows that reference dependence is not inconsistent with the positive wage elasticity of labor supply even in the absence of intertemporal substitution effects.

The importance of taxpayers' relative income concerns is well recognized in the literature on income taxation, see Boskin and Sheshinski (1978), Oswald (1983), Ireland (2001), Aronsson and Johansson-Stenman (2008, 2018), and Kanbur and Tuomala (2013). Zubrickas (2022) extends the income taxation literature by modeling relative income concerns in the form of taxpayers' reference dependence and loss aversion similarly to the present paper. Specifically, it demonstrates that loss aversion through its non-monotonic effect on labor supply elasticity can offset the aggregation role of income distribution for income tax policy. In contrast to the present paper, Zubrickas (2022) does not introduce the concept of the relative income effect, nor analyzes its general effects on labor supply. Also see Neumark and Postlewaite (1998), who find empirical evidence about the role of relative income concerns for women's employment decisions. A theory of reference dependence and loss aversion has proved useful in the study of employment contracts and work performance (e.g., Mas, 2006; Dickson and Fongoni, 2019). Lastly, the observation that the elasticity of labor supply is not merely a function of individual preferences over leisure and consumption but also of the socioeconomic environment, institutional framework, or behavioral biases is an object of extensive study, see Slemrod and Kopczuk (2002), DellaVigna (2009), Chetty (2012), and Piketty and Saez (2013).

The remainder of this paper is organized as follows. In Section 2, we introduce loss aversion and reference dependence into the labor supply model commonly used in the literature. In Section 3, we introduce micro and macro labor supply elasticities and derive them from the model. In Section 4, we discuss the empirical properties of the derived labor supply elasticities and relate them to empirical studies. The last section concludes the study.

2. Model

There is a population of workers who differ in their gross wage rate w. Each worker decides how much labor ℓ to supply, which yields disposable income $c = (1 - \tau)w\ell$, where $\tau \in [0, 1)$ is a uniform income tax rate. There are two components in a worker's individual utility function $u = u(c, \ell)$. The first component is neoclassical utility function $g(c, \ell)$, which we define by

$$g(c, \ell) = c - \frac{\ell^{1+\nu}}{1+\nu}.$$

This function gives the utility of income less the cost of labor, where $\nu > 0$ is a degree of cost convexity. In our paper, the assumed quasi-linear specification of utility function g is useful not only for analytical convenience. This specification allows us to abstract from the confounding (absolute) income and intertemporal substitution effects.

The second component of the utility function u gives the utility of relative income measured in reference to other workers' income. Given a heterogeneous population of workers, we model the reference point of income as a distributional variable similarly to Köszegi and Rabin (2006). Denoting the population distribution of income by F and its density by f, we define relative income component $h(c)$ as

$$h(c) = \int \mu(c - \bar{c})dF(\bar{c}),$$

where

$$\mu(x) = \begin{cases} x & \text{if } x \geq 0 \\ \lambda x & \text{if } x < 0 \end{cases} \tag{1}$$

and $\lambda > 1$ is a parameter for loss aversion. The loss aversion function μ imposes that the marginal utility of income c is higher if it is below reference point $\bar{c}$ and lower otherwise. The specification in (1) implies the assumption of constant sensitivity to losses and gains, which is convenient for theoretical analysis. In Section 4, we discuss the implications of diminishing sensitivity, where the impact of change in losses and gains diminishes with the distance from the reference point (Tversky and Kahneman, 1991). Finally, we express a worker's individual utility function u as a weighted average of the two components:

