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Abstract

Our research examines the effect of interdependence on estimation and interpretation of earnings/labor supply equations. We consider the cases of (1) a positive spillover from others' labor supplied and (2) a need for conformity with others' labor supplied. Qualitative and quantitative comparative statics results with a Stone-Geary utility function demonstrate how spillover effects increase labor supply uniformly. Alternatively, conformity effects move labor supplied toward the mean of the reference group so that, in the limit, labor supply becomes perfectly inelastic at the reference group average. When there are un-modeled exogenous social interactions, conventional wage elasticities are still relatively well estimated although structural parameters may not be. Omitting endogenous social interactions may seriously misrepresent the labor supply effects of policy, however.

1. Introduction

Critics of the economic approach to human behavior sometimes cite models with an atomistic decision maker as excessive abstraction leading to un-informative behavioral implications and inaccurate predictions. Among the reasons economic researchers have avoided models with interdependent agents are complexity and no generally accepted theoretical framework for examining interdependent economic agents (Manski 2000, Moffitt 2001, Durlauf and Young 2001, Durlauf 2004). Empirically, researchers would need to construct econometric models confrontable with data for testing, and available data sets are typically short on information concerning economic interactions among persons or firms. Still, economic interactions among persons are a fact of life and both microeconomic models and data become more informative by taking greater account of the individual's social group connections in decision making. Our research examines the potential quantitative labor supply effects of two types of interactions in utility, spillover from others' decisions and conformity with others' decisions.

Because the broad topic of social interactions is interesting and important, social interactions have received much recent attention and the literature is growing rapidly (Durlauf and Moffitt 2003). Many studies recognize that to identify social interactions the researcher must account for the fact that the interdependent behavior potentially creates the problem of simultaneity in the data (Kelly and Ó Gráda 2000; Angrist and Lang 2002; Evans, Oates, and Schwab 1992; Marmoros and Sacerdote 2002; Duflo and Saez 2002; Katz, Kling, and Liebman 2001; Sacerdote 2001; Kremer 1997; Glaeser, Sacerdote, and Scheinkman 1996). The empirical researcher and policymaker must be cautious, though, when considering evidence of interaction effects because empirical studies may not be informative concerning the reference group identity and in turn not identify the underlying structure of interactions, such as whether it is endogenous, exogenous, or both (Manski 1993, 2000; Morgan and Ó Gráda 2000; Moffitt 2001).

There is little research addressing identification of social interactions in basic labor market behavior underlying labor supply differences. Recent evidence suggests that a worker's choice of hours worked can depend on average hours worked by social reference group members and that neglecting the interdependence can lead to serious underestimates of the labor supply effects of income taxes or local labor market conditions (Blomquist 1993; Woittiez and Kapteyn 1998; Aronsson, Blomquist, and Sacklén 1999; Weinberg, Reagan, and Yankow 2000).

Social interactions are of much policy relevance for taxation programs or policies directed toward improving the well-being of the unemployed if the social reference group's mean value affects the outcome of interest to the individual (Blomquist 1993). When there are substantial amounts of socially interactive decisions in the form of, say, positive spillovers, then there will be a social multiplier effect to consider in optimal policy design as individuals react to the actions of others (Becker and Murphy 2000, Glaeser, Sacerdote, and Scheinkman 2002).

Our research bridges theoretical and econometric considerations in household models where non-ignorable social interactions may be present. We use the popular Stone-Geary utility function, which leads to the easily estimable linear earnings function, and demonstrate that even when we introduce a relatively low level of social interaction in utility it can cause an economically significant effect on an individual's labor supply (and consumption). Ignoring social interactions can cause a serious bias on the estimated structural (utility function) parameters of interest. We also identify situations when other economic concepts that depend on combinations of biased structural parameters, such as labor supply/consumption derivatives and elasticities, may or may not be accurately estimated. The shifts of the labor supply function are general qualitatively for any utility function with imbedded social utility components and with leisure as a normal good (Grodner 2003); the calibrated Stone-Geary utility function lets us quantify the results.

2. Theoretical Framework

We build on the a flexible treatment of social interactions formulated by Brock and Durlauf (2001a,b), where interactions enter into a model with total utility, $V(\bullet)$, encompassing a social utility term, $S(\bullet)$, and individual utility term, $u(\bullet)$:

$$V=V(u(\bullet),S(\bullet)) \tag{1}$$

Our starting point is the model without interactions (baseline, without $S(\bullet)$); we then discuss forms of interdependence.

Our focus throughout is on labor supply using the Stone-Geary utility function. The Stone-Geary has convenient properties for estimating labor supply and consumption expenditures. Because the earnings function is linear in the wage rate and non-labor income, w and Y, and the associated labor supply function is linear in $1/w$ and Y/w, similar social interactions effects appear in other widely used utility functions (Stern 1986).[1] The Stone-Geary has also been shown to be a convenient functional form for studying issues related to intertemporal substitution and risk sharing (Ogaki and Zhang 2001, Low 2002, Low and Maldoom 2004). Stone-Geary utility easily admits social interactions in a natural way through its structural parameters. Kooreman and

Schoonbeek (2004) and Abel (2005) prove conditions for the existence of welfare improvements over the market equilibrium case with interdependence and the implied optimal taxes that mitigate negative effects of social interactions.

We begin with the baseline utility function without interactions:

$$U(h,c) = \theta \ln(\gamma_h - h) + (1-\theta)\ln(c - \gamma_c) \quad \textbf{(2)}$$

$$st.\ c \le wh + Y\ ,\ 0 < \theta < 1\ ,$$

where c is consumption, h is hours worked, θ is the expenditure share on leisure ($l = T - h$, with l being leisure and T being total hours available), γ_h is the level of maximum feasible hours of work, and γ_c is the minimum necessary commodity consumption.

An econometric advantage of the Stone-Geary (2) is that after maximizing utility with respect to consumption and labor supplied the optimal hours worked imply that earnings are linear in both the variables and parameters (Abbott and Ashenfelter 1976):

$$wh = (\theta\gamma_c) + (\gamma_h(1-\theta))w + (-\theta)Y = \beta_0 + \beta_w w + \beta_Y Y\ . \quad \textbf{(3)}$$

The three parameters of the utility function are exactly identified as estimates of ($\beta_0, \beta_w, \beta_Y$) reveal ($\theta, \gamma_h, \gamma_c$). We will refer to the earnings function in (3) as the Stone-Geary without interactions or, more simply, as the baseline model, which is always the point of comparison. The wage effect on labor supply in our benchmark case is

$$\partial h / \partial w = \frac{(1-\theta)\gamma_h - h}{w}\ . \quad \textbf{(4)}$$

Because the models quickly become complicated, most theoretical studies involving social interactions use a specific functional form, which can still permit quite general conclusions about social interaction effects (Bernheim 1994, Akerlof 1997, Akerlof and Kranton 2000). The Stone-Geary utility function encompasses much of the previous theoretical research on social interactions and is a convenient objective function for introducing social interactions in a theoretically satisfactory way. We follow the approach known as demographic translating where the demographic characteristics of the individuals reside inside the parameter representing the limit value for hours of work, γ_h (Pollak and Wales 1992).

