Labor Supply Elasticities: Can Micro Be Misleading for Macro?

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Abstract

In this paper we compare in a consistent way micro and macro labor supply elasticities: the individual elasticity is obtained from the Panel Study of Income Dynamics (PSID); the aggregate, time-series, elasticity is estimated from the exact aggregation of the individual units, each year. Our aggregation procedure relies on a life-cycle labor supply model with home production. The individual (hours per worker) elasticity has a standard low value (0.18), while the aggregate (total hours) elasticity is much larger (0.81), with most of the difference due to the extensive margin, i.e. participation/employment decisions. This result conforms to a well-known stylized fact of the labor market, though we derive it as a pure aggregation effect. A broader suggestion is that micro evidence is not always a reliable guidance for calibrating aggregate macroeconomic parameters.

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1 Introduction

The intertemporal substitution between work and leisure is crucial for the explanation of aggregate fluctuations in modern macroeconomics. When explaining how the benchmark RBC model should be calibrated, Prescott (1986) suggested to restrict the stochastic growth model on the basis of the available micro-econometric evidence:

“A fundamental thesis of this line of inquiry is that the measures obtained from aggregate series and those from individual panel data must be consistent. After all, the former are just the aggregates of the latter.” (op. cit., p. 22).

Yet, when labor supply is involved things seem to be more complicated. This is pointed out by several authors (Heckman,1993; Browning, Hansen and Heckman,1999), and by Prescott (2006) himself. Microeconomic studies based on cross-sectional data generally report a small real-wage elasticity (e.g. Pencavel, 1986, and Killingsworth and Heckman, 1986). This is not surprising since in a static, long-run, setting the income effect is likely to prevail. What is more surprising is that the elasticity is still low in studies based on panel data (e.g. MaCurdy, 1981 and Altonji, 1986).¹

On the other hand, the macroeconomic evidence is far less numerous and is generally mixed. In their seminal paper, Lucas and Rapping (1969) find that, for the US economy (1930-1965), total hours are strongly real-wage elastic (1.4) in the short-run. Among the others, Hall (1980) finds an intertemporal elasticity of substitution which is about 0.5, while Mankiw, Rothemberg and Summers (1985) reject the intertemporal substitution hypothesis by estimating the intensive margin only, i.e. hours per worker, rather than the most appropriate aggregate hours changes (Heckman, 1993).

It is well known that the RBC model requires a much larger elasticity than those estimated in micro studied in order to reproduce observed aggregate

¹All of these are reviewed by Blundell and MaCurdy (1999).

fluctuations. Furthermore, most of the changes in aggregate hours stem from the extensive–employment/participation–rather than from the intensive margin–intertemporal adjustment of hours (Kydland, 1995). Probably this explains why the intertemporal substitution hypothesis is not rejected when it applies to aggregate employment in the US (see Alogoskoufis, 1987).

The necessity of reconciling the relatively high aggregate elasticity used in calibration studies with the low elasticity estimated in microeconomic studies brought about a number of different orientations. In some cases (e.g. Summers, 1986, and Mankiw, 1989) the whole relevance of the RBC model was denied. A more constructive orientation explored several variants of the standard RBC model (Prescott, 1986) in order to better accommodate the data. A precursor is the seminal work of Kydland and Prescott (1982) based on non-separability of leisure at different points in time. This was followed by the lottery (Rogerson, 1988) and the indivisible labor model (Hansen, 1985) where people either work a fixed or a zero amount of hours. Among the other relevant extensions, the introduction of government consumption (Christiano and Eichenbaum 1992), the home production model (Benhabib, Rogerson and Wright, 1991) and the introduction of taxation in general equilibrium models (Baxter and King, 1993, and McGrattan, 1994) are all noteworthy.

More recent studies that generate a wedge between individual and aggregate labor elasticities range from heterogeneous reservation wages (Chang and Kim, 2005, 2006) to the omission of such different variables as wealth (Ziliak and Kniesner, 1999), liquidity constraints (Domeji and Floden, 2006) and human capital accumulation (Imai and Keane, 2004), to nonlinearities in the relation between labor services and hours of work (Rogerson and Wallenius, 2007). A large aggregate elasticity is also required to explain the difference in patterns of work in Europe and the US on the basis of different tax rates (Prescott, 2004). Needless to say, the list is incomplete.

