Perceptions of Equity and the Distribution of Income *

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Abstract

This paper builds a simple model in which there is a connection between employees' perception of the "fairness" of employers and the actual distribution of income. Employers base their wages on their assessments of the productivity of individual employees. I show that the equilibrium distribution of income depends on the beliefs of employees concerning the accuracy of these assessments. This distribution tends to be more dispersed the more accurate employees believe these evaluations to be. This fits with the observation that, in a sample of seven countries, there is a negative correlation between actual inequality and the extent to which inequality is perceived to be excessive. The changes in beliefs that increase inequality in the model can be expected to lead voters to favor candidates who oppose redistribution. The model can thus account for the disproportionate increase in inequality in countries, such as the United States and the United Kingdom, where the popular political discourse has shifted against redistribution. The model is also consistent with some recent changes in job tenure in the United States and France, where the former experienced a much larger increase in inequality. Among highly educated workers, the tenure of workers whose wages are relatively high has been falling relative to that of lower-paid workers in the United States, while the opposite is true in France.

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People have opinions about the degree to which differences in pay reflect differences in productivity or are, instead, the result of favoritism, personal connections and the whimsy of people with influence. In this paper, I show that opinions of this sort can matter a great deal. In particular, I demonstrate that opinions about the extent to which people believe that differences in pay reflect differences in individual productivity can affect the actual distribution of income even when they have no effect on individual marginal products.[1]

My focus on the effects of these beliefs raises the question of where these beliefs come from. In particular, there is the issue of whether one shouldn't simply assume that people know the truth so that there is no difference between beliefs about the connection between income and productivity and the actual connection between these variables. In this paper, I allow the actual and the perceived connections to differ and I do this for two reasons.

First, the truth about the connection between pay and productivity is difficult to know. If one leaves aside the possibility of experimenting by varying one's own productivity, it is very hard to learn about this connection unless one actually observes the output of different people.[2] But, in modern industrial firms where workers are extremely interdependent and where the aggregate value produced by the firm is subject to large random disturbances, measuring the output of individuals is very hard. There are, of course, indirect measurements of the relationship between productivity and pay. Under the assumptions of the stripped down model I present, for instance, this relationship can be inferred from the statistical properties of individual wages. However, the extent to which statistics of this sort shed light on the issue depends on auxiliary assumptions, the validity of which is itself difficult to establish empirically.

A second, related, reason to consider models where the perceived connection between pay and productivity differs from the actual one is that people do not appear to agree on

[1] The paper is closely related to Piketty (1995) where changes in the perceived connection between effort and income change the equilibrium level of effort and thus change actual income. The difference is that in Piketty (1995), these changed beliefs affect actual income only by first affecting the potential productivity of individuals.

[2] This too is closely related to Piketty's (1995) argument that it is difficult to learn the connection between effort and pay.

this connection. A particularly telling set of examples of this disagreement can be found in Hochschild (1981), who reports on twenty eight in-depth interviews about the distribution of resources. Summarizing she says (p. 140), "The poor ... often argue that if productivity were truly rewarded, this would create *more* equal incomes (italics in original)." And goes on to say (p. 141) "On the other hand, wealthy respondents ... often argue that if productivity were truly rewarded, this would create *less* equal incomes." [3]

The difficulties in determining individual output do not stop firms from basing their pay on estimates of this output. Indeed, in the case of a frictionless competitive labor market, the wage of an individual is equal to his employer's estimate of his marginal product. Opinions about whether people are or are not paid their marginal product do not alter this so that they have no effect on the actual distribution of income.

In the model I present, there are two departures from the assumptions of the standard competitive labor market which ensure that these opinions matter. First, I suppose that a worker's departure from a firm depends on his outside opportunities and that the firm has imperfect information about these opportunities. The result is that employers have some monopsony power and that wages depend both on the firm's perception of their employees' marginal products, and on the firm's assessment of the likelihood that these employees will leave. Second, there are search costs so that workers have to form an opinion about what they will be paid on the outside before they leave a firm.

This combination of assumptions yields a simple mechanism by which opinions affect the distribution of income. If workers regard the evaluations of their employers as inaccurate, they are tempted to quit if they receive a low evaluation while they are inclined to stay if they receive a favorable one. The reason is that, if firms are inaccurate, it is good to work for a firm that has an inaccurately high estimate of one's own ability. Employees who receive high ratings from their current employers conclude that they have found a good match while

[3] These differences are consistent with those found in larger surveys. McClosky and Zaller (1984) report that 84% of respondents whose family income is above $35000 view the capitalist system as fair and efficient while only 51% of respondents with lower income do so. This type of statement may simply reflect different tastes for redistribution but it also could reflect differences in opinions about the determinants of individual incomes.

those who receive a low rating expect alternate employers to pay higher wages.

Thus, if workers change their minds and come to see firms as being more accurate, they change their quitting behavior. Workers who receive a low rating from their firm become more predisposed towards staying (because they now expect a low rating from other firms as well). A rational monopsonistic firm would then tend to cut their wages. Similarly, this change in perception leads workers that have gotten a high rating to become more prone to quit because their fear of getting low wages from alternate employers is reduced. This, in turn, tends to raise their wages. Since the wages of highly rated employees rise while those of employees with low ratings fall, inequality increases.

The paper proceeds as follows. Section 1 presents the model and studies how the wage distribution changes in response to changed perceptions by workers of the accuracy of firm's evaluations. Section 2 studies the change in aggregate output when workers come to perceive firms as more accurate. One difficulty with evaluating aggregate outcomes is that one needs an "objective" measure of firms' ability to evaluate workers and, for the reasons I mentioned it is hard to know how one would go about obtaining one. For the purpose at hand, I pretend that firms have an accurate assessment of their own ability to judge individuals' productivity. This leads me to use the firms' estimates of their accuracy in computing the model's predictions regarding aggregate output.

The main conclusion of this section is there are plausible conditions under which aggregate output declines when workers deem firms to be more accurate, though there also exist conditions under which output rises. One reason for output to decline is that increased confidence in the ability of firms to evaluate workers leads more high-wage workers to quit and there is often a larger deadweight loss associated with these quits than there is with the quits of low-wage workers.

Section 3 discusses the empirical relevance of the model. Beliefs about the fairness of the distribution of income differ both cross-sectionally and over time. In particular, residents of different countries harbor differ beliefs about this fairness. I thus study the connection between the income distribution in individual nations and the beliefs held in those nations.

I show that, across a sample of seven countries, actual inequality is negatively correlated with the perception that income inequality is excessive. This is in broad accordance with the predictions of my model.

It also may be possible for beliefs about the fairness of the income distribution to change fairly rapidly within a country. This could occur as a result of the spreading of incontrovertible new evidence (as in Bolton and Harris 1999) but might also happen in cases where the "new" evidence is relatively tenuous. The perception that inequality is excessive is presumably associated with voting for candidates who favor redistribution. Thus, changes in the dominant political discourse can to some extent be read as changes in the degree to which individuals see unequal outcomes as fair. The model would then be able to account for the fact that income inequality has increased disproportionately in countries such as the U.S. and the U.K. where the political support for redistribution appears to have waned.