2.1 Spillover Effects

We embed the social utility (spillover) effect into the parameter $\gamma_h{}'$, using the specification suggested by Brock and Durlauf (2001a,b), $\gamma_h(S(\bullet))' = \gamma_h + \alpha_1 h \mu_h$, where μ_h is the expectation (perhaps sample mean) of hours worked by the reference group members. The reference group is any set of other individuals in the population to which the person refers when making a labor supply decision. The parameter α_1 represents the importance of social utility (spillover) to the individual so that now

$$U(h, c; \mu_h) = \theta \ln(\gamma_h + \alpha_1 \mu_h h - h) + (1-\theta)\ln(c - \gamma_c)\,. \tag{5}$$

The spillover effect can be viewed as a positive externality generated by the labor supplied in the reference group, where a higher mean of hours worked in the reference group decreases the individual's disutility from working. An obvious way to interpret the spillover effect is that someone feels less pain from working if he or she knows others also work.[2]

Maximizing (5) with respect to *c* and *h* yields the augmented earnings function

$$wh = \frac{\{\gamma_c\theta\} + \{\gamma_h(1-\theta)w\} + \{-\theta Y\} - (\gamma_c\theta\alpha_1)\mu_h + (\theta\alpha_1)\mu_h Y}{(1-\alpha_1\mu_h)}\,. \tag{6}$$

The curly brackets {} contain terms from the baseline model. Note that the addition of spillover effects adds two variables to the earnings equation, μ_h and $\mu_h Y$, makes the earnings equation nonlinear, and over-identifies the parameters.

When the base utility function is Stone-Geary incorporating spillovers from others' work efforts, the wage effect on labor supply is

$$\partial h / \partial w = \frac{\{\gamma_h(1-\theta) - h\} + \alpha_1 \mu_h h}{\{w\} - \alpha_1 \mu_h w}. \tag{7}$$

Note that $\partial^2 h / \partial w \partial \alpha_1 \geq 0$ so that labor supply spillover effects make the individual's response to the wage more positive than in the absence of spillovers.[3]

2.2 Conformity Effects

Conformity in behavior and attitudes is a fundamental concept in social psychology (Sherif 1935). The general idea is that individuals tend to conform to broadly defined social norms and the magnitude of response depends on cohesiveness, group size, and social support.[4] Again, we embed the interdependence via the parameter γ_h'' of the baseline utility function so that $\gamma_h(S(\bullet))'' = \gamma_h - \frac{\alpha_2}{2}(h-\mu_h)^2$. Augmented utility is now

$$U(h, c; \mu_h) = \theta \ln(\gamma_h - \tfrac{\alpha_2}{2}(h-\mu_h)^2 - h) + (1-\theta)\ln(c - \gamma_c). \tag{8}$$

The practical implication of a conformity effect in utility is that the person feels penalized when working a different amount of hours than what is typical for the reference group. Intuitively, because there is a penalty for differing from the conformity value for *h*, the utility function incorporating conformity in (8) should have a smoothing effect on hours relative to the baseline model. The smoothing effect of conformity should in turn mean that a change in *h* will have a smaller effect on utility than in the baseline case with an accompanying regression toward the group mean.

The augmented earnings function with a conformity effect is

$$wh = \frac{\{\theta\gamma_c\} + \{\gamma_h(1-\theta)w\} + \{-\theta Y\} + \gamma_c\theta\alpha_2(h-\mu_h) - \theta\alpha_2(h-\mu_h)Y + \tfrac{\alpha_2}{2}(\theta-1)\mu_h^2 w}{(1-\alpha_2\mu_h + (1+\theta)\tfrac{\alpha_2}{2}h)}\,. \quad \textbf{(9)}$$

In the case of conformity the spillover effect introduced into the earnings function via the presence of μ_h is replaced by $(h-\mu_h)$. Again, the conformity version of the earning function is non-linear, but now more complicated in that there is not a simple (linear) closed-form solution for either earnings or hours of work. The underlying fundamental parameters are again over-identified as there are more interaction terms and non-linearity due to the presence of both the individual's labor supplied and the reference group's average hours worked.

The wage effect on labor supply when there is a conformity effect is

$$\frac{\partial h}{\partial w} = \frac{\{(1-\theta)\gamma_h - h\} + \tfrac{\alpha_2}{2}(h-\mu_h)((1+\theta)\mu_h - (1-\theta)h)}{\{w\} + \theta\alpha_2(Y-\gamma_c) + w\alpha_2((1+\theta)h-\mu_h)}\,, \quad \textbf{(10)}$$

where the terms in curly brackets { } again indicate the basic Stone-Geary model.

Even in the Stone-Geary case the expression for the effect of the wage on labor supplied is lengthy, and without specific assumptions it is impossible to determine the labor supply function effects of conformity compared with the baseline case.

2.3 Stone-Geary Utility and Linear Expenditure System with Interactions

Earlier we noted that the Stone-Geary utility function is convenient for its simplicity and relative flexibility. However, most research that includes social interactions into the LES does not distinguish among different forms of interactions, such as spillover versus conformity, and the interactions are not modeled as related to the individual's demand for the particular good. Using the notation we introduced earlier, most research implicitly uses $S = S(\alpha, \mu_h) = \alpha\mu_h$. Our work can then be viewed as an extension of the LES with interactions where the individual's choice affects the level at which one responds to the choices of others. Our extension is reasonable because we contend that people are more likely to care about the actions of others in their reference group if the particular activity makes a significant contribution to the individual's utility. Here we take $S(\alpha, h, \mu_h) = \alpha h \mu_h$ for the particular case of spillover and $S(\alpha, h, \mu_h) = (\alpha/2)(h - \mu_h)^2$ for the particular case of conformity. The most common LES model with interactions to date, which uses $S(\alpha, \mu_h) = \alpha\mu_h$, then closely resembles our spillover effect.

Finally, in further relation to the past literature on the LES with interactions we also distinguish between exogenous and endogenous interactions as represented by the presence of μ_h. By considering endogeneity as an issue we attempt to include the concept of a social multiplier into a popular parametric utility specification used in studies of interdependence in consumption and labor supply.

3. Exogenous Social Interactions

We now present the details of labor supply with versus without social interactions in utility. We first compute the basic Stone-Geary utility function and then add spillover or conformity. Last we compute the labor supply functions and elasticities. The end product is an enhanced understanding of the relative effect of social interactions in the individual's preferences on the labor supply outcomes. As Appendix A demonstrates, the conclusions in the following sections concerning spillover and conformity are general in that only the magnitudes differ for various functional forms (Grodner 2003). We select the Stone-Geary utility function form mainly for tractability.