In this paper we take a different, empirical, route based on a sound and testable aggregation principle. We use all of the annual waves (1968-1997) of

the Panel Study of Income Dynamics (PSID) to estimate the Frisch labor supply elasticity via a long-enough panel to be compared with the corresponding time series estimate resulting from the exact aggregation of individual units each year.

This procedure allows us to estimate and compare micro and macro elasticities on the basis of entirely consistent individual and aggregate datasets. We show that microeconomic estimates are not a good source for calibrating total worked hours: our panel results deliver a Frisch elasticity of about 0.2, while the aggregate time-series results deliver a Frisch elasticity of about 0.8. Moreover, we decompose the aggregate elasticity into the contribution of adjustment of hours (intensive margin) and of employment (extensive margin), finding that the latter accounts for about $4/5$ of the aggregate elasticity. This means that the gap between micro and macro elasticities is mainly due to the positive covariance between number of workers and the wage rate. These results, which are based on observational data, complement the findings of Rogerson and Wallenius (2007) as well as Chang and Kim (2005, 2006), which are based instead on calibration of the aggregate economy.²

Our estimates should be interpreted with care. Our goal is mainly methodological, in the sense that we do not aim at providing reliable estimates of labor supply elasticities, though the individual elasticity agrees with standard estimates. Rather, we are interested in assessing the *relative* magnitude of individual and aggregate elasticities.

We are well aware of the fact that our procedure is not costless, for several reasons. First, the resulting aggregate time series is short, and even more so because we cannot use all of the available PSID waves (1968-2005). The reason is that after 1997 data were collected every two years. To avoid arbitrary interpolation of the microdata, we prefer using the annually released data (1968-1997). The obvious cost of this choice consists of a shorter time-

²In particular, Chang and Kim assume an individual elasticity of 0.4 and find an aggregate elasticity of about 1.

series, and so less robust results. Second, PSID data do not report for all waves important variables such as wealth. Another missing variable is the real interest rate, whose nominal component might differ among individuals and groups. For the same reason, our real wage variable is before- rather than after-tax, as it should be whenever statutory or effective tax rates are not constant. However, this problem should be mitigated if the variables are omitted both in the panel and in the macro estimate. Therefore, the relative magnitude of the labor supply elasticity—which is what we are interested in—might not be affected in a significant way. Third, by defining aggregate employment as the number of individuals who work in a given wave, we are confounding variations in employment with variations in sample size. These can be substantial in the PSID, as we discuss later in the paper. We control for such variations by using dummies for years in which the panel underwent major modifications.

On the other hand, our procedure seems to release a number of benefits. In particular, the macro dataset is based on *exactly* the same units of observation that compose the micro dataset. We are not aware of other empirical work doing this. Our aggregation is legitimate since is derived from the aggregation of individual first order conditions under the assumption that heterogeneity takes a special, macroeconomic meaningful, form. This should provide an appropriate framework for comparing aggregate and individual elasticities.

The remainder of the paper is organized as follows. In Section 2 we discuss the relevance of disentangling between the intensive and the extensive labor margin. Section 3 illustrates the theoretical model. Section 4 presents the dataset and Section 5 the results. Section 6 concludes.

2 Intensive vs. Extensive Margin

The indivisible labor case (Hansen, 1985), where individual either work a fixed amount of hours or do not work at all, accomodates the well-known evidence that labor adjustment on the extensive margin dwarfs adjustment on the intensive margin. If we denote by n_t employment and by $\bar{h}_t$ the average supply of hours, then aggregate labor is $H_t \equiv n_t \bar{h}_t$. By taking logs, the variance of labor input can be decomposed as follows:

$$\text{var}(\ln H_t) = \text{var}(\ln n_t) + \text{var}(\ln \bar{h}_t) + 2\text{cov}(\ln n_t, \ln \bar{h}_t).$$

The share of the total variation that is due to n_t provides a measure of the importance of the extensive margin. For the US quarterly data ranging from 1995 to 1984, Hansen (1985) finds that employment changes account for 55% of the total hours deviations from the HP trend, while the hours per worker deviations account for only 20%. This pattern is observed in several countries. In HP-filtered, quarterly manufacturing data (1960-1989), for which variance is scale-free, Fiorito and Kollintzas (1994) found that the variance of employment deviations from the smooth trend always exceed the corresponding variance in the hours per worker: by a factor of about eight in the US, about four in Canada and West Germany and between two and three in the UK and in Japan, respectively.