Since the implications of the model for the distribution of income are closely tied to its implications for quits, it seems worthwhile to compare the changes in job tenure across countries who have experienced different changes in their income distributions. I thus study changes in job tenure in France and the United States. According to the model, job tenure among those with relatively high incomes should have fallen in the United States relative to the tenure of lower-wage individuals (as it is the willingness to hop from job to job among high-wage individuals that has raised their wages). By contrast, in France, job tenure among individuals with high incomes should not have fallen relative to that of individuals with low incomes. The actual changes in the tenure of individuals with relatively high levels of education are consistent with these implications, though this is not true for individuals whose educational attainment is lower. Section 5 concludes.

1 The Model

1.1 The Basic Structure

Employees are of two types. I suppose that those for whom a parameter r is equal to one have higher productivity, at least in certain occupations, than those for whom the parameter r is equal to zero. While firms do not observe r directly, they do observe signals that are correlated with r. The focus of my study is the connection among wages, employee turnover and employee beliefs about the accuracy of firms' signals about r.

There are two periods because this is the minimal number of periods required to study turnover and my model is one where beliefs affect wages only through their effect on the tendency to quit. The sequence of potential employers for each employee is depicted in Figure 1. In each period, employees choose whether to work at a firm of type S where their output equals $q_S + vT$ with $v > 0$, or whether to work at a firm of type N where employee output is independent of r. Individuals start the first period attached to particular firms of type S in the sense that, for each employee, there exists a firm which observes a signal s_1 which is correlated with the employee's productivity. This firm makes a wage offer to the employee at the beginning of period 1. Simultaneously, the employee receives an offer from a type N firm. The employee then chooses which firm he wants to work for in period 1.

If he works for the firm of type N in period 1, there is a second type S firm which observes a new signal s_2 about the employee's productivity at the beginning of period 2. This employee then receives two wage offers in period 2, one from this new type S firm and one from a new type N firm. If, by contrast, the employee stays with his initial type S firm in period 1, no other type S firm offers him a job in period 2. Such an employee must thus decide in period 2 whether to accept the new wage offer that he receives from his initial type S firm or whether to accept an offer made by a new type N firm. This captures two aspects of quitting a job. The first is that departure from a job often expands an employee's range of opportunities. The second is that the opportunities that will become available are somewhat uncertain at the time the individual quits.

The offers from firms of type N play a dual role in my analysis. On the one hand, they dampen the monopsony power of the type S firms and this is indeed their only role in period 2. In addition, they serve as transitional jobs for employees who wish to move from one type S employer to another. To keep the analysis simple I suppose that firms of type N pay employees the value of their marginal product q_N while also conferring on to them a nonpecuniary utility which is equivalent to an additional compensation of n.[4] Abusing the language somewhat, I thus treat him as receiving a total compensation of $q_N + n$. For any given employee, the value of n is drawn independently at each point in time from a distribution whose cumulative density function is $F(n)$ with $0 \leq n \leq \bar{n}$.[5]

There is another interpretation for n which yields similar results for the behavior of wages and quitting decisions. Instead of being thought of as a nonpecuniary benefit of working at a firm of type N, n can be thought of as a nonpecuniary cost of working at a firm of type S. One can imagine that at the beginning of each period, the employer of type S assigns a particular task to the employee and that this gives him a disutility of n. The analysis of equilibrium wages in the second period is then unchanged as long as the level of this disutility is unknown to the employer of type S. First period wages are not the same, but respond in a similar way to changes in employee beliefs.

I analyze the model backwards starting with the wages paid in the second period at firms of type S. I then study expected compensation in the second period as viewed from period one. This differs from expected wages at S because individuals have the option of working in firms of type N. Finally, the last subsection describes equilibrium wages in the first period.

[4]The simplest rationalization for this is there are actually two alternative firms in which the individual has a productivity q_N and that the employee gets the same nonpecuniary utility in both. If each of these firms gets to make one wage offer to the employee then the logic of Bertrand competition leads them to offer him q_N.

[5]Using zero as the lower bound for the realizations of n does not reduce the generality of the analysis since one can think of the lowest value for n as being incorporated in q_N.

1.2 Second Period Wages

Employers in type S firms know that employees will leave and go to type N firms if they are offered a wage w that is lower than the employee's realization of $q_N + n$ (or, equivalently, if q_N exceeds the realization of $w - n$). The expected benefit from keeping an employee to which the firm pays w is $(q_S + vEr - w)$, where Er represents the firm's expectation of the employee's r. Thus, these employers set their wage offers w to maximize

$$F(w - q_N)[q_S + vEr - w] \tag{1}$$

where E takes expectations conditional on the information available to the firm.

The first order condition for this problem is

$$f(w^* - q_N)[q_S + vEr - w^*] - F(w^* - q_N) = 0. \tag{2}$$

This represents the optimum wage as long as the boundary conditions

$$[f(0)[q_S - q_N + vEr] > 0 \qquad f(q_N + \bar{n})[q_S - q_N - \bar{n} + vEr] < 1 \tag{3}$$

and second order condition

$$f'[q_S + vEr - w^*] - 2f < 0 \tag{4}$$

are satisfied. I assume that $f(0)$ is positive and that, for all workers,

$$q_S - q_N + vEr > 0 \tag{5}$$

which ensures that the first boundary condition holds so that $[q_S + vEr - w^*]$ is positive in equilibrium and the firm earns positive rents on employees who stay. If the rents $[q_S - q_N + vEr - \bar{n}]$ are sufficiently large, the second boundary condition in (3) is violated and the firm simply pays $q_N + \bar{n}$ which ensures that the employee stays with probability one.

Turning back to the interior case, differentiating (2) with respect to Er, q_N and w^* one obtains

$$dw^* = \frac{f}{2f - f'[q_S + vEr - w^*]} vdEr + \frac{f - f'[q_S + vEr - w^*]}{2f - f'[q_S + vEr - w^*]} dq_N. \tag{6}$$

The second order condition (4) implies that the denominator in these expressions is positive so that an increase in the employee's expected productivity r raises the wage offer. To ensure that increases in the employee's outside wage, q_N, also raise the firm's wage offer, it is necessary and sufficient that

$$f'[q_S + vEr - w^*] - f < 0 \tag{7}$$

which is consistent with (4) but puts an even tighter bound on the extent to which f' is allowed to be increasing. This bound is needed because an increase in q_N lowers the value of n at which individuals depart for a given wage. If f' is increasing in n, this implies that an increase in q_N lowers the extent to which increases in w promote employee retention, and this tends to reduce the optimal wage. Given (2), (7) is satisfied as long as $\frac{f'}{F} - \frac{f^2}{F^2}$ is negative. This, in turn, is satisfied if and only if the hazard f/F (which is the hazard of increased departures due to reductions in n) decreases as n rises. I assume this monotone hazard condition from now on.