3.1 How Social Interactions Shift Labor Supply

We begin by creating results comparable to Blomquist (1993) who computes hours of work for given wage rates and selected magnitudes of interactions. The values for hours of work we will discuss have been computed using the solutions for desired *h* from the three earnings functions, (3), (6), and (9), with numerical details described in Appendix B. In the case of the baseline model versus spillover, computing labor supply is a straightforward manipulation of the earnings function. In the case of the baseline versus conformity, deriving labor supply involves the solution to the quadratic function for earnings with respect to *h*.

The three labor supply functions that we examine numerically are

Baseline (rearranged equation (3))

$$h = \frac{\theta\gamma_c}{w} + (1-\theta)\gamma_h - \frac{\theta Y}{w}. \tag{11}$$

Spillover (rearranged equation (6))

$$h = \frac{\{\gamma_c\theta + \gamma_h(1-\theta)w\} - \{\theta Y\} + (\gamma_c - Y)\theta\alpha_1\mu_h}{\{w\}(1-\alpha_1\mu_h)}. \tag{12}$$

Conformity (positive value after solving the quadratic equation in (9))

$$h = \frac{1}{2a}(-b - \sqrt{b^2 + 4ac}), \tag{13}$$

where

$$a = \tfrac{\alpha_2}{2}\{w\}(1+\theta)$$
$$b = (w(\alpha_2\mu_h - 1) + \alpha_2\gamma_c\theta - \alpha_2\{\theta Y\})$$
$$c = [\{w(1-\theta)\gamma_h\} - \tfrac{\alpha_2}{2}\mu_h^2 w(1-\theta) + \{\theta(Y-\gamma_c)\}(\alpha_2\mu_h - 1)]$$

We compute results for the two different interactions specifications with differing magnitudes of spillover and conformity effects as represented by the numerical value for the parameter α_i. For simplicity we use $\alpha_1 = 0.00001$ to represent a small amount of spillover and (double it to) $\alpha_1 = 0.00002$ to represent much greater spillover.[5] For comparability we present results for low versus high conformity effects that are $\alpha_2 =$ 0.005 and twice its value, $\alpha_2 =$ 0.01.[6] It is important to recognize that α_1 and α_2 are not connected; they are totally different parameters governing two separate models of social interactions.

To understand labor supply with social interactions we present our results graphically. Figure 1 shows that spillover creates mostly a parallel rightward shift in the labor supply function where the magnitude of the shift depends on the value of α_1. Spillover leads to more labor supplied and a similar wage responsiveness of labor supply with and without spillover.[7] Figure 2 illustrates that conformity causes labor supplied to tend toward the mean of the reference group, μ_h. Workers with $h < \mu_h$ in the absence of conformity work more hours under conformity, and workers with $h > \mu_h$ in the absence of conformity work fewer hours under conformity. As the importance of conformity in the utility function (α_2) rises, labor supply becomes steeper and less elastic. The conclusions for both spillover and conformity are general in that only the magnitudes differ for various functional forms (Appendix A and Grodner 2003).

3.2 Bias When Spillover Is Present

To determine the effect of the unmodeled social interactions in a hypothetical empirical study we first need to consider what kind of data and estimator are to be used. As a starting point it seems reasonable to assume that the norms individuals refer to may be related to behavior (a) of their own in the past (time series), (b) of other individuals in the present (cross-section), or (c) both (panel data). If the levels of the norms vary across individuals, it means that μ_h from (5) or (8) may be group-specific or even individual specific. Each case would require a specific data set and the appropriate estimation technique.

One interesting example is the case of the family members being the reference group for each other (Neumark and Postlewaite 1998). The idea has both theoretical foundation and reasonably good quality data available for testing it. In a family reference group situation the model would be similar to the approach used in studies of the Rotten Kid Theorem (Becker 1981). One of the model's predictions is that dividing income equally is usually not family welfare maximizing. In our setup we would consider the effect of the overall family non-work time on each individual's labor supply. The difficulty of the research would be in identifying the effect of the social interaction from the effect of the public good in the household due to the benefits of living together. In his review article Bergstrom (1997) discusses how interactions within the family can affect the behavior of the individuals in the household, Jenkins and Osberg (2002) investigate social interactions within the family as a leisure coordination problem, and Alesina, Glaeser, and Sacerdote (2005) find that Europeans may work less than Americans because of regulations that enable Europeans to take vacations at the same time, which raises the satisfaction from vacations and induces more vacation time.

In the following discussion we assume the simplest possibility: the same norm for every person. It is the most basic case relevant for the cross-sectional data. Although constant μ_h may be unrealistic, it is instructive and relatively easy to examine.

When the reference group is the population the relevant comparison point is μ_h, which is the same for every person. Because there is no variation in the reference group in our simple example, μ_h becomes another parameter in the utility function, so we call it a distorted Stone-Geary. The system in terms of the structural parameters is exactly identified, so the linear labor earnings equation with spillover (6) is

$$wh = \{\gamma_c \theta\} + \left(\frac{\{\gamma_h (1-\theta) w\}}{(1-\alpha_1 \mu_h)} \right) - \{\theta Y\} . \qquad \textbf{(14)}$$

From (14) we see that a consequence of ignoring positive spillover and estimating the linear earnings regression in (3) versus the correct non-linear earnings function in (14) is an upward bias in the coefficient of the wage, β_w, by $\left(\frac{1}{1-\alpha_1\mu_h}\right)$. Ignoring positive spillovers in turn produces an upward bias in $\hat{\gamma}_h = (\hat{\beta}_w / (1+\hat{\beta}_Y) = \gamma_h / (1-\alpha_1 \mu_h)$ because $0 < (1-\alpha_1\mu_h) < 1$.[8] When the spillover in hours is ignored incorrectly two of the structural parameters are correctly estimated as $E(\hat{\theta} - \theta) = 0$, $E(\hat{\gamma}_c - \gamma_c) = 0$. The third is not. Specifically, $E(\hat{\gamma}_h - \gamma_h) = (\alpha_1 \mu_h / (1-\alpha_1\mu_h))$ is the proportional upward bias in the estimated value of γ_h.

Note that replacing $\hat{\gamma}_h$ with $\left(\widehat{\frac{\gamma_h}{(1-\alpha_1\mu_h)}}\right)$ in the slope of the baseline model yields

$$\left(\frac{\partial h}{\partial w}\right)_{\substack{misspecified\\ baseline}} = \frac{\hat{\gamma}_h(1-\hat{\theta})-h}{w} = \frac{\frac{\gamma_h}{(1-\alpha_1\mu_h)}(1-\theta)-h}{w} = \left(\frac{\partial h}{\partial w}\right)_{\substack{correct\\ spillover}} . \quad \textbf{(16)}$$

As long as the researcher uses the correct slope formula implied by the assumed model, even incorrectly omitting spillover need not affect a result of interest. The baseline earnings function approximates the spillover model.