$$u(c, \ell) = (1 - \eta)\, g(c, \ell) + \eta\, h(c),$$

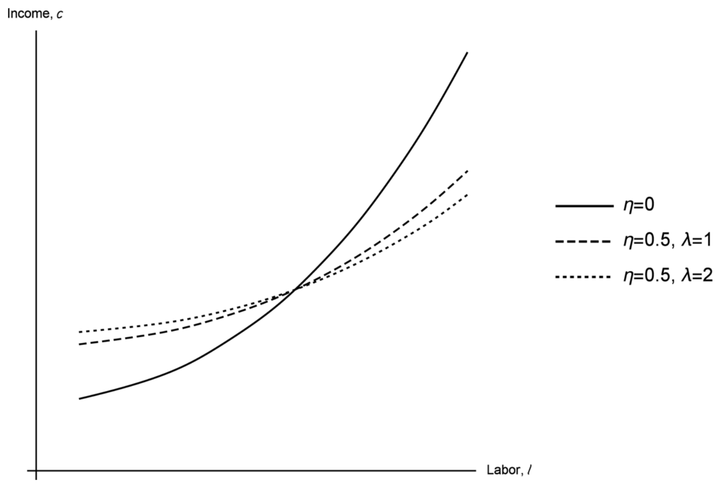

Fig. 1. Indifference curves with and without relative income concerns. *Note*: We set cost parameter $\nu = 2$ and use the lognormal-Pareto distribution of gross wage rates w from Mankiw et al. (2009). The indifference curves are drawn through the optimal income-labor allocation of the median-wage worker in the benchmark case of $\eta = 0$.

where $\eta \in [0, 1)$ is a utility weight on relative income.

A very similar utility specification appears in the applied study of Thakral and Tô (2021), where the stochastic reference point represents the full distribution of potential earnings of taxi drivers. Thakral and Tô (2021) numerically evaluate the underlying parameters of the model, which we later draw upon for empirical implications of our theoretical findings. For similar utility specifications but without a stochastic reference point, also see Farber (2005, 2008), Fehr and Goette (2007), and Card et al. (2012). We do not model reference dependence with respect to labor supplied, which can be justified by empirical research findings indicating that leisure (and labor as its complement) is less positional, i.e., less conspicuous than private consumption (Alpízar et al., 2005; Solnick and Hemenway, 2005; Carlsson et al., 2007). The case of $\lambda = 1$ yields a specification where the utility of relative income is measured against the average level of income as in Oswald (1983), Aronsson and Johansson-Stenman (2008), and Kanbur and Tuomala (2013).

We note that loss aversion with a stochastic reference point adds two properties to a worker's utility, which will play an important role for our findings. The first property is concavity in income, rather than a kink, added to utility u. Intuitively, because of loss aversion the marginal utility of income is larger for those who are at the lower end of income distribution, whereas the stochastic reference point ensures the smoothness of utility. This property can also be interpreted as workers' aversion to disadvantageous inequality of income (Fehr and Schmidt, 1999). The second property is that the concavity properties of utility u captured by the sign of the third derivative $u_{ccc} = -\eta(\lambda - 1)f'(c)$ depend on income distribution, which will affect the dynamic properties of labor supply elasticity.

For the illustration of the effect of loss aversion on preferences, in Fig. 1 we plot indifference curves for three cases: (i) no relative income concerns ($\eta = 0$), (ii) relative income concerns but no loss aversion ($\eta = 0.5$, $\lambda = 1$), and (iii) relative income concerns with loss aversion ($\eta = 0.5$, $\lambda = 2$). For each case, the indifference curves are drawn through the optimal income-labor allocation of the median-wage worker from the wage dataset of Mankiw et al. (2009) in the benchmark case of $\eta = 0$. Due to the relative income effect, we obtain flatter indifference curves in the case of $\eta = 0.5$ or that the worker requires less income for additional labor. This relative income effect becomes increasingly stronger with loss aversion (see the dotted curve).

Letting $\widetilde{w} = (1 - \tau)w$ denote a worker's net wage, we obtain from the first-order condition of utility maximization that the optimal supply of labor satisfies

$$(1 - \eta)(\widetilde{w} - \ell^{\nu}) + \eta\,\widetilde{w}\,(F(c) + \lambda(1 - F(c))) = 0. \tag{2}$$