The extensive margin is closely related to the relationship between individual and aggregate labor supply elasticities. In particular, it explains why the latter is larger than the former. This is easy to see in a regression framework. Denote by ϵ_m and ϵ_M the "micro" and "Macro" Frisch elasticities of labor supply, respectively, and by w_{it} and $\bar{w}_t$ the individual and mean wage rates, respectively. Consider the following regression models, which we derive below in detail:

$$\text{individual} : \Delta \log h_{it} = \kappa + \epsilon_m \Delta \log w_{it} + u_{it},$$

$$\text{aggregate} : \Delta \log H_t = \kappa' + \epsilon_M \Delta \log \bar{w}_t + v_t,$$

where κ and κ' are constants. What is the relation between individual and aggregate elasticities? Suppose for a moment that we can consistently estimate ϵ_m and ϵ_M by OLS. Then the intertemporal elasticities can be written as follows:

$$\begin{aligned} \epsilon_m &= \frac{\text{cov}(\Delta \log h_{it}, \Delta \log w_{it})}{\text{var}(\Delta \log w_{it})}, \\ \epsilon_M &= \frac{\text{cov}(\Delta \log H_t, \Delta \log \bar{w}_t)}{\text{var}(\Delta \log \bar{w}_t)} \\ &= \frac{\text{cov}(\Delta \log \bar{h}_t, \Delta \log \bar{w}_t)}{\text{var}(\Delta \log \bar{w}_t)} + \frac{\text{cov}(\Delta \log n_t, \Delta \log \bar{w}_t)}{\text{var}(\Delta \log \bar{w}_t)}. \end{aligned} \tag{1}$$

That is, the micro elasticity consists of a single term capturing adjustment on the intensive margin only, and the macro elasticity is the sum of two terms, representing the intensive and the extensive margins, respectively. Since the second term is positive if we move along a labor supply curve, this may be the reason why the aggregate elasticity is larger than the individual one.³

³This cannot be proved in general, since while it is true that $\text{var}(\Delta \log \bar{w}_{t+1}) < \text{var}(\Delta \log w_{it+1})$, it is not true in general that $\text{cov}(\Delta \log (\bar{h}_{t+1}), \Delta \log \bar{w}_{t+1}) > \text{cov}(\Delta \log h_{it+1}, \Delta \log w_{it+1})$. Simple numerical simulations show that the latter may be violated. However, all of these terms—and their analogs when using other linear estimators such as IV—can be estimated so that one can take a stance about the sources of the difference. We will report such decomposition of the aggregate elasticity below.

3 The Model

Consider an economy populated by n individuals, indexed by $i = 1, \dots, n$, and two consumption goods. The consumption good can be produced via market or home production, using a constant returns to scale technology whose only input is labor. Individuals have identical preferences and the same endowment of labor services but differ in ability. Therefore, there are no intermediate goods.

Denote by θ_{it} and θ_{it}^H , respectively, individual i 's ability on the market and at home at time t , and with h_{it} and h_{it}^H the fraction of hours spent producing on the market and at home. Then the total amount of the consumption good in the economy at time t is

$$c_t = c_t^M + c_t^H,$$

where

$$\begin{aligned} c_i^M &= \sum_{i=1}^n \theta_{it} h_{it}, \\ c_i^H &= \sum_{i=1}^n \theta_{it}^H h_{it}^H. \end{aligned}$$

In other words, work on the market and at home are perfect substitutes in production, and the respective outputs are perfect substitutes in consumption.⁴ Labor services can be sold on the market at an individual-specific and time-varying wage rate, w_{it} . Profit maximization in production implies $w_{it} = \theta_{it}$ is the wage offer available to individual i at time t . Individuals are assumed to be forward-looking, and the credit market is unconstrained. Due to data limitations, we assume that the tax rate on labor is constant, so it is immaterial whether the wage rate is pre- or after-tax. We also allow