Unbiasedness of $\hat{\beta}_0$ and $\hat{\beta}_Y$ extends to other earnings/labor supply functions when the estimated coefficients are not a function of γ_h. When spillover does not have a linear form then all coefficients can be biased in undetermined ways (Grodner 2003).

3.3 Bias When Conformity Is Present

When there is a conformity effect we cannot solve for the bias in the structural parameters inferred from the estimated regression coefficients of a linear labor earnings function ignoring social interactions. The difficulty in establishing bias analytically happens because the conformity case (9) cannot be solved explicitly for earnings, and the associated labor supply function (12) is non-linear in the wage and non-labor income.

From Figure 2 we can deduce the bias to the coefficients in the labor supply or earnings functions. Because we know that conformity makes labor supply flatter the dependent variable, hours of work, has less variation. In the limit labor supply becomes constant. As a consequence, all coefficients that are not a function of γ_h will be zero. In the particular case of the Stone-Geary earnings function $\hat{\beta}_0 \to 0$, $\hat{\beta}_Y \to 0$, and $\hat{\beta}_w \to \mu_h$. The inferred structural parameters will also be biased in that $\hat{\theta} \to 0$, $\hat{\gamma}_c \to 0$, and $\hat{\gamma}_h \to \mu_h$.

3.4 Summary: Bias From Ignoring Exogenous Social Interaction

The fact that the bias to the baseline coefficients is different when spillover or conformity effects are present but ignored, underlines the need for a precise modeling of interactions effects. For example, a researcher cannot simply include μ_h into the regression to control for the omitted variable bias. If the interactions are exogenous, though, we believe that using a so-called partly linear regression model will suffice to control for social interactions of unknown functional form (Yatchew 2003).

So far our discussion has taken the expectation of hours worked for others in the individual's reference group, μ_h, as an exogenous social norm. The consequence of the social norm interpretation is that social interactions are effectively a response by the individual to the labor supply of the reference group. The difficulty of estimating labor supply with exogenous social interactions comes from the likelihood that the researcher does not know what μ_h is for an individual (omitted variable bias) or mis-specifies how μ_h enters the labor supply function algebraically (incorrect functional form bias). We have demonstrated how the presence of exogenous positive spillover social interactions shifts out the labor supply schedule and how exogenous conformity social interactions pivots labor supply to approach a constant hours worked that is the group norm. Now we consider what happens to labor supply when μ_h is endogenous.

4. Endogenous Social Interactions and Economic Policy

For the intuition behind an endogenous μ_h consider a worker who, in addition to being directly affected by the social norm in the reference group (in the form of average hours worked), now can also affect the social norm by changing labor supplied (which in turn affects reference group average hours worked). In addition to the direct wage effect there is also an indirect effect through feedback from the other (n – 1) members of the reference group. Because $\mu_h = \bar{h}_{-i} = \sum_{j=1, i \neq j}^{n} h_j / (n-1)$ here the labor supply model within each reference group becomes a simultaneous system as the labor supply of each member enters into the labor supply of all other members. Now the interactions no longer depend on an exogenous social norm, but rather on an endogenous social norm that is jointly determined by all the members of the reference group. Practically speaking, μ_h becomes an endogenous variable such that an increase in the labor supply of each reference group member increases the mean hours worked in the reference group, and when the other members of the group respond to the change of the overall mean there is a feedback effect to the person who initially changed labor supply.

There are two situations to consider: (a) only the individual's wage changes and (b) the wage change is general to the reference group such that each member experiences the same wage change. The size of the reference group also plays a crucial role concerning the wage effects in the two situations of person-specific versus group-wide wage changes. With person-specific wage effects, $\partial \bar{h}_{-i} / \partial h_i \to 0$ as n increases so that in large groups the endogenous feedback effect is negligible and can be ignored in evaluating the labor supply effects of policies that alter the wage.[9] Group-wide wage effects make the researcher consider, however, that

$$\partial h_i / \partial w_i = (\partial h_i / \partial w_i)|_{\bar{h}_{-i}} + (\partial h_i / \partial \bar{h}_{-i})(\partial \bar{h}_{-i} / \partial w_i) . \quad \textbf{(17)}$$

Represented more completely in a schematic the social interactions process looks like

$$\overbrace{w_i \rightarrow h_i}^{(\partial h_i / w_i)|_{\bar{h}_{-i}}} \underbrace{\overbrace{\rightarrow}^{(\partial \bar{h}_{-i} / \partial w_i)}}_{(\partial \bar{h}_{-i} / \partial h_i)} \overbrace{\bar{h}_{-i} \rightarrow h_i^1 \rightarrow \bar{h}_{-i}^1 \rightarrow \ldots \rightarrow h_i^e}^{(\partial h_i / \partial \bar{h}_{-i})} \ . \tag{18}$$

When the interactions are exogenous $\partial \bar{h}_{-i} / \partial h_i = 0$; changes in individual hours worked do not affect average hours worked because average hours worked are at the norm. When the interactions are endogenous and there is only an individual's wage change, $\partial \bar{h}_{-i} / \partial h_i \neq 0$ due to the feedback effect, but $\partial \bar{h}_{-i} / \partial h_i$ tends to zero as the number of reference group members increases (Glaeser, Sacerdote, and Scheinkman 2002). With both exogenous and endogenous interactions and an individual wage change, the wage causes only a $(\partial h_i / \partial w_i)|_{\bar{h}_{-i}}$ change in hours worked because $\bar{h}_{-i}$ does not change (much) so that we have exogeneity in the sense of no observable feedback effect for large groups.

When the interactions are endogenous and $(\partial \bar{h}_{-i} / \partial h_i)$ is non-negligible the individual experiences not only an exogenous effect that is $(\partial h_i / \partial w_i)|_{\bar{h}_{-i}}$ but also an endogenous effect that is $(\partial h_i / \partial \bar{h}_{-i})(\partial \bar{h}_{-i} / \partial w_i)$. The schematic in (18) emphasizes that an endogenous effect is first triggered by the exogenous change in the wage rate $(\partial \bar{h}_{-i} / \partial w_i)$, and then the endogenous change continues on its own through the circular feedback effects $(\partial h_i / \partial \bar{h}_{-i})$ until the labor market reaches an equilibrium hours worked, h_i^e.[10]