To compute the optimal wage, one must know the value of Er. For simplicity, I assume that s_1 and s_2 are the only sources of information about r used by firms. In particular, firms whose employees join them in period 2 ignore the work histories of these employees in computing Er. This is so even though such firms ought to recognize that employees who left their period 1 employers have, on average, drawn different values of s_1 than those that didn't. The simplest rationalization for this is to suppose that period 2 employers do not believe that the signals observed by these earlier employers are informative.[6] In an earlier version of this paper I imagined instead that they computed Er under the assumption that they regarded these signals as informative. While this complicates the analysis considerably, it neither changes the results nor contributes much additional insight.

Along similar lines, I suppose that the work carried out by employees during period one does not lead their own employers to acquire additional information about their productiv-

[6]It may also be possible to rationalize such an assumption by embedding this model into one where there are overlapping generations of workers and firms do not know the age of their employees. In such an extended model, however, the quality of the pool of unattached workers is likely to depend on firms' wage policies as in Acemoglu and Pischke (1996) and I ignore this in my analysis.

ity. Again, the main reason for this assumption is the extra simplicity it brings, though the assumption can be justified by supposing that the firm's only additional information is an indicator of total output which contains negligible information about individual contributions.[7] Alternatively, one can imagine that the value of the employee's output accrues over time and that the effect on firm output of employees of different productivities is not detected until much after the employees have left the firm.

I now turn to the characteristics of the signals s_1 and s_2. I let the unconditional probability that s_1 (or s_2) is equal to one as well as the unconditional probability that r is equal to one be equal to ϕ. Thus ϕ denotes both the fraction of high productivity individuals and the fractions of individuals who get high signals.

Consider now the beliefs concerning the likelihood that s_1 (or s_2) equals a particular value as a function of the value taken by r. It is important to stress that these are subjective beliefs concerning the accuracy of a signal. Thus these beliefs can differ across agents. I therefore denote by σ and σ_w respectively the subjective conditional probabilities held by firms and workers that s_1 (or s_2) equals one conditional on r being equal to one. To ensure that the signals are regarded as informative about r, I assume that both σ and σ_w exceed ϕ.

I let r^z denote the subjective probability of firms that r is equal to 1 given that s_1 (or s_2) is equal to z. This also equals their conditional expectation of r. These conditional probabilities are

$$r^1 \equiv P(r=1|s_1=1) = \frac{P(s_1=1|r=1)P(r=1)}{P(s_1=1)} = \sigma \tag{8}$$

$$r^0 \equiv P(r=1|s_1=0) = \frac{P(s_1=0|r=1)P(r=1)}{P(s_1=0)} = \frac{(1-\sigma)\phi}{1-\phi}. \tag{9}$$

Letting w_2^z denote the wage paid in the second period by type S employers to employees whose s_1 (or s_2) is equal to z, this implies

Proposition 1: $w_2^1 > w_2^0$

Proof: Because σ exceeds ϕ, (8) and (9) imply that Er (which equals r^z) is larger when the

[7] Even if such an indicator contained good information about average productivity, this would not be very useful if economies of scale obliged the firm to hire many employees of independent ability.

signal is equal to 1. Given (6), this implies that the wage is higher as well. ■

At the same time:

Proposition 2: $w_2^1 - w_2^0 < v(r^1 - r^0)$

Proof Using (2) in (6),

$$\frac{dw^*}{dEr} = \frac{f}{f + \{f - \frac{f'F}{f}\}}. \tag{10}$$

Since the term in curly brackets is positive, this is smaller than one. This immediately implies the result. ■

Thus, while employees with $s_1 = 1$ receive higher wage offers than employees with $s_1 = 0$, the difference between an employee's expected productivity and his wage is also increasing in the value of s_1.

1.3 The Expectation of Second Period Compensation in Period 1

I suppose that each individual worker knows the signal s_1 that is observed by his original type S employer.[8] Supposing n is the nonpecuniary compensation in a firm of type N, an employee with $s_1 = z$ who stays with his original employer can expect to earn w_2^z if $q_N + n$ turns out to be less than w_2^z. Otherwise he earns $q_N + n$. Thus, such an employee can expect to earn c_2^z in the second period where

$$\begin{aligned} c_2^z &= F(w_2^z - q_N)w_2^z + \int_{w_2^z - q_N}^{\bar{n}} (q_N + n)dF(n) \\ &= q_N + F(w_2^z - q_N)(w_2^z - q_N) + \int_{w_2^z - q_N}^{\bar{n}} ndF(n) \end{aligned} \tag{11}$$

The derivative of c_2^z with respect to w_2^z is the probability of earning this wage, $F(w_2^z - q_N)$. Because this is positive proposition 1 implies that the expected compensation of an employee whose s_1 equals to one exceeds that of an employee whose s_1 is equal to zero. However,

[8] Alternatively, one can assume that he has to infer his s_1, and thus his second period wage at both his current and alternate type S firm, from his first period wage. This gives the same equilibrium allocation as in the case where the employee observes s_1 directly as long as employees with different values for s_1 get different first period wages. What complicates the analysis of this case is that the firm can now choose to pay all employees the same first period wage so as to make it impossible for them to learn their realization of s_1. In numerical simulations I have carried out, I have not found any parameter combinations for which the firm would profit from this concealment of information. Thus, for the parameters I have studied the equilibrium is the same whether employees observe s_1 directly or not.

because this derivative is less than one, expected compensation does not rise as fast as this wage offer. The reason, of course, is that individuals who receive low wage offers are more likely to leave their type S employer.[9]

Consider now the expected compensation of an employee who leaves his initial type S employer. If this employee draws a signal s_2 equal to z at his new type S employer in period 2, he can expect to receive a compensation of c_2^z. This means that his expected period 2 compensation is

$$c_L^z = P_w(s_2 = 0|s_1 = z)c_2^0 + P_w(s_2 = 1|s_1 = z)c_2^1 \tag{12}$$

where P_w represents employees' subjective probabilities. This compensation depends crucially on the conditional distribution of s_2 given s_1. I calculate this under the additional assumption that everyone agrees that the realization of s_2 is independent of the realization of s_1 once one conditions on the true value of r. In other words

$$P(s_2 = 1|s_1 = j, r = k) = P(s_2 = 1|r = k) \qquad \text{where } k, j = 0, 1. \tag{13}$$