⁴This is a special case of the general model of Benhabib, Rogerson and Wright (1991).

heterogeneity in the endowment of assets and other sources of income beyond labor and assets. Preferences are defined over consumption (c) and leisure (l), and are represented by the utility function $u(c_{it}, l_{it})$, a strictly increasing, twice differentiable, strictly quasi-concave function. The individual problem is to choose sequences of consumption, $\{c_{it}\}_{t=0}^{\infty}$, labor supply to the market, $\{h_{it}\}_{t=0}^{\infty}$, and home production, $\{h_{it}^H\}_{t=0}^{\infty}$, as well as asset holding, $\{a_{it+1}\}_{t=0}^{\infty}$ that maximize the expected discounted present value of the utility stream, given the budget and time constraints:

$$\max_{\{c_{it}, h_{it}, h_{it}^H, a_{it+1}\}} E_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_{it}, l_{it}) \right]$$

subject to :

$$\begin{aligned} c_{it} + a_{it+1} &\leq w_{it} h_{it} + \theta_{it}^H h_{it}^H + (1+r) a_{it} + y_{it}, \\ h_{it} + h_{it}^H + l_{it} &= 1, \end{aligned}$$

and the no-Ponzi game condition: $\lim_{T \rightarrow \infty} \beta^T \frac{\partial u_i(c_{iT}, l_{iT})}{\partial c_{iT}} a_{iT+1} = 0$.

In the above, β is the discount factor and r the real return on assets, both assumed to be invariant in time and across individuals, and y_{it} summarizes other sources of income. In order to derive a structural equation, we assume that utility is separable in both time and consumption-leisure and is of the CRRA class:

$$u(c_{it}, l_{it}) = \frac{c_{it}^{1-\gamma}}{1-\gamma} - \alpha \frac{(1-l_{it})^{1+\eta}}{1+\eta},$$

where $\alpha > 0$ determines the relative preference for leisure, γ is the coefficient of relative risk aversion (as well as the inverse of the intertemporal elasticity of substitution of consumption) and η is the inverse of the elasticity of labor supply, which in this case is the same as the intertemporal elasticity of substitution of work.

Denoting by λ_{it} the Lagrange multiplier, i.e. the marginal utility of wealth, at an interior optimum the following intratemporal and intertemporal conditions hold:

$$c_{it} : c_{it}^{-\gamma} = \lambda_{it}, \quad (2)$$

$$h_{it} : \alpha (h_{it} + h_{it}^H)^\eta = \lambda_{it} w_{it}, \quad (3)$$

$$h_{it}^M : \alpha (h_{it} + h_{it}^H)^\eta = \lambda_{it} \theta_{it}^H, \quad (4)$$

$$a_{it+1} : \lambda_{it} = \beta (1 + r) E_t [\lambda_{it+1}], \quad (5)$$

$$\lambda_{it} : c_{it} + a_{it+1} = h_{it} w_{it} + \theta_{it}^H h_{it}^H + (1 + r_t) a_{it} + y_{it}. \quad (6)$$

It is straightforward to see that individuals will either supply a positive number of hours to the market or spend a positive number of hours performing home production, but never both. In particular, in equilibrium:

$$h_{it} = \begin{cases} \alpha^{-1/\eta} (\lambda_{it} w_{it})^{1/\eta} & \text{if } w_{it} \geq \theta_{it}^H \\ 0 & \text{otherwise} \end{cases},$$

$$h_{it}^H = \begin{cases} \alpha^{-1/\eta} (\lambda_{it} \theta_{it}^H)^{1/\eta} & \text{if } w_{it} < \theta_{it}^H \\ 0 & \text{otherwise} \end{cases}.$$