One way to have a non-negligible $\partial \bar{h}_{-i} / \partial h_i$, which makes endogenous social interactions matter, is when there is a general wage change so that each person experiences the same Δw_i. Even a small Δw_i can generate a significant aggregate effect on hours worked, Δh_i. Therefore, $\bar{h}_{-i}$ for each person will initially change by exactly Δh_i, and the effect $\partial \bar{h}_{-i} / \partial h_i$ will no longer be negligible. An increase in the number of reference group members means that $\partial \bar{h}_{-i} / \partial h_i$ decreases for each person because it is distributed across more workers, in turn making the aggregate effect, $\partial \bar{h}_{-i} / \partial h_i$, the same no matter what *n* is. Regardless of the size of the reference group the labor supply effect through $\partial \bar{h}_{-i} / \partial h_i$ will be the same for a given Δw_i. If we represent aggregate changes in terms of the changes in the average hours worked and average wage, the total effect in (17) and (18) can be conveniently rewritten as

$$(\partial \bar{h} / \partial \bar{w}) = (\partial h / \partial w)\,|_{h=\bar{h}, w=\bar{w}} + ((\partial h / \partial \bar{h})\,|_{h=\bar{h}})((\partial \bar{h} / \partial w)\,|_{w=\bar{w}}). \quad \textbf{(19)}$$

[11]

Up to now we have considered the first term in (19) compared to a model that incorrectly ignores exogenous social interactions (equations (11)–(13) and Figures 1 and 2). We now turn our attention to the two specific algebraic forms of (19) capturing spillover and conformity. In particular, we numerically examine the relative size of the total effect $\partial \bar{h} / \partial \bar{w}$ and the exogenous effect $(\partial h / \partial w)_{h=\bar{h}, w=\bar{w}}$ in (19), which reveals by how much the labor supply wage effect differs when one now considers group-wide wage changes that alter the labor supply reference point for the individual.

In what follows we compute $m = (\partial \bar{h} / \partial \bar{w}) / (\partial h / \partial w)\,|_{h=\bar{h}, w=\bar{w}}$, which is sometimes called a social multiplier because it measures how much the total change differs from the exogenous change due to an exogenous shock (Becker and Murphy 2000, Glaeser et al. 2003). When there are no interactions or interactions are exogenous the social multiplier equals 1. The multiplier also connects labor supply elasticities where interactions are endogenous versus exogenous: $\eta(endogenous) = m \times \eta(exogenous)$.

Empirically it is critical to identify the social multiplier because a researcher can estimate only $\eta(exogenous)$ correctly (Aronsson et al. 1999). A researcher can control for exogenous interactions by including a nonlinear function for μ_h. In the case of endogenous interactions, one not only needs a nonlinear function of μ_h but also worry about the endogeneity of μ_h and the degree of the feedback effect.

4.1 The Wage Effect When the Spillover Effect Is Endogenous

In the case of spillover with Stone-Geary utility, the social multiplier with endogenous social interaction is

$$m = \frac{\partial \bar{h} / \partial \bar{w}}{(\partial h / \partial w)\,|_{\substack{h=\bar{h} \\ w=\bar{w}}}} = \frac{\frac{(1-\theta)\gamma_h - \bar{h} + h^2\alpha_1}{\bar{w} - 2\bar{w}\alpha_1\bar{h} - \theta\alpha_1(Y-\gamma_c)}}{\frac{(1-\theta)\gamma_c - \bar{h} + h^2\alpha_1}{\bar{w} - \bar{w}\alpha_1\bar{h}}} = \frac{\bar{w}(1-\alpha_1\bar{h})}{\bar{w}(1-\alpha_1\bar{h}) - \alpha_1(\bar{w}\bar{h} + \theta(Y-\gamma_c))}. \qquad \textbf{(20)}$$

We present simulation results for different levels of the spillover effect (α_1) in Table 1 along with the calibrated parameters explained in Appendix B. The social multiplier when there is endogenous spillover increases with the level of interactions, and the increase becomes more than proportional for high levels of interactions, which suggests that the feedback effect works longer or the changes are larger. For spillovers where $\alpha_1 = 0.00001$ the wage effect is about two percent greater when spillover effects are endogenous; when the spillover importance increases 10 times to where $\alpha_1 = 0.0001$, the wage effect is 40 percent (or about 20 times) larger when spillover effects are endogenous.

It is helpful to reinforce the social multiplier under social interactions by considering it graphically in Figure 3. When we consider the shift of the labor demand curve from D_0 to D_1, the equilibrium moves from point A to point B (exogenous change: $h_B - h_A$) and then from point B to point C (endogenous change: $h_C - h_B$). The endogenous change comes from the fact that the exogenous change increased equilibrium labor supply to h_B and so the reference hours worked μ_h increased also (feedback effect). Absent exogenous social interactions labor market equilibrium would be at O.

Our measure of the importance of endogenous social interactions in (20), which represents by how much higher the effect of the wage change on the labor supply is when interactions are endogenous than when the interactions are exogenous, is essentially the ratio of the total change to the exogenous change in hours worked, or $(h_C - h_A)/(h_B - h_A)$ in Figure 3. Moreover, if one uses individual data and does not control for interactions, one will incorrectly observe total change as to h_B (multiplier = 1). On the other hand, if one uses aggregate data, one observes correctly the total change as to h_C. The logic follows Glaeser et al. (2003) who demonstrate both theoretically and empirically that the level of aggregation can reveal the existence of social interactions in the data. Our discussion also formalizes a point made by Blomquist (1993) who notes that the researcher needs to consider the effect of interdependence when data are disaggregated.[12]

4.2 The Wage Effect When the Conformity Effect Is Endogenous

When there is conformity in the Stone-Geary case the social multiplier with endogenous social interaction is

$$\frac{\partial \bar{h}_i / \partial \bar{w}}{(\partial h_i / \partial w)\big|_{\substack{h=\bar{h} \\ w=\bar{w}}}} = \frac{\frac{(1-\theta)\gamma_h - \bar{h}}{\bar{w}}}{\frac{\{(1-\theta)\gamma_h - \bar{h}\} + \frac{\alpha_2}{2}(\bar{h} - \bar{h})(1+\theta)\bar{h} - (1-\theta)\bar{h})}{\{\bar{w}\} + \theta\alpha_2(Y - \gamma_c) + \bar{w}\alpha_2((1+\theta)\bar{h} - \bar{h})}} = 1 + \frac{\alpha_2\theta(Y - \gamma_c + \bar{w}\bar{h})}{\bar{w}}. \qquad \textbf{(21)}$$

We present simulation results for different levels of the conformity effect (α_2) in Table 2 along with the calibrated parameters explained in Appendix B. Notice that the proportionate increases in α_2 as one moves down the first column in Table 2 match the proportionate increases in the social multiplier going down the second column. The social multiplier under endogenous conformity increases proportionally with the level of interactions largely because the wage effect with endogenous conformity does not depend on α_2.