We note that while the income distribution function F is endogenous, an individual worker has no discernible effect on its shape and, therefore, takes it as given. The first term of (2) is the neoclassical condition for optimal labor supply where the marginal income of labor is equal to the marginal cost of labor. In the presence of relativity concerns, the marginal benefit of additional labor consists not only of a change in income but also of a change in relative income, which is captured by the second term of (2). Loss aversion $\lambda > 1$ increases the effect of relative income on labor supply in proportion to the population mass $1 - F(c)$ of workers that are money-wise ahead of the worker, which in turn implies that a change in a worker's position in the income distribution can affect his supply of labor. Absent loss aversion ($\lambda = 1$), the second term would be constant, implying an invariant relative income effect on labor supply. We also note that loss aversion does not change the monotonicity properties of income with respect to net wage $\widetilde{w}$ as we have the implicit derivative

$$\frac{d\,(\widetilde{w}\ell)}{d\widetilde{w}} = \frac{(1 - \eta)k\ell^{\nu} + \widetilde{w}(1 - \eta + \eta(F(c) + \lambda(1 - F(c)))}{(1 - \eta)\nu\ell^{\nu-1} + \eta\widetilde{w}^2(\lambda - 1)f(c)} > 0.$$

Thus, irrespective of relativity concerns the income distribution F is isomorphic to the distribution of gross wage rate w.

3. Labor supply elasticities

We are interested in the labor supply response to a change in net wage rate $\widetilde{w}$. In our model, we can distinguish two sources of net wage change. The first source is tax rate τ and the second source is individual gross wage rate w. This distinction is important because in the presence of relative income concerns the labor supply response depends not only on the size of wage change but also on its wider economic effects. When the rate of taxation changes, all workers experience a change in net wage and, accordingly, make adjustments to their supply of labor. We will use the term *macro* labor supply elasticity or, for brevity, macro elasticity when analyzing the labor supply response due to global wage change. When an individual gross wage rate changes, only the affected worker experiences a change in net wage, whereas the wages of other workers and, accordingly, their labor supply and income remain the same. We will use the term *micro* labor supply elasticity or, for brevity, micro elasticity when analyzing the labor supply response due to individual wage change.

Micro elasticity

Consider a change in a worker's gross wage rate w while keeping the wage rates of other workers and their income fixed. The worker's labor supply response will not only bring a change in disposable income but also in relative income because of the resultant positional change in the income distribution. We capture the relative income effect by defining

$$r(c) = \frac{f(c)c}{\frac{\Lambda}{\Lambda-1} - F(c)},$$

where $\Lambda = 1 + \eta(\lambda - 1)$ as in Thakral and Tô (2021). Absent loss aversion, i.e., for $\lambda = 1$, we would have $r(c) = 0$. Function $r(c)$ can be interpreted as the inverse hazard rate of income distribution $F(c)$ adjusted for the strength of relativity concerns and loss aversion. Defining Marshallian (uncompensated) micro elasticity by $\xi^u = \frac{\widetilde{w}}{\ell}\frac{\partial \ell}{\partial \widetilde{w}}$, we obtain from (2)

$$\zeta^u = \frac{1 - r(c)}{\nu + r(c)}. \tag{3}$$

We immediately observe that, similarly to the role played by the absolute (i.e., standard) income effect, the relative income effect $r(c)$ subdues the responsiveness of labor supply as elasticity ζ^u is smaller for larger values of $r(c)$. Formally, as the hazard rate determines the conditional probability of the termination of the worker's ascend on the curve of income distribution resulting from a marginal increase in income, we obtain that the larger this probability, the less responsive the labor supply. More intuitively, the hazard rate captures the worker's cost of improving his relative income position and, thus, we obtain that the larger this cost, the less responsive the labor supply.

Microeconometric studies (Saez et al., 2012) typically estimate Hicksian (compensated) labor supply elasticities through the application of the Slutsky decomposition of labor supply response. In our model, this decomposition yields the income effect equal to

$$\rho = \widetilde{w}\frac{\partial \ell}{\partial R} = -\frac{r(c)}{\nu + r(c)}, \tag{4}$$

where R stands for non-labor (virtual) income. Because of the underlying quasi-linear preferences, the income effect in (4) is only determined by the relative income effect and, as expected, it is negative. From the Slutsky equation we find the substitution effect in the form of Hicksian (compensated) micro elasticity equal to

$$\zeta^c = \frac{1}{\nu + r(c)}. \tag{5}$$

The formula obtained above shows that the substitution effect is not constant but depends on the worker's position in the income distribution. We will return to this observation when discussing empirical implications in the next section.