It follows that θ_{it}^H is exactly individual i 's reservation wage at time t , which we denote $\widehat{w}_{it}$. Therefore the probability that individual i at time t works on the market is equal to the probability that the reservation wage, productivity at home, is below the wage offer:

$$\Pr(h_{it} > 0) = \Pr(\widehat{w}_{it} \leq w_{it}).$$

The following derivation of the structural equation is standard. We can

rewrite (2), (3) and (5) in (natural) logs, provided that both consumption and labor supply are strictly positive in equilibrium, i.e. $(c_{it}, h_{it}) > (0, 0)$. The first condition can be assumed. The second requires $\Pr(\hat{w}_{it} \leq w_{it}) > 0$, which also implies $h_{it}^H = 0$. In this case we have:

$$\log c_{it} = -\frac{1}{\gamma} \log \lambda_{it}, \quad (7)$$

$$\log h_{it} = k + \frac{1}{\eta} \log \lambda_{it} + \frac{1}{\eta} \log w_{it}, \quad (8)$$

$$\log \lambda_{it} = \log \beta (1 + r) + \log E_t [\lambda_{it+1}], \quad (9)$$

where $k \equiv -\eta^{-1} \log \alpha$ is a constant. Equation (8) cannot be estimated, since we do not observe λ_{it} . Notice that the conditional expectation appearing on the RHS of (9) amounts to the future realization of λ_i (i.e. of the budget constraint) plus a white noise term, ε_{it+1} . Therefore, we can write $\varepsilon_{it+1} \equiv E_t [\lambda_{it+1}] - \lambda_{it+1}$ and approximate $\log E_t [\lambda_{it+1}]$ using a first-order Taylor expansion around the zero-error point $\varepsilon_{it+1} = 0$, or equivalently $E_t [\lambda_{it+1}] = \lambda_{it+1}$:

$$\log E_t [\lambda_{it+1}] \simeq \log \lambda_{it+1} + e_{it+1} \quad (10)$$

where $e_{it+1} \equiv \varepsilon_{it+1}/\lambda_{it+1}$ is the forecast error expressed in percentage. Using this approximation and adopting the notational convention, for any variable X , $\Delta X_t \equiv X_t - X_{t-1}$, we can rewrite (8) and (9) in first differences :

$$\Delta \log h_{it} = \frac{1}{\eta} \Delta \log \lambda_{it} + \frac{1}{\eta} \Delta \log w_{it} \quad (11)$$

which leads, after defining $u_{it} \equiv \Delta e_{it}$ to the following estimable equation:

$$\Delta \log h_{it} = \frac{1}{\eta} \Delta \log w_{it} + u_{it}. \quad (12)$$

Equation (11) allows us to estimate η^{-1} , the intertemporal (Frisch, or

λ -constant) elasticity of labor supply as determined by first order condition (8). This is the response of labor supply to the wage changes. We label (12) the "micro regression". Consistency requires instrumenting for changes in the wage rate which are obviously endogenous.

We derive the analogous "macro regression" by exact aggregation of the relevant units. Solving equation (3) for h_{it} and aggregating across all individuals that in equilibrium at time t supply a positive number of hours (these are $n_t \leq n$), yields aggregate labor supply:

$$n_t \bar{h}_t = \sum_{i=1}^{n_t} \left(\frac{\lambda_{it} w_{it}}{\alpha} \right)^{-\frac{1}{\eta}}, \quad (13)$$

where $\bar{h}_t$ represents hours per-worker at time t . The key to aggregation is the relation between individual and mean wage implied by the model. To see this, denote by $\tilde{w}_t \equiv n^{-1} \sum_{i=1}^n \theta_{it} = \tilde{\theta}_t$ mean productivity of all individuals, regardless of whether they work or not. The following relation holds:

$$w_{it} = \frac{\theta_{it}}{\tilde{\theta}_t} \tilde{w}_t. \quad (14)$$

On the other hand, mean productivity of workers can be computed as the mean of productivities of all individuals, each weighted by the probability that the single individual supplies a positive number of hours to market production:

$$\bar{w}_t \equiv \sum_{i=1}^n \theta_{it} \Pr(\hat{w}_{it} \leq w_{it}).$$

In any period t there exists a number ξ_t such that

$$\tilde{w}_t = \bar{w}_t^{\xi_t}.$$

Notice that $\xi_t = 1$ if and only if all individuals are employed. Therefore, when $\xi_t \neq 1$ the extensive margin comes into play, as movements in employ-