4.3 Implications for Research and Policy

In the presence of endogenous social interaction effects there are two components of the change in hours worked due to a wage change. The first component of interactions is exogenous, which increases the labor supply effect due to the wage changes relative to the situation with no social interactions. The second component is due to the endogeneity of μ_h, which further increases the wage effect. The total wage effect that includes endogenous spillover may be large relative to the baseline case of no social interactions, and the bias in labor supply wage effects may be even larger from ignoring social interactions. If the ultimate goal is to use structural parameters of labor supply in simulations of policy, such as income tax reforms, the researcher investigating social interaction effects empirically needs to determine not only whether social interactions are present but also whether they are exogenous or endogenous. When interactions are exogenous the results from a mis-specified model can still be useful for policy evaluations. When interactions are endogenous the results from a mis-specified model can be quite misleading because the researcher cannot correctly identify elasticities (See Aronsson, Blomquist, and Sacklén 1999 for an example). The result is more important because even the introduction of a flexible functional form will not solve the problem. Not taking into account the multiplier will likely understate the true effect.

If there are exogenous social interactions the individual wage effect will be higher for spillover but the elasticity can be well estimated. If spillovers become endogenous the wage effect on labor supply will be higher than when spillovers are exogenous although the implications for relative point elasticities are unclear. When there is exogenous conformity the wage effects become smaller. Practically speaking, when there are social interactions in the form of spillover there is an externality effect that makes behavioral responses to any policy induced wage change stronger. Endogeneity of spillovers further strengthens the policy impact.

Considering all the theoretical implications of social interactions, to make reliable inferences for policy evaluations a researcher must still decide which behavioral effects to use in the particular situation. Ideally the researcher concerned with labor supply-wage issues would want to have the correct individual effect, $(\partial h / \partial w)^{indiv}$, along with the social interactions effect, $(\partial h / \partial \mu_h)^{social}$, to reveal the total effect, $(\partial h / \partial w)^{total}$. However, decomposing the total wage effect into its two components may be infeasible because the researcher may not know the functional form for social interactions or whether they are exogenous or endogenous.

5. Conclusion

Our research has provided evidence concerning the possible bias in estimating labor supply that may stem from the situation where there are un-modeled social interactions present. We considered cases of positive spillover and conformity in hours worked both analytically and numerically. The social interaction effects and their consequences we identify are relevant not only for social interactions in labor supply but also for social interactions in consumer demand, particularly for the Stone-Geary based linear goods and services expenditures and labor earnings system.

The results that there is a positive shift of labor supply due to spillover and a pivoting of the labor supply schedule due to conformity are relatively general for concave utility functions with two goods and most likely in models with many goods as well (Appendix A and Grodner 2003). Depending on the functional form of utility and the social utility term the exact changes in the labor supply schedule due to social interactions may differ, although the general patterns remain as we present. Calibration and usage of the popular Stone-Geary utility function lets us connect the ideas of social interactions to the empirical studies in the literature, relate our work to past research on the LES with interactions, and underline the economic significance of different forms and levels of interdependence. The implications of interactions related to specific functional forms of social utility extend to other theoretical specifications of total utility.

Our results suggest that the bias in the parameters of interest from ignoring social interactions can be economically significant and will differ depending on the form and magnitude of the interactions. Even if one correctly knows the reference group for each individual, adding the reference group's mean hours of work to the regressor list may not be enough to control for the presence of social interactions because the mean hours of work for the reference group may enter non-linearly. Still, something can be learned about the form of social interactions if the researcher can compare results of a badly mis-specified model with the true or closer-to-true model. For example, if the mis-specified model fits the data well then the relative parameters, such as elasticity, can still be accurately estimated.

When there are unmodeled exogenous interactions the estimated structural parameters are biased but elasticities are well estimated. The potential solution is a flexible functional form. However, when interactions are endogenous both parameters and elasticities are incorrect. The possible solution is not only a flexible functional form but also a way to estimate the multiplier. Testing for endogenous versus exogenous interactions and specific solutions are beyond what we do here and are left for future research.

We contend that because a researcher usually uses micro data for demand or supply estimation our insights are of interest to those involved in applied microeconomic studies where social interaction may be present. We have also demonstrated that our work connects to as well as extends established results in the literature and have developed more generally the concept of the social multiplier.

There are different effects on labor supply generated by the different forms that social interactions may take. There is sometimes confusion among economists about the exact meaning of concepts acquired from other disciplines (Manski 2000), and sometimes economists are not clear that the broad term social interactions may encompass many different types of behavior. We have attempted to demonstrate the important differences between endogenous and exogenous spillover versus exogenous and endogenous conformity effects in labor supply. The discussion highlights the research value added from specifying correctly what type of interaction may be present. Our results also warn the applied researcher against using a common econometric specification of interaction effects where the reference group mean is simply included as an additional regressor. Finally, our results also imply the benefits of trying to identify the correct type of interaction.

Endnotes

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1. Obvious ones are utility and labor supply functions linear in [w, Y], [lnw, lnY], or [w, w2, Y, Y2, (wY)].

2. Such a positive externality is recognized in different contexts in social psychology. Under the rule of reciprocation one feels equally deserving of outcomes in the reference group (Cialdini 1993). In cultural spillover the more society legitimates long work hours the more people work to gain social approval (Baron and Straus 1989). In behavioral therapy a person feels relief from trauma when he or she knows that others had similar negative experiences (Hawkins and Eagger 1999).

3. We can also write (7) more informatively as $\partial h / \partial w = \frac{\frac{\gamma_h}{(1-\alpha_1\mu_h)}(1-\theta)-h}{w}$, which highlights that the slope is larger because of the homogeneity of the utility function $1 > (1-\theta) > 0$, and by the fact that leisure is a normal good $0 < (1-\alpha_1\mu_h) < 1 \Rightarrow 0 < \alpha_1 < \frac{1}{\mu_h}$. Now we can see that $\partial^2 h / \partial w \partial \alpha_1 = \frac{\mu_h \gamma_h (1-\theta)}{w(1-\alpha_1\mu_h)^2} \geq 0$. For a game-theoretic approach to social norms and consumption see Young (1998) and Soetevent and Kooreman (2002).

4. For an interesting recent discussion of the costs and benefits to society of conformity versus non-conformity see Sunstein (2002).
5. A small value for α1 is close to 0; the limiting value is 1/2172 = 0.00046 because leisure is a normal good.

6. Here a small value for α2 is again close to zero, but there is no obvious maximum.

7. Notice that the point elasticity changes because the person chooses higher hours of work at a given wage.

8. Another way to view the issue is that if γ_h varies across individuals due to the presence of μ_h but γ_h is treated as a constant we have what amounts to an incorrectly specified random parameters model.

9. Specifically, $\bar{h}_{-i}$ is a weighted mean with weights 1/n, and in larger groups an individual's contribution of h_i to $\bar{h}_{-i}$ ($\forall j \neq i$) is negligible because 1/n $\rightarrow$ 0 as n $\rightarrow \infty$.