For the purpose of comparison with the case of macro elasticity, in Fig. 2 we graphically illustrate the change of labor supply in response to individual wage increase for the median-wage worker from the wage dataset of Mankiw et al. (2009). The initial labor allocation is given by ℓ found at the tangency point of indifference curve *IC* and the lower budget line. An increase in individual wage shifts the budget line upwards and brings the worker to indifference curve *IC*', which the worker achieves by increasing labor supply to ℓ'.

Macro elasticity

Now consider a change in tax rate τ. As this change affects the wage rates of all workers, the income distribution will also change, implying a change in the relative income component $h(c)$ of utility u. Hence, a change in the tax rate affects not only the budget line but also indifference curves unlike in the case of individual wage change. When everyone's income increases, an individual worker's relative income decreases and, therefore, he will value income more relative to non-conspicuous labor. This implies a clockwise rotation of indifference curves in the space of (ℓ, c) as illustrated by (dashed) indifference curve *IC*"

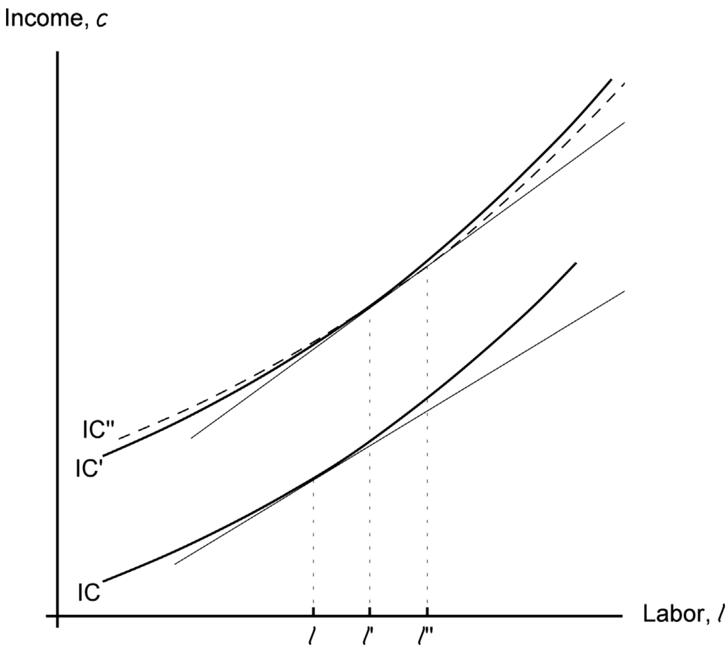

Fig. 2. Labor supply response to wage increase. *Note*: The figure shows the indifference curves (marked by *IC*) and the budget lines of the median-wage worker from Mankiw et al. (2009) for a 20% wage increase. The parameters of the model are $\nu = 2$, $\eta = 0.5$, and $\lambda = 3$. Indifference curve *IC'* relates to the case of individual wage increase, which results in the increase of labor supply from ℓ to ℓ'. Indifference curve *IC"* (dashed) relates to the case of global wage increase, which results in the increase of labor supply from ℓ to ℓ''.

in Fig. 2. Comparing to the case of individual wage increase, we observe that the global wage increase makes the median-wage worker increase his supply of labor from ℓ to ℓ'', which is above the labor supply ℓ' obtained under the individual wage increase of the same size. This additional increase in the supply of labor is due to the change in the worker's preferences dictated by the changes in income distribution arising from the global wage increase.

Analytically, as a change in tax rate τ results in the same proportional change in net wage for all workers, the income distribution changes but remains isomorphic to the distribution of gross wage rates (see Section 2). In the optimum, therefore, each worker's position in the income distribution remains the same as before the tax change, implying that the term $F(c) + \lambda(1 - F(c))$ is invariable in the first-order condition (2). Therefore, we can define Marshallian (uncompensated) macro elasticity by $\Xi^u = \frac{\tilde{w}}{\ell}\frac{\partial \ell}{\partial \tilde{w}}|_{F(c)=const}$ and obtain a well known expression

$$\Xi^u = \frac{1}{\nu}.$$

In words, a worker's labor supply response to global wage change inversely depends on the labor cost parameter. Such wage change does not create an income effect, which is a consequence of the quasi-linear property of the neoclassical utility component $g(c, \ell)$ and the invariance of income distribution function $F(c)$. Absent income effects, the Hicksian (compensated) macro elasticity Ξ^c is equal to the Marshallian macro elasticity, $\Xi^c = \Xi^u = 1/\nu$.[3]