The worker's subjective probability that a signal s_1 equal to one will be followed by an s_2 equal to one is then

$$\begin{aligned} P_w(s_2 = 1|s_1 = 1) &= P_w(s_2 = 1, r = 0|s_1 = 1) + P_w(s_2 = 1, r = 1|s_1 = 1) \\ &= P_w(s_2 = 1|s_1 = 1, r = 0)P_w(r = 0|s_1 = 1) + P_w(s_2 = 1|s_1 = 1, r = 1)P_w(r = 1|s_1 = 1) \\ &= \frac{(1-\sigma_w)^2\phi + \sigma_w^2(1-\phi)}{1-\phi} = \phi + \frac{(\sigma_w - \phi)^2}{1-\phi}. \end{aligned} \tag{14}$$

Similarly, the subjective probability that s_2 will equal zero given that s_1 equals zero is

$$\begin{aligned} P_w(s_2 = 0|s_1 = 0) &= P_w(s_2 = 0, r = 0|s_1 = 0) + P_w(s_2 = 0, r = 1|s_1 = 0) \\ &= P_w(s_2 = 0|s_1 = 0, r = 0)P_w(r = 0|s_1 = 0) + P_w(s_2 = 0|s_1 = 0, r = 1)P_w(r = 1|s_1 = 0) \\ &= \Big[1 - \frac{\phi(1-\sigma_w)}{1-\phi}\Big]^2 + \frac{\phi(1-\sigma^2_{)}}{1-\phi} = 1 - \phi + \phi\Big(\frac{\sigma_w - \phi}{1-\phi}\Big)^2. \end{aligned} \tag{15}$$

[9]Consider instead the case where n is the disutility of working at the type S firm. The employee then earns $w_2^z - n$ for n below $w_2^z - q_N$ and q_N otherwise. Thus, his expected compensation is $q_N + F(w_2^z - q_N)(w_2^z - q_N) - \int_0^{w_2^z - q_N} ndF(n)$. This differs from the value in (11) only by the average value of n, $\int_0^{\bar{n}} ndF(n)$ which is a constant independent of w_2^z. Because only the properties of the connection between expected compensation and the second period wage matter for the comparative statics concerning how first period wages and turnover respond to σ_w, these comparative statics carry over to this case as well.

Both the expression in (14) and that in (15) are increasing in σ_w (assuming the signal is seen as informative so that σ_w exceeds ϕ). The intuitive reason for this is that a higher σ_w implies that both s_1 and s_2 are seen as more highly correlated with r. As a result, a higher σ_w ensures that s_1 and s_2 are more highly correlated with each other.

Using (12), this implies that expected compensation for employees who leave with s_1 equal to zero and one are, respectively

$$\begin{aligned} c_L^0 &= P_w(s_2 = 0|s_1 = 0))c_2^0 + (1 - P_w(s_2 = 0|s_1 = 0))c_2^1 \\ &= c_2^0 + \phi\Big[1 - \Big(\frac{\sigma_w - \phi}{1 - \phi}\Big)^2\Big]\Big[c_2^1 - c_2^0\Big] \end{aligned} \tag{16}$$

$$\begin{aligned} c_L^1 &= (1 - P_w(s_2 = 1|s_1 = 1))c_2^0 + P_w(s_2 = 1|s_1 = 1))c_2^1 \\ &= c_2^0 + \Big[\phi + \frac{(\sigma_w - \phi)^2}{1 - \phi}\Big]\Big[c_2^1 - c_2^0\Big]. \end{aligned} \tag{17}$$

This implies immediately

Proposition 3: An increase in σ_w raises c_L^1 and lowers c_L^0.

Proof: Differentiating (16) and (17),

$$\frac{dc_L^1}{d\sigma_w} = -\frac{1 - \phi}{\phi}\frac{dc_L^0}{d\sigma_w} = 2\frac{\sigma_w - \phi}{1 - \phi}[c_2^1 - c_2^0] \tag{18}$$

This is positive because $\sigma_w > \phi$ and because the discussion below proposition 1 implies that c_2^1 exceeds c_2^0. ■

Thus, the belief that firms are more inaccurate (so that σ_w is low) leads workers who get an s_1 equal to one to expect lower wages on the outside while it leads workers who get an s_1 equal to zero to expect higher wages on the outside. The reason is that a low value of σ_w leads workers to regard both the current realization of s_1 and the future realization of s_2 as likely to be mistaken. As σ_w falls, workers deem it more likely that a high realization of s_1 will be followed by a low realization of s_2. Thus, an employee who gets a high s_1 value becomes less optimistic about his compensation on the outside. Similarly, an employee with a low s_1 becomes less pessimistic about his compensation by an alternate type S firm.

Note that σ_w matters only because it affects workers' subjective distribution of the wages they would be paid by their next employer if they quit their current job. Thus, σ_w would not matter if workers had independent knowledge of the distribution of future wage offers conditional on a worker's characteristics including their current wage. Obtaining this information directly by moving frequently is costly, however. Aggregate statistics describing the wage changes of job movers will generally not suffice as these depend critically on the distribution of n which affects the extent to which job changers started out with different values of s_1. More generally, workers are unlikely to know the distribution of shocks, including shocks to individual worker productivity from which I have abstracted, which prompt other workers to move. This ignorance reduces the value of information about the wage distribution of job changers. The result is that general opinions about the fairness of firms, which I have captured through the parameter σ_w, can play a role in workers' quitting decisions.

1.4 First Period Wages

I now turn to the analysis of the wages paid in period 1 by firms of type S. I denote by w_1^z the wages paid by these firms to the employees whose signal s_1 equals z. Ignoring discounting, an employee who is offered this wage and stays with his original type S employer can expect to receive $w_1^z + c_2^z$ over the two periods. By leaving, the employee can expect to earn $\bar{q}_S + n + c_L^z$ over the two periods. Thus employees whose s_1 equals z stay if their realization of n is lower than that the cutoff value n_1^z such that

$$w_1^z + c_2^z = q_N + n_1^z + c_L^z \tag{19}$$

Thus employees stay with probability $F(w_1^z + c_2^z - q_N - c_L^z)$ and the profits of a firm that offers a wage equal to w_1^z to an employee whose signal is z equal

$$F(w_1^z + c_2^z - q_N - c_L^z)\Big\{q_S + vr^z - w_1^z + F(w_2^z - q_N)[q_S + vr^z - w_2^z]\Big\}. \tag{20}$$

In this expression, the term in curly brackets takes into account that the presence of the employee in the first period leads to a probability $F(w_2^z - q_N)$ that the employee also stays in the second period. The firm thus maximizes (20) with respect to w_1^z while taking w_2^z as given. Assuming an interior solution, the first order condition that characterizes w_1^z, is

$$f(w_1^z + c_2^z - q_N - c_L^z)\Big\{q_S + vr^z - w_1^z + F(w_2^z - q_N)[q_S + vr^z - w_2^z]\Big\}$$
$$-F(w_1^z + c_2^z - q_N - c_L^z) = 0. \tag{21}$$

Differentiating (21) with respect to the wage and to c_L^z, and using (21), gives

$$\frac{dw_1^z}{dc_L^z} = \frac{f^2 - f'F}{2f^2 - f'F} \tag{22}$$

where F, f and f' are evaluated at $(w_1^z + c_2^z - \bar{q}_S - c_L^z)$. The second order condition ensures that the denominator is positive. My assumption that f/F is uniformly decreasing in n implies that the numerator is positive as well. An increase in expected outside compensation in the second period leads then leads firms of type S to raise their first period wage. This, together with Proposition 3, implies immediately

Proposition 4: *An increase in σ_w increases w_1^1 and reduces w_1^0.*

Thus, an increase in σ_w increases the dispersion of the initial wages offered by firms of type S if w_1^1 exceeds w_1^0. While the necessary conditions for this to occur are much weaker, a sufficient condition is given by the following proposition.