10. There are certain additional conditions that need be satisfied for existence, uniqueness, and stability of equilibrium. The explicit Stone-Geary utility function guarantees a unique stable equilibrium. For more discussion see Brock and Durlauf (2001b).

11. As a practical note, in our simulations we first compute $(\partial h / \partial w)|_{h=\bar{h}, w=\bar{w}}$ by taking μ_h as constant, calculating $\partial h / \partial w$, and then setting $\mu_h = \bar{h}$. We also compute $\partial \bar{h} / \partial \bar{w}$ by first setting $\mu_h = \bar{h}$, then taking $\partial \bar{h} / \partial \bar{w}$. Thus, the total effect on the left-hand side of (19) and the exogenous effect in the first term on the right-hand side are only the same when either $\mu_h = 0$ or $\alpha_i = 0$. Note also that (19) is a particular form of the decomposition introduced by Becker and Murphy (2000, p. 13) for a demand for goods and services.

12. The multiplier computed in Glaeser et al. (2003) at different levels of aggregation can be interpreted in our framework as if only part of the population experienced an exogenous wage change, and the researcher observes the equilibrium somewhere between B and C. When the entire population has the exogenous wage change the multiplier in Glaeser et al. coincides with our total change multiplier so that our result extends theirs.

Appendix A: More General Social Interactions Results

It is useful to consider now whether changes in labor supply due to social interactions hold more generally than the Stone-Geary case. To investigate the generality of our results for spillover and conformity effects rewrite labor supply as a general function of the social utility component

$$h = h(w, Y, S(h, \mu_h)) . \qquad \textbf{(A-1)}$$

The algebraic labor supply representation in (A-1) is sufficient to demonstrate what can be said generally about the effect of social interaction on labor supply.

Totally differentiating (A-1) yields

$$dh = h_w dw + h_Y dY + h_S (S_h dh + S_{\mu_h} d\mu_h) . \qquad \textbf{(A-2)}$$

Collecting terms yields

$$dh = \frac{h_w dw + h_Y dY + h_S S_{\mu_h} d\mu_h}{1 - h_S S_h} . \qquad \textbf{(A-3)}$$

Suppose we first consider a spillover effect in the basic form $S = \alpha_1 h \mu_h$, with properties $0 < h_s$, $S_h < 1$. Because $S_{\mu_h} > 0$ the effect of spillover, then, will be to increase labor supply.

Alternatively, with a basic conformity function it is not obvious what the sign of $(1 - h_S S_h)$ would be. Suppose we consider the case where $S = -\frac{\alpha_2}{2}(h - \mu_h)^2$, which has partial derivative $S_{\mu_h} = -\alpha_2 (h - \mu_h)$, together with $(1 - h_S S_h) > 0$. The result emerges that the effect of conformity depends on the location of the individual currently along his or her labor supply curve relative to the reference group hours worked, or h relative to μ_h. For example, if the person works more hours than the reference group he or she will work less under conformity, and the labor supply schedule will be flatter than if no social interactions. More generally, labor supply will pivot around the average hours of the reference group but the exact way depends on the specifics of the underlying fundamentals.

In summary, qualitatively the shifts of labor supply due to social interactions will be the same as in our specific example of the Stone-Geary utility function. The quantitative results depend of the specific utility function and the way social interactions are modeled or how social utility enters total utility.

Appendix B: Calibration

To begin, we need values for the parameters of the utility function: γ_h (maximum feasible hours of work), γ_c (minimum necessary consumption), θ (proportion of full income implicitly spent on leisure), and the moments of the distributions for the independent variables: *Y* (non-labor income) and *w* (hourly wage). We calibrate the model using data from a well-known econometric study that examines the Stone-Geary based labor supply model (Abbott and Ashenfelter 1976, 1979).

Here $\theta = 0.113$ based on our own regression estimates with the data of Abbott and Ashenfelter. Our other econometric parameter estimates include minimum consumption, $\gamma_c = 636$, and maximum hours of work, $\gamma_h = 2465$. The remaining calibration values we use are the mean of annual hours of work needed for spillover and conformity effects in labor supply, $\bar{\hat{h}} \equiv \mu_h = 2172$, and the sample means ($1967) of non-labor income, $\bar{Y} =$ $733, and the hourly wage rate, $\bar{w} =$ $0.77. Note that 2172 is not the exact mean of hours worked in the data, but rather hours worked at the mean wage and mean non-labor income using our estimation results form the Stone-Geary earnings function. We force labor supply through the mean hours worked at the mean wage rate, which the earnings function itself need not do. Finally, note that the slope of labor supply is positive here.

Table 1. The Social Multiplier With Endogenous Versus Exogenous Spillover: Labor Supply Wage Effects

α_1	$m = \frac{\Delta(total)}{\Delta(exogenous)}$
0	1.000
0.00001	1.023
0.00002	1.048
0.00005	1.140
0.00010	1.388
0.00020	4.407

Table 2. The Social Multiplier With Endogenous Versus Exogenous Conformity: Labor Supply Wage Effects

α_2	$m = \frac{\Delta(total)}{\Delta(exogenous)}$
0	1.0000
0.00001	1.0026
0.00005	1.0130
0.00010	1.0260
0.00020	1.0519
0.00040	1.1039
0.00100	1.2597
0.00500	2.2984