ment are possible. Replacing this equation into (14), then back into (13) and taking logs we have:

$$\log(H_t) = k' + \frac{\xi_t}{\eta} \log \bar{w}_t + \frac{1}{\eta} \log(\sum_{i=1}^{n_t} \lambda_{it} \theta_i) + v_t, \quad (15)$$

where $H_t = n_t \bar{h}_t$ denotes aggregate labor supply, $k' \equiv \log \alpha$ is a constant and $v_t \equiv \bar{\theta}_t / \tilde{\theta}_t$ is the ratio between workers and population average productivities. Notice that multiplying both sides of the Euler equation (5) by θ_{it} , aggregating across workers at time t and taking logs yields:

$$\log \sum_{i=1}^{n_t} \lambda_{it} \theta_i = k'' + \log \sum_{i=1}^{n_t} E_t [\lambda_{it+1} \theta_i], \quad (16)$$

where $k'' \equiv \log \beta (1+r)$ is a constant. As before, we can approximate the log of the aggregate expectation:

$$\log \sum_{i=1}^{n_t} E_t [\lambda_{it+1} \theta_i] \simeq \log \sum_{i=1}^{n_t} \lambda_{it+1} \theta_i - \Xi_t, \quad (17)$$

where Ξ_t is a function of the aggregate forecast error at time t . Replacing (17) into (16) we can write:

$$\log \sum_{i=1}^{n_t} \lambda_{it+1} \theta_i - \log \sum_{i=1}^{n_t} \lambda_{it} \theta_i = -k'' + \Xi_t.$$

Using this equation, and defining the aggregate differential error $v_t \equiv \Delta \Xi_t$, we can rewrite equation (15) in first differences:

$$\Delta \log(H_t) = \frac{\xi_t}{\eta} \Delta \log \bar{w}_t + v_t, \quad (18)$$

which is the exact aggregate analog of (12), and which we can use to estimate $\xi_t \eta^{-1}$. This is the aggregate Frisch elasticity, or the response of aggregate labor supply to the mean wage rate, keeping constant the marginal utility of wealth of all individuals. The model implies that in each period the macro elasticity is different from the micro one if and only if $\xi_t \neq 1$, i.e. if there

are some individuals who allocate zero hours to market production. On the other hand, if $\xi_t = 1$ the two elasticities coincide. This is intuitive: if $\xi_t = 1$, any adjustment of labor supply cannot take place on the extensive margin, since everybody is working. Therefore, in this simple model the two elasticities are different because, like in Chang and Kim (2005), the reservation wage distribution is nondegenerate and so there are some individuals who are adjusting on the extensive margin in response to wage shocks. For estimation purposes, we need to treat ξ_t as a constant⁵. This assumption is not so strong if the employment rate does not vary too much over time.

To summarize, referring to the notation introduced earlier in the paper, we will estimate models (12) and (18)⁶:

$$\text{individual} \quad : \quad \Delta \log h_{it} = \kappa + \epsilon_m \Delta \log w_{it} + u_{it}, \quad (19)$$

$$\text{aggregate} \quad : \quad \Delta \log (H_t) = \kappa' + \epsilon_M \Delta \log \bar{w}_t + v_t, \quad (20)$$

In both equations, the relevant wage rate is endogenous because it is determined at equilibrium between demand and supply. So, in a rational expectation framework, its first difference must be instrumented by appropriate wage changes lags. Further, while in principle the estimate of individual elasticities suffers from ignoring the zero-hours wages, the aggregate regression by itself provides the best way for measuring the importance of employment/participation decisions without altering the comparison between the

⁵We replicated our study on the basis of a static model, which is relevant when individuals do not fully optimize intertemporally or credit markets do not work. In this case one can estimate labor supply equations in levels rather than in differences, and the resulting elasticity is the uncompensated (Marshallian) elasticity (see Blundell and MaCurdy 1999). The results from this alternative model are available from the authors upon request.