Proposition 5: *If $f' \geq 0$, $w_1^1 > w_1^0$*

Proof: Let w_1^0 be the optimal wage when $s_1 = 0$. The optimal wage w_1^1 exceeds this wage if the left hand side of (21) is positive for z equal 1 when w_1^1 is set equal to w_1^0. I demonstrate that this is the case by holding constant w_1 and c_L, and showing that increases in vr^z that are accompanied by the corresponding increases in w_2^z and c_2^z raise the left hand side of (21). The monotonicity of f/F together with $c_L^1 > c_L^0$ then ensure that the left hand side of (21) evaluated at the point where w_1^1 is equal to w_1^0 is indeed positive.

Let d denote the derivative of c_2^z with respect to changes in vr^z. This is given by the expression in (10) times $F(w_2^z - q_N)$ so that it is positive and less than one. Using the envelope theorem for the optimality of w_2^z, the change in the left hand side of (21) as one changes vr^z while varying w_2^z and c_2^z is

$$df'\Big\{q_S + vr^z - w_1^0 + F(w_2 - q_N)[q_S + vr^z - w_2^z]\Big\} + f(1 + F(w_2^z - q_N) - d)$$

where f and f' are evaluated at $(w_1^0 + c_2 - q_N - c_L^0)$. Since $d < 1$ this expression is positive if f' is nonnegative, though this condition is clearly stronger than necessary. ■

The uniform distribution simultaneously satisfies the condition that f/F be monotonically decreasing in n and the condition that f' be nonnegative. Thus, the gap between w_1^1 and w_1^0 is increasing with σ_w for this distribution. This gap corresponds, broadly, to the variability of wages inside firms. Consider next the gap between the highest and lowest first period wage paid in the model economy, which corresponds broadly to measures such as the interdecile range. Whether q_N represents the lowest, the middle, or the top wage, this measure of inequality rises with σ_w as long as w_1^0 falls and w_1^1 rises.

The model also has implications for turnover, and I turn to these next. Differentiating (19)

$$\frac{dn_1^z}{d\sigma_w} = -\frac{dc_L^z}{d\sigma_w}\left(1 - \frac{dw_1^z}{dc_L^z}\right) = \frac{-f^2}{2f^2 - f'F}\frac{dc_L^z}{d\sigma_w} \tag{23}$$

where the second equality follows from (22). This means that, in spite of the corresponding increase in w_1^z, a rise in c_L^z unambiguously lowers the cutoff n_1^z at which employees leave and thereby raises the number of quits. Therefore, a reduction in σ_w increases the turnover of employees whose s_1 is equal to zero while it lowers the turnover of employees whose s_1 is equal to one.

I now provide some intuition for the result that increases in σ_w raise the relative turnover of high s_1 individuals together with their relative wages. Figure 2 helps one interpret these results. This figure shows the labor supply curve given, implicitly, by (19). This is a labor supply curve because a higher wage leads workers to have a higher cutoff n_1^z so that the fraction of this type of workers staying at the firm, $F(n_1^z)$, rises. The firm then has a conventional monopsony problem in which there is a marginal cost of labor that lies above the labor supply curve and a marginal revenue from an additional unit of labor which, in this case, is horizontal. The equilibrium cutoff is the one that ensures that marginal cost is equal to marginal revenue and the equilibrium wage ensures that this cutoff is on the labor supply curve.

An increase in c_L for this worker (which would result if the employee had an s_1 equal to zero and σ_w fell) shifts the labor supply curve to the left because it raises what the worker can expect to earn outside and thereby makes departures more attractive. This leads to a reduction in the cutoff, so that more workers of this type leave in equilibrium and, at least when labor supply is linear, the equilibrium wage increases. An increase in σ_w lowers c_L for workers with s_1 equal to zero while raising it for those with s_1 equal to one, so that it moves the labor supply curve of employees with s_1 equal zero to the right while it moves that of employees with s_1 equal to one to the left. It thus increases the relative turnover and wages of high s_1 workers.

Before closing this section, it is worth computing wages and turnover in the case where F is uniform for n between 0 and $1/h$. This means that, when the optimal second period wage is interior, (2) reduces to

$$w_2^z = \frac{q_S + q_N + vr^z}{2} \tag{24}$$

and this applies as long as the second inequality in (3) is satisfied, or

$$q_S + q_N + vr^z < 2/h. \tag{25}$$

Equation (11) then implies that expected second period compensation is

$$c_2^z = h(w_2^z - q_N)w_2^z + \int_{w_2^z - q_N}^{1/h} (q_N + n)hdn.$$

Carrying out the integration, this is

$$c_2^z = q_N + \frac{h}{2}(w_2^z - q_N)^2 + \frac{1}{2h} \tag{26}$$

This falls with h when w_2^z is equal to q_N because an increase in h lowers the mean of the value of outside offers.

Substituting the wage in (24) into (26) (21) becomes

$$h\Big[q_S + vr^z + h\Big(\frac{\delta^z}{2}\Big)^2 - w_1^z\Big] - h\Big[w_1^z + \frac{h}{2}\Big(\frac{\delta^z}{2}\Big)^2 + \frac{1}{2h} - c_L^z\Big] = 0$$

where $\delta^z = q_S - q_N + vr^z$ is the difference between the expected output of an employee with $s_2 = z$ at a type S and a type N firm.

The optimal first period wage is thus

$$2w_1^z = q_S + vr^z - \frac{1}{2h} + c_L^z + \frac{h}{2}\Big(\frac{\delta^z}{2}\Big)^2. \tag{27}$$

which is clearly larger for z equal to one.

2 Aggregate "Output"

In this section I show that increases in σ_w can reduce the sum of the output produced by firms and the nonpecuniary utility enjoyed by individuals. I denote the per capita value of this aggregate output in period t by Ω_t. Even when changes in σ_w raise Ω_t, this by no means implies that such changes lead to Pareto improvements. Indeed, they generally do not since some workers see their wages rise while others see their wages decline. Still, it is useful to know the reasons why increasing trust in capitalism by increasing σ_w can lower, in some sense, the total value of the pie that is produced.