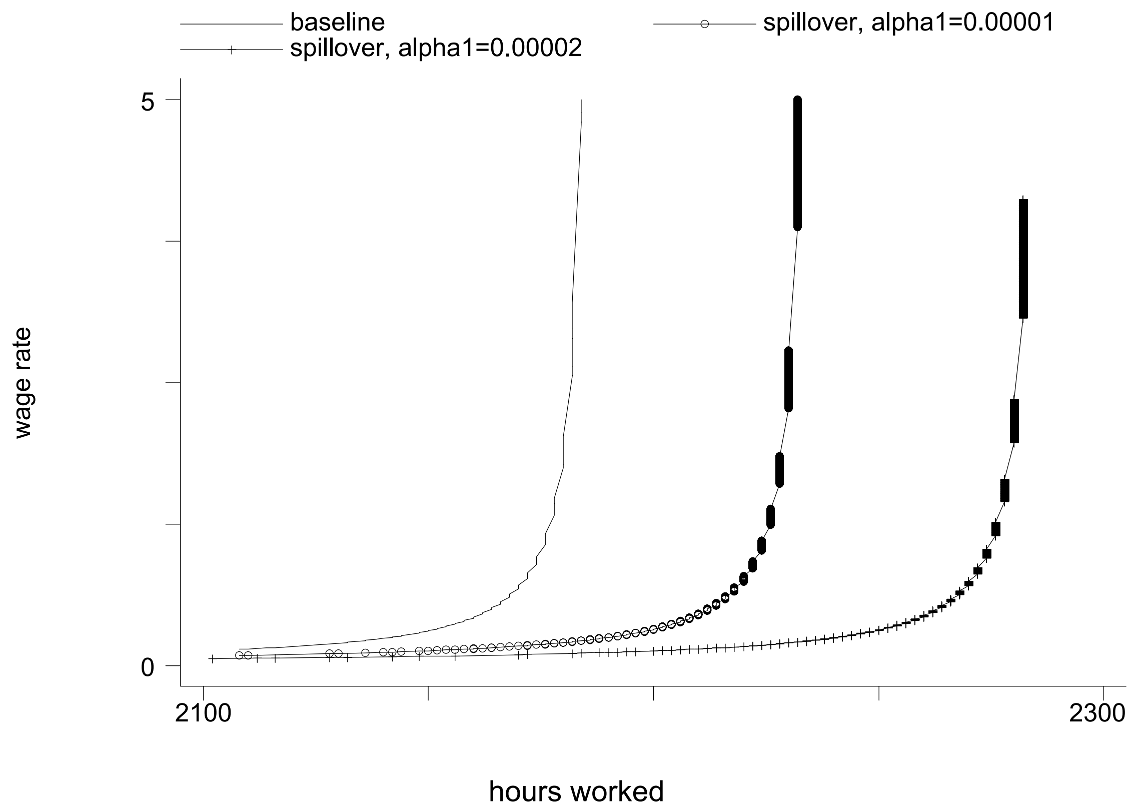


Figure 1. Baseline and spillover with μ_h = 2172, θ = 0.113.

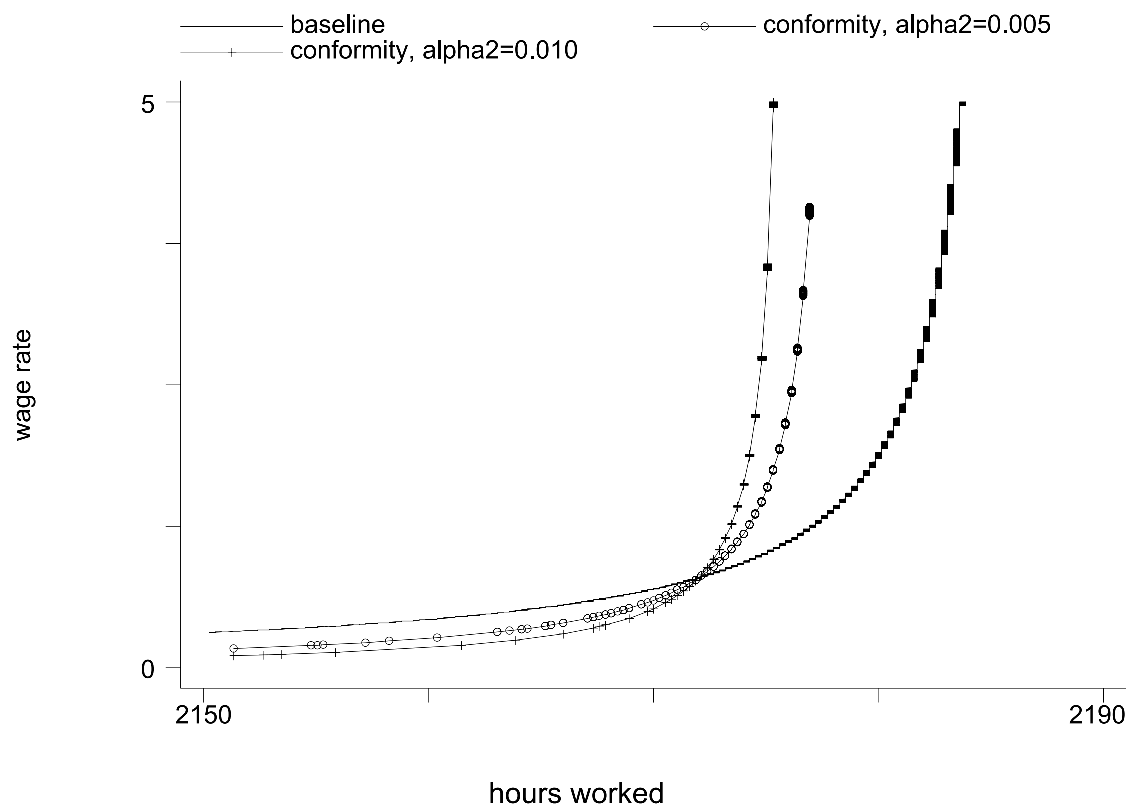
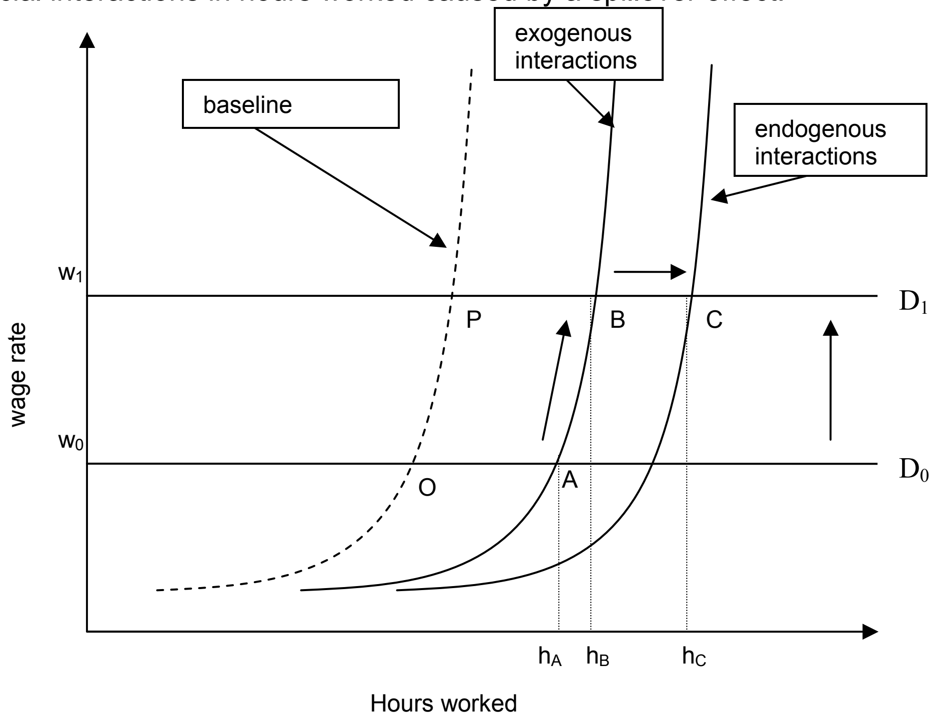


Figure 2. Baseline and conformity with μ_h = 2172, θ = 0.113.

Figure 3. Labor market equilibrium when there are endogenous versus exogenous social interactions in hours worked caused by a spillover effect.



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