4. Discussion

4.1. Empirical implications

Our first and main theoretical finding is that macro labor supply elasticity is larger than micro elasticity:

$$\Xi^c > \xi^c \quad \text{and} \quad \Xi^u > \xi^u.$$

Labor supply response is stronger for global wage change because the relative income effect of wage change is offset by changes in the income distribution. Our second theoretical finding is that Hicksian micro elasticity ξ^c depends on the

[3] Formally, the Hicksian labor supply $\ell^c(\tilde{w}, \overline{u})$ is determined by the optimal labor allocation from the solution to the program

$$\min_{c,\ell} c - \tilde{w}\ell$$
$$s.t. \quad u(c, \ell) \geq \overline{u}.$$

While obtaining an explicit expression for $\ell^c(\tilde{w}, \overline{u})$ is hardly feasible, we can find the implicit derivative $\frac{\partial \ell^c}{\partial \tilde{w}}$ from the first-order conditions of the program above. Straightforward derivations yield $\Xi^c = \frac{\tilde{w}}{\ell^c}\frac{\partial \ell^c}{\partial \tilde{w}}|_{F(c)=const} = 1/\nu$.

strength of the relative income effect captured by the worker's position in the income distribution. Next, we argue that these findings are consistent with empirical evidence.

In their numerical estimation of the utility specification with a stochastic reference point, Thakral and Tô (2021, Table 4) find labor cost parameter $\nu = 0.7$ and loss aversion with relativity concerns parameter $\Lambda = 5.2$.[4] Using these parameter values, we obtain macro elasticity $\Xi^c \simeq 1.4$, which is in line with the estimates reported in macroeconomic studies, and micro elasticity $\xi^c = \frac{1}{0.7+r(c)}$, where $r(c) = \frac{f(c)c}{1.2-F(c)}$. Saez (2001, Figure 4) reports the hazard rate of the US income distribution taking a U-shape form with values starting at above 1 going down to about 1/3 and then going up to 0.5 (for similar hazard rate values, also see Sachs et al., 2020). The inverse hazard rate, accordingly, takes an inverted U-shape with values starting at below 1 going up to 3 and then going down to 2. Hence, even after adjusting for the loss aversion factor $(\Lambda/(\Lambda-1) = 1.2)$ and income taxes, the adjusted inverse hazard rate function $r(c)$ can bring micro elasticity ξ^c well below 1 as reported in microeconometric studies. All in all, we obtain that the extension of the labor supply model with loss aversion can produce labor supply elasticities that are consistent with macroeconomic and microeconometric studies.

In the literature, a common test for the role of loss aversion and reference dependence for labor supply is a negative wage elasticity of labor supply (Camerer et al., 1997). This test is consistent with our derived elasticity formula in (3), which can take negative values only in the presence of loss aversion and reference dependence. At the same time, positive values cannot rule out the role of loss aversion and reference dependence as in, e.g., Farber (2015) but can only imply that the adjusted hazard rate function $r(c)$ is less than 1, which is empirically not implausible.

The empirical shape of the inverse hazard rate implies that our derived Hicksian micro elasticity ξ^c takes a U-shape form in income. As the hazard rate is smaller at the low and high ends of income distribution, where income density $f(c)$ is flat, our model implies larger values of labor supply elasticity for low and high earners than for average earners. This finding is consistent with empirical evidence (Gruber and Saez, 2002; Mertens and Montiel Olea, 2018; also see Table 1 of Chetty, 2012). In this light, our theory offers a testable hypothesis that the hazard rate of income distribution is a regressor of labor supply. Testing this hypothesis would allow for a better differentiation of our explanation from alternative explanations such as, for instance, tax evasion and income shifting for high earners, participation in welfare programs for low earners, institutional frictions like fixed working hours for average earners.

4.2. Reference group

In the model, we assume that each worker considers the entire population of workers as the reference group for income comparison. This assumption can be justified by the argument of Wilkinson and Pickett (2006) that the comparison across the entire population is the most important: "people' s judgment of who their near equals are is dependent on a prior recognition of their class identity and where they fit into the wider class structure. (p. 1776)" At the same time, the literature on the relative income hypothesis (Duesenberry, 1949) recognizes that defining the appropriate comparison group is not unequivocal. For example, Brown et al. (2015) show that the estimation results of the relative income effect on individual well-being are sensitive to the definition of the reference group.