Given that a fraction ϕ of individuals receive a signal s_1 equal to one, per capita output in period 1 is equal to

$$\Omega_1 = (1-\phi)\left[F(n_1^0)(q_S + vr^0) + \int_{n_1^0}^{\bar{n}}(q_N + n)dF(n)\right] + \phi\left[F(n_1^1)(q_S + vr^1) + \int_{n_1^1}^{\bar{n}}(q_N + n)dF(n)\right]. \tag{28}$$

Thus, the change in Ω_1 is equal to

$$d\Omega_1 = (1-\phi)[\delta^0 - n_1^0]f(n_1^0)dn_1^0 + \phi[\delta^1 - n_1^1]f(n_1^1)dn_1^1. \tag{29}$$

This change depends only on the two cutoffs n_1^0 and n_1^1. An increase in either cutoff leads to a gain in output that is proportional to the difference between the marginal employee's total output (inclusive of nonpecuniary compensation) in a type S firm and in a type N firm. The existence of a monopsonistic distortion in firms of type S together with its absence in firms of type N implies that this difference is positive because workers get paid less than their marginal product in the former. As a result,

Proposition 6: *If F is uniform between 0 and $1/h$, $\frac{d\Omega_1}{d\sigma_w} < 0$ as long as*

$$0 < \frac{\delta^1}{2} + \frac{h}{8}(\delta^1)^2 + \frac{h(1-\phi)}{16}\left[1 - \left(\frac{\sigma - \phi}{1-\phi}\right)^2\right][(\delta^1)^2 - (\delta^0)^2] < \frac{1}{h}. \tag{30}$$

If (30) is violated while

$$0 < \frac{\delta^0}{2} + \frac{h}{8}(\delta^0)^2 + \frac{h\phi}{16}\left[1 - \left(\frac{\sigma - \phi}{1 - \phi}\right)^2\right]\left[(\delta^0)^2 - \min\{\frac{2}{h^2}, (\delta^1)^2\}\right] < \frac{1}{h}, \tag{31}$$

$\frac{d\Omega_1}{d\sigma_w} > 0$. *If the second inequality in (31) is violated as well, no employee departs firms of type S in the first period so that σ_w has no effect on output.*

Proof: See the Appendix.

Condition (30) effectively ensures that some workers with $s_1 = 1$ quit (so $n_1^1 < \bar{n}$) and this occurs only for certain values of $(q_S - q_N)$ and v. Then, employees with both realizations of s_1 alter their quitting behavior as σ_w changes. Output in period 1 then falls with σ_w because, in the uniform case, the difference between the marginal employee's output at a firm of type S and at a firm of type N is larger for workers whose s_1 equals one. The reason is related to the result in proposition 2: the difference between an employee's wage and his marginal product is larger for more productive employees so that society has more to lose from having these employees depart from their type S employer. This then implies that increases in σ_w lower aggregate output because the cost that results from the reduction in the attachment of more productive workers is larger than the gain that results from the increased attachment of less productive workers.

For other parameter values, particularly those where $q_S - q_N$, v or h are relatively large, (30) can be violated while (31) holds. High values of these parameters imply that firms of type S raise wages to raise the probability of keeping their employees. They might then keep all employees whose s_1 equals one while setting wages so that some employees with $s_1 = 0$ depart. Then, only the turnover of employees with $s_1 = 0$ is reduced when σ_w increases. This raises output because, at the margin, these employees produce more inside type S firms.

I now turn my attention to second period per capita output, which I denote by Ω_2.

Proposition 7: *In response to changes in n_1^0 and n_1^1, the change in Ω_2 is given by*

$$\begin{aligned} d\Omega_2 \;&= P(s_2 = 0|s_1 = 1)\left[\int_{w_2^0 - q_N}^{w_2^1 - q_N} (vP(r = 1|s_1 = 1, s_2 = 0) - q_N - n)dF(n)\right] f(n_1^1)dn_1^1 - \\ &\quad P(s_2 = 1|s_1 = 0)\left[\int_{w_2^0 - q_N}^{w_2^1 - q_N} (vP(r = 1|s_1 = 0, s_2 = 1) - q_N - n)dF(n)\right] f(n_1^0)dn_1^0 \end{aligned} \tag{32}$$

Proof: Start with the last term. A small reduction in n_1^0 increases by $-f(n_1^0)dn_1^0$ the number of employees with $s_1 = 0$ that leave their original type S employers. If these employees draw an s_2 equal to zero, their output in the second period is the same as if they had stayed with their original type S employer regardless of the value of their n. If they get an s_2 equal to 1 and their realization of n is either below $w_2^0 - q_N$ or above $w_2^1 - q_N$, their total output is again the same because, whether they originally stay or leave, they work at a type S firm in period 2 in the former case and at a type N firm in the latter. Their period 2 behavior is different only if, after they leave, they get an s_2 equal 1 while their realization of n lies between $w_2^0 - q_N$ and $w_2^1 - q_N$. This leads them to stay at the type S firm in period 2 whereas they would have left their original type S firm if they had stayed in the first period. As a result, such employees see their output increase by $q_S - q_N + vEr - n$ where the expectation of r must be computed taking into account that $s_1 = 0$ while $s_2 = 1$.

Similarly, a small reduction in n_1^1 increases by $-f(n_1^1)dn_1^1$ the number of employees with $s_1 = 1$ that leave their original type S employers. If these individuals draw an s_2 equal to 1, their output is again unchanged regardless of the realization of n. Their behavior changes only if they draw an s_2 equal to zero and an n between $w_2^0 - q_N$ and $w_2^1 - q_N$. This now leads them to leave their new type S firm in period 2 whereas they would have stayed with their original type S firm if they had stayed in the first period. Their output thus falls by $q_S - q_N + vEr - n$ where the expectation of r must be computed taking into account that $s_1 = 1$ while $s_2 = 0$. ■

Note that the two terms in square brackets in (32) are equal. If these integrals are positive, Ω_2 falls when σ_w rises. This, in turn, occurs if individuals whose signals are mixed (in the sense that they get one signal equal to 1 and one signal equal to 0) and whose nonpecuniary compensation in type N firms have values between $(w_1^0 - q_N)$ and $(w_1^1 - q_N)$ are more productive on average when they work in type S firms. That this condition leads to an output loss can be seen by focusing first on individuals with $s_1 = 1$ and $s_2 = 0$. By leaving their original type S employer, these individuals now work for type N employers in the second period when n falls in this range and this condition implies that their resulting output is on average lower. This condition implies also that individuals who stay after receiving an s_1 equal to zero lower their social output in period 2 in those states of nature where they would have gotten an s_2 equal to one had they left their original type S employer.