⁶A constant is added to be interpreted as trend.

observed individual and aggregate elasticities. To control for the role of non-labor income (transfers), we also estimate the following equations

$$\text{individual} \quad : \quad \Delta \log h_{it} = \tilde{\kappa} + \tilde{\epsilon}_m \Delta \log w_{it} + \gamma' \Delta y_{it} + \tilde{u}_{it}, \quad (21)$$

$$\text{aggregate} \quad : \quad \Delta \log (H_t) = \tilde{\kappa}' + \tilde{\epsilon}_M \Delta \log \bar{w}_t + \delta' \Delta \bar{y}_t + \tilde{v}_t, \quad (22)$$

where y denotes exogenous transfers. Notice that, in particular, equations (21) and (22) are the first-difference version of what Heckman (1993) labels the labor supply of workers and the aggregate labor supply curve, respectively. Also notice that our simple theoretical framework provides a precise link between the individual and the aggregate level, i.e. solves the aggregation problem, so that we can compare individual and aggregate elasticities in a meaningful way (see Blundell and Stoker, 2005).

4 Data

Our data come from the Panel Study of Income Dynamics (PSID), a panel of about 8,000 households. This choice has an important disadvantage, namely missing information on assets and other relevant controls for most of the waves.⁷ However, it has an important advantage: it covers 35 years for a total of 32 waves (annually from 1968 to 1997, then biennial).

Unfortunately, for estimation purposes, our series is shorter than it might otherwise be, because in order to avoid arbitrary interpolation we only consider the annual releases. We aggregate each wave, creating an “artificial” time series. We call this artificial because the PSID is a panel of households and we use labor market data for the household head only. When the house-

⁷Omitted wealth is likely to bias downward estimated elasticities, as showed by Domeij and Flodén (2006).

hold includes a couple, the husband is conventionally defined as the head. Therefore, women are under-represented in our sample and this of course reduces the estimated labor supply elasticity (see Killingsworth and Heckman, 1986).

All nominal values are converted into real terms using the CPI (source: BLS). An obvious problem concerns individual wages. It is well known that wage reports in the PSID are affected by measurement errors (Pischke 1995). This problem should be mitigated by our aggregation procedure, that makes—inter alia—measurement errors common to the micro and the macro estimate.

How does such artificial time series compare with NIPA data? Figure 1 illustrates the case for average hours worked by employed individuals. Notice first that using weights provided by the PSID to make averages nationally representative does not make any substantial difference. However, we don't use weights in the estimation, in order to preserve aggregation conditions. Second, the series provided by the OECD (based on US Bureau of Labor Statistics data) is smoother and differs about 100-200 hours from the aggregated PSID series.

The difference can be explained by the over-representation of men, who typically work more than women. The different volatility can be explained by the changes occurring in the panel due to attrition and—most importantly—the inclusion of new households in the survey. Part of the latter is nonrandom: the PSID automatically includes as new households children that leave a family already included in the survey. Therefore, our series is not fully comparable with the official ones.

However this leaves our main point, exact aggregation, unaffected. As we stressed above, our goal is not to provide reliable estimates of aggregate labor supply elasticities but to look at the relative magnitude of individual and aggregate elasticities when these are consistently estimated. While the modification of the composition of the panel is not a problem for the estimation of the individual elasticity, some care is needed when estimating the

aggregate one.

The reason is illustrated in Figure 2. This compares again PSID and OECD data. The series is the variation of log hours worked. There are clearly three outliers in the PSID series, namely years 1989, 1993 and 1996, which do not match actual variations in employment of a given population. In fact these years are particular in the PSID: the 1990 wave (which collected our 1989 data) added about 2,200 new households (from 7,114 to 9,371), the so-called Latino sample. This explains why the series jumps up. Similarly, in 1994 and 1997 (which collected our 1993 and 1996 data respectively) the panel experienced substantial modifications, reflected into the anomalous downward jumps in Figure 2. Also, year 1992 is characterized by an excessive, implausible, jump in the log mean wage, as shown in Figures 3. This is likely to be due to measurement error. For all these years (1989, 1992, 1993 and 1996) we construct dummy variables to control for anomalous behavior of the series. Figure 4 shows the series of the wage rate and average hours worked according to the PSID. These are consistent with NBER recessions, which are located by the vertical dashed lines.

Figure 1. Average hours worked in the US: PSID and OECD data compared

Figure 2. Variation of log mean hours worked in the US:
PSID and OECD data compared

Figure 3. Variation of log mean wage in the US: PSID data.