While in this paper we abstract from the question of the appropriate reference group, we note that in the light of our results this question could be relevant for labor supply studies for specific groups of workers. For instance, should we consider the entire population or just the group of taxi drivers as the reference group for taxi drivers in Camerer et al. (1997)? If it is the entire population, then in terms of the present paper the wage increase in Camerer et al. (1997) can be viewed as individual. The implication of this observation is that a part of estimated labor supply response could be attributed to the relative income effect. In contrast, if the reference group is just the group of taxi drivers, then no relative income effect arises as the wage increase is then global.

4.3. Diminishing sensitivity

The relaxation of the assumption of constant sensitivity of loss aversion has interesting methodological implications for the empirical analysis of labor supply. With diminishing sensitivity of loss aversion, a distance from a reference point would also play a role for labor supply decisions. This property, then, implies non-zero cross wage/tax labor supply elasticities, which may create a bias in the application of econometric methods that use control groups.

A common approach to estimating labor supply elasticity is to use tax reforms, which typically affect only subgroups of the population, leaving tax rates essentially unchanged for the rest of the population. Using this feature of tax reforms, labor economists construct treatment and control groups, where the workers affected by the reform are placed in the former and those unaffected into the latter. As in difference-in-differences estimation methods, the purpose of the control group is to control for unobserved changes in income, e.g., due to a common trend, in the treatment group (for a comprehensive review of empirical approaches, see Saez et al., 2012). With diminishing sensitivity of loss aversion, however, workers in the control group may also be indirectly affected by the tax reform through the relative income effect arising from income changes in the treatment group. As a result, workers in the control group may make adjustments to their supply of labor, which can

[4] In a related empirical study on labor supply under loss aversion, Crawford and Meng (2011) also obtain low values for labor cost parameter ν lying in the range between 0.2 and 1.4.

then be misinterpreted as a common trend and deducted from labor supply changes in the treatment group, thus, creating a bias in estimated labor supply elasticity. For instance, with risk seeking in reference to losses (Tversky and Kahneman, 1992) the labor supply elasticity of top earners can be overestimated in the empirical analysis of tax reform of the top income tax rate.

4.4. Optimal elasticity

Lastly, our finding that micro elasticity ξ^c is determined by income distribution can be connected with the idea of optimal elasticity studied by Slemrod and Kopczuk (2002). Noting that the economic environment is a determinant of labor supply elasticity, Slemrod and Kopczuk (2002) extend the income taxation problem with policy instruments for manipulating the economic environment and, in turn, labor supply elasticity. One of their findings is that the government with stronger egalitarian concerns should seek an instrument that would lower labor supply elasticity. As the inverse hazard rate tends to increase with less dispersion, our model suggests that more equal income distribution itself can play the role of such instrument for lowering labor supply elasticity.

5. Conclusion

In this paper, we extend the standard model of labor supply with relative income concerns in the form of loss aversion with a stochastic reference point. We argue that this extension increases the predictive modeling power in practically relevant ways. In particular, the model predicts a smaller labor supply response to individual wage change than to global wage change. This difference arises from the relative income effect, which in the case of global wage change is offset by changes in income distribution. We relate the difference in labor supply response predicted by our model to the existing controversy about the difference in micro and macro labor supply elasticities observed in empirical studies. Furthermore, we argue that the predicted difference is also quantitatively consistent with the empirical difference. The relative income effect can also account for a variety of empirical patterns of labor supply elasticity that could not be previously addressed within a single framework. Lastly, the model presents two testable predictions left for future research. First, relative income concerns imply that a worker's position in income distribution, captured in the model by the hazard rate, is a determinant of labor supply response. Second, the model extended with diminishing sensitivity of loss aversion predicts non-zero cross wage/tax labor supply elasticities that can have methodological implications for the empirical analysis of labor supply.

Declaration of Competing Interest

I declare that I have no relevant or material financial interests that relate to the research described in this paper.

Data availability

No data was used for the research described in the article.

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