Once again, one can obtain more definite results in the uniform case. Then,

$$\int_{w_2^0-q_N}^{w_2^1-q_N} [vP(r=1|s_1=1,s_2=0)-q_N-n]dF(n) = h(w_2^1-w_2^0)\left[q_S+vP(r=1|s_1=1,s_2=0)-\frac{w_2^1-w_2^0}{2}\right]$$

so that Ω_2 falls if $q_S + vP(r=1|s_1=1,s_2=0) - (w_2^1-w_2^0)/2$, which I denote by Δ, is positive. This requires that expected output in a firm of type S of an employee with a mixed signal is higher than the arithmetic average between the wages paid to high and low signal employees in the second period. Moreover,

Proposition 8: *If F is uniform, sufficient conditions for $\Delta > 0$ include*

i) $q_S - q_N + v\frac{(1-\sigma)\phi}{1+\sigma-2\phi} > 0$

ii) $\phi < 3/4$

iii) $\phi \geq 3/4$ *and* $\sigma - \phi > \frac{4(1-\phi)(\phi-.75)}{(4\phi-1)}$ *where this latter number is no greater than .026.*

There do, however, exist parameters that violate all these conditions and which ensure that $\Delta < 0$ *so that* $\frac{d\Omega_2}{d\sigma_w} > 0$.

Proof: See the Appendix.

It follows immediately that Ω_2 falls with σ_w if $q_S > q_N$, which is equivalent to assuming that there exist realizations of n low enough that it is more efficient for the employee to stay at a firm of type S even if one is sure that his r is equal to zero. Indeed, what is needed to overturn the conclusion that $\frac{d\Omega_2}{d\sigma_w} < 0$ is that the productivity of employees in firms of type N, q_N be relatively high. At the same time, condition (5) which requires that employees sometimes be more productive in firms of type S even if their s_1 is equal to zero, puts a limit on q_N since it requires that

$$q_N < q_S + \frac{\phi(1-\sigma)}{1-\phi}$$

The violations of ii) and iii) in Proposition 8 arise only when ϕ is high and σ, while greater than ϕ, is relatively low. Such combinations of parameters allow q_N to be relatively high without violating (5). It then becomes possible that $\frac{d\Omega_2}{d\sigma_w} > 0$ because more is produced when employees with mixed signals switch to type N firms when they draw offers whose value is between w_2^0 and w_2^1.

That there is a broad range of parameters for which $\frac{d\Omega_2}{d\sigma_w} < 0$ is not unexpected. Since firms pay workers less than their marginal products, it is not too surprising that the average of w_1^0 and w_1^1 can be below the expected marginal product of a worker with mixed signals. Increases in σ_w then lower Ω_2 in the uniform case. This conclusion can be overturned if productivity in sector N is sufficiently high, because the monopsony distortion is lower in this case. Faced with employees whose productivity in sector N is high, firms of type S raise wages and thereby reduce the extent to which productivity in sector S exceeds wages. Still, because productivity is always at least somewhat greater than wages, the range of parameters such that $\frac{d\Omega_2}{d\sigma_w} > 0$ is relatively small.

To summarize the results of this section, increases in σ_w have the potential to lower output in both periods both because they reduce the most productive attachments in period 1 and because they reduce the extent to which individuals who either get or would have gotten mixed signals work in type S firms in the second period. If (30) and any of the three conditions in Proposition 8 hold, aggregate output actually falls in both periods. This is the case for a broad range of parameters, including for example, setting q_S, q_N, v and h equal 1 while $\phi = .7$ and $\sigma = .9$. When v is increased beyond about 1.6, (30) ceases to hold and Ω_1 rises with σ_w. Another method for violating (30) is to raise h. By raising h to 4, keeping q_S and q_N equal to 1, and setting σ, ϕ and v to .9, .89 and .462 respectively, the gains in Ω_1 from raising σ_w exceed the losses in Ω_2.

It is also straightforward to find numerical values such that all the conditions of proposition 8 are violated and Ω_2 rises with σ_w. However, because this occurs only when δ^0 is close to zero, h must be small to ensure that the first inequality of (31) holds. In my numerical experiments these low values of h made it impossible to violate (30). I was unable to find parameters for which output falls in both periods.

3 Empirical Relevance

The model predicts that populations that differ only in their beliefs about the extent to which pay reflects productivity will have different distributions of both turnover and wages. Unfortunately, data on the extent to which people feel that compensation is tied to productivity do not appear to exist, and this limits the extent to which one can ascertain the importance of these beliefs for labor market outcomes. While these beliefs are not observable, other variables that would seem to be closely related to these beliefs can be measured. In particular, individuals in different countries differ both at a point in time and over time in the programs of their elected representatives and in the typical responses they give to surveys asking about the desirability of income redistribution. In the absence of improved data, I treat countries where redistribution is favored (and whose elected representatives reflect this) as being more skeptical about the extent to which differences in compensation reflect differences in productivity. There may well be other reasons why people see inequality as excessive. They may, for example, regard inequality as a problem because the see poor individuals as unable to meet what are regarded as basic needs. However, Hochschild (1981, p 111, 140) reports that both her rich and her poor (U.S.) respondents favored tying income to individual productivity and differed mainly in the extent to which they regarded this as occurring in practice.

I first study the connection between beliefs and inequality and then I turn to the connection between inequality (or beliefs) and turnover. The data on beliefs is more extensive at a point in time for different countries, and so I start with this. I then discuss the little bit of data that is available about changing beliefs through time.

Figure 3 focuses on seven countries at a point in time. It shows the relationship between the attitudes towards inequality from the 1987 International Social Survey as well as inequality measures from around the same period.[10]

The vertical axis of this figure gives the fraction of people who agree with the statement

[10] Inequality measures change slowly over time so that it should not matter very much that these measurements were not all taken precisely in 1987.

that “Differences in income in [respondent's country] are too large”. These figures are drawn from Evans (1993).[11] On the horizontal axis, the figure gives the Gini coefficient for household pre-tax income. These figures are drawn from Deininger and Squire (1995) who report inequality measures from a number of sources. To help make these figures comparable, I used figures from the LIS data base (Atkinson, Rainwater and Smeeding, 1995) for all the countries for which these figures were available, namely for all countries except Austria and Australia.[12] The correlation between these figures is -.72. Such a negative correlation fits with the model presented earlier if one regards the opinion that inequality is too large as closely related to the opinion that individual pay does not reflect individual performance.

There are, of course, alternative interpretations. One possibility is that the perception of large inequities leads to government policies that reduce actual inequality. In an extreme version of this interpretation, perceptions affect incomes only through their effect on policies. One way these policies could be leading to the negative correlation in figure 3 is by affecting the measured income distribution itself. The measure of pre tax household income on which my Gini coefficients are based includes some government transfers and cash transfers to poor people which might be larger in countries where people dislike inequality more. I have thus also looked at OECD measures of the distribution of labor earnings. The coverage of these data is not uniform for the seven countries in my sample. For Austria, the U.K. and the U.S., the figures appear to be comparable and the ratio D9/D5 is largest in the U.S., intermediate in the U.K. and smallest in Austria. The D5/D1 ratio is highest in the U.S. and lower for the U.K. and Austria, though the latter two numbers are essentially identical. These figures are broadly consistent with the Gini coefficients for pre-tax income.