Figure 4. Dynamics of average wage (right scale) and average hours (left scale) worked in the PSID

5 Results

Our main results are reported in Tables 1 and 2 below. Table 1 reports our estimates of the individual and aggregate labor supply elasticities. Columns 1 and 2 report estimates of the individual elasticity, not controlling and controlling, for transfers, respectively. That is, equations (19) and (21).⁸ Both models are estimated using the fixed effects estimator, and both yield a Frisch elasticity of about 0.2. In estimating the micro elasticity we do not correct for selection into the pool of workers, because we don't want to alter the precise correspondence between the micro and the macro levels.

Columns 3 and 4 report, analogously, estimates of equations (20) and (22). Both produce an aggregate Frisch elasticity of about 0.8, although this is imprecisely estimated when controlling for mean transfers.⁹ Therefore, aggregation alone magnifies the aggregate elasticity by about four times.

This is due to variation along the extensive margin, as illustrated in Table 2. This table evaluates empirically the two terms at the end of equation (1), i.e. it splits the aggregate elasticities sub model 3 in Table 1 into the contribution due to the intensive and extensive margins, respectively. Specifically, the dependent variable in column 5 is the first difference of log mean hours worked in the economy (intensive margin), while in column 6 is the first difference of log employment (extensive margin). The estimate forcefully shows that the extensive margin (0.7) explains most of the difference between micro and macro elasticities.

⁸The log variation in the wage rate is instrumented using 2 lags (the 2nd to the 3rd, because the error term also reflects a first difference). Transfers are also instrumented, using one lag (the 2nd). First-stage results (not shown) suggest that the instruments allow identification.

⁹Here we use five lags (2nd to 6th) to instrument the log variation in the wage rate, and again one lag for transfers. First-stage statistics are again well-behaved.

Table 1. Estimated individual and aggregate Frisch elasticities.

	$\Delta \log (h_{it})$		$\Delta \log (H_t)$	
	1	2	3	4
$\Delta \log (\text{wage})$	0.18** (0.04)	0.18** (0.05)	0.81* (0.38)	0.86 (0.52)
$\Delta \log (\text{transfers})$	- (0.01)	-0.02** (0.01)	- (0.01)	-0.11 (0.41)
Constant	-0.02** (0.00)	-0.02** (0.00)	0.02** (0.00)	0.02* (0.01)
Year dummies	yes	yes	yes	yes
Observations	101,823	83,305	24	24
Individuals	11,543	10,570	-	-

Table 2. Sources of the aggregate elasticity

	$\Delta \log (\bar{h}_t)$	$\Delta \log (n_t)$
	5	6
$\Delta \log (\text{wage})$	0.11 (0.27)	0.70* (0.28)
Constant	-0.00 (0.00)	0.02** (0.00)
Observations	24	24

6 Conclusions

In this paper we have estimated the individual and aggregate Frisch elasticities of labor supply, using exact aggregation of the microeconomic units on which the individual estimate is based. We found that the micro elasticity is about 0.2 and the macro elasticity is four times as much, i.e. about 0.8. As expected, a large part of the difference is explained by adjustments at the extensive margin.

We do not claim that our estimates are the right ones, although our micro elasticity is very close to the typical results found in a massive, specialized, literature. Given our aggregation procedure and the limitations of PSID data, we are aware of the fact that our specification does not account for such important variables as marginal tax rates, individual wealth, and after-tax return on assets though these limitations equally apply to the individual and the aggregate estimates that we compare. Moreover, what we estimate is a short-run elasticity only, because our simple theoretical approach and the scarcity of data points (in the aggregate dataset) prevent from exploiting a richer dynamics.

Despite these limitations, the main achievement of the present paper is showing that aggregation *alone* leads to a larger aggregate elasticity, via the implied inclusion of the extensive margin. In our model this is captured by allocation of work between market and home production. Despite being a simple empirical result, we are not aware of other econometric studies indicating the relevance of adjustments on the extensive margin based on exact aggregation. Finally, our results show that parameter estimates from micro data may are not always appropriate for calibrating the national economy.

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