Another source of potential endogeneity, is that high-income people might work less

[11] The only other country included in this international survey was Hungary which I excluded because I felt that the data on actual inequality was probably not very meaningful during its post-communist transformation.

[12] I picked, for each country the observation that was closest to 1987. The data for Switzerland are from 1982, those for Germany are from 1983, those for Norway, the U.K. and the U.S. are from 1986 and those for Ireland and the Netherlands are from 1987. The Australian data come from the 1989 Statistical Yearbook for Australia while those for Austria, whose data are probably the least comparable to the others, comes from 1987.

in countries where perceived inequality is higher because tax rates are more progressive.[13] In practice, it is not clear that the countries in my sample in which inequality is seen as particularly excessive have particularly progressive income taxes. The correlation of the Gini coefficients based on after tax household income (all of which come from the LIS data base) with the Evans' measure is only -.40.

It may also be possible to rationalize the findings in Figure 3 by using the gift exchange model of Akerlof (1982). In that model, worker effort depends on the relationship between a worker's wage and his "reference wage," which Akerlof supposes to be the wage earned by similar workers. If the extent to which people see inequality as excessive is related to workers' reference wages, this dislike could affect equilibrium wages. In particular, one might imagine that societies where inequality is regarded as more excessive are ones where low-paid workers have higher reference wages (because they see themselves as more similar to higher paid workers) while workers who are paid more have lower reference wages. This is not enough to ensure that wage dispersion is lower in such societies. Dispersion falls if firms have more to gain from raising wages of low wage workers (and less to gain from raising wages to high wage workers) in such societies. This might occur if, for example, workers whose wage is below their reference wage increase their effort by more in response to an increased gift of the firm than do workers whose wage is already above the reference wage. It might also occur if increasing the wages of high-paid workers discourages effort of low-paid workers in the same firm. While this idea still requires development, it suggests that an effort based efficiency wage model in which norms of gift giving play a role might have similar implications than those of the turnover-based efficiency wage model developed here.

Because it corresponds most closely to the belief that pay does not reflect performance, I focused attention on the survey which asked whether people thought income disparities were excessive. It is important to note, however, that the answer to this question is strongly positively correlated with the answer to questions that ask whether people favor additional

[13]Higher tax rates alone might account for the phenomenon if these have a bigger effect on the effort of individuals whose income is high.

redistribution from the rich to the poor. Evans (1993) reports a measure which gives the mean response to questions asking people whether they would like the unemployed to receive a guaranteed standard of living, whether they support more spending on benefits for the poor, whether they support a guarantee of jobs for everyone and whether they are in favor of a basic income for everyone. With a higher means score representing less enthusiasm for redistribution, the correlation between this mean score and the answer plotted in Figure 3 is -.80. Similarly, the mean score against redistribution has a correlation of .78 with the pre-tax Gini coefficient and of .52 with the after-tax coefficient.

Time series evidence on attitudes towards income inequality seems even harder to obtain. This is particularly surprising given that many political analysts have noted a "shift to the right" in U.S., British and Canadian electoral outcomes. In all three countries, the late 1970's and early 1980's saw the election of political leaders like Ronald Reagan, Margaret Thatcher and Brian Mulroney whose rhetoric was substantially more "pro-market" than that of their predecessors. The only U.S. data that confirms that this was accompanied by a change in people's attitude towards redistribution are reported in Kluegel and Smith (1986). They conducted a national survey in 1980 and found that only 18% of their respondents disagreed with the statement that the U.S. was spending too much on welfare. As they say, this is substantially smaller than the 39% of the people who agreed, in a 1969 survey conducted by Feagin (1975), that the U.S. was spending too little on welfare. This comparison suffers from several difficulties not the least of which is that the public perception of government policies might have been different in the two instances.

In spite of the paucity of attitudinal data, it may be reasonable to suppose that the change in electoral outcomes in these three countries is suggestive of an increased confidence in the free market system as well as a more benign view of employers.[14] It would then be possible

[14]Other changes in measured attitudes are consistent with this. As Uchitelle (1994) reports citing a study by Richard Freeman and Joel Rogers, workers no longer view big business as an adversary. They do not blame their employers for the anxiety that they feel about their income and job security. Instead, workers regard their employers as victims of global competition which forces employers to cut costs and lay off workers.

Thus, interestingly, international competition may have increased income inequality via two mechanisms. The first and more traditional one, is that this competition may have reduced the demand for low skilled to explain the increased income inequality in these three countries over the last 20 years by this change in attitudes. What makes this explanation attractive is that, as Moss (1995) shows, inequality has worsened disproportionately in these three countries (together with Australia). By contrast countries in continental Europe such as France, Italy and Germany have seen their earnings inequality fall. At the same time, political leaders in these countries appear not to have shifted nearly as much towards a free market rhetoric.

A more distinctive source of evidence on the importance of the links highlighted in this paper is the evolution of turnover. Admittedly, the model has only two periods so that taken literally, its implications concern only whether individuals stay in jobs for one period or not. However, it seems reasonable to imagine that suitable extensions imply that job durations are shorter whenever the model implies that people are more likely to separate after one period. Suppose, in particular, that σ_w rises. The model implies that more workers with s_1 equal to 1 quit, and this presumably corresponds in practice to relatively rapid turnover (and thus short jobs) for individuals whose wages are relatively high. I thus take the model to imply that increases in σ_w ought to increase job tenure of low wage workers while reducing that of high wage workers. If other forces are changing everyone's tenure equally, it should still be the case that the tenure of low wage workers ought to rise relative to that of their higher paid counterparts.

In practice, tenure is reduced not only by quits (as in my model) but also by employment terminations that are initiated by employers - most of which take the form of layoffs. McLaughlin (1991) shows that layoffs are significantly more likely for low education than for high education workers. This suggests that my model ought to be more consistent with the evolution of employment durations among individuals with relatively high levels of education.

Naturally, even if actual tenure has changed in the way predicted by my model, this could be due to other changes in the labor market, including changes in the composition of the labor force, in the average educational level, in unionization, in managerial practices or

workers. The second is that the existence of this international competition may have convinced workers that their employers are not being unfair when they cut wages. This, in turn, may have exacerbated inequality through a mechanism akin to the one presented in this paper.

in labor market regulations. The effects of these changes on the duration of attachments between workers and firms is unknown and I am thus unable to control for them in my analysis. What is known is that average tenure appears to have fallen in the United States, particularly among individuals with low levels of educational attainment. The overall size of this reduction has been small, however. (See Farber (1995), Diebold, Neumark and Polsky (1996) and Swinnerton and Wial (1996)). In Great Britain, Burgess and Rees (1998) show that the recent period of vast changes in labor markets has had led to no secular changes in expected tenure once one controls for demographic, educational and occupational characteristics of workers.

To study whether the implications for tenure predicted by my model are borne out, I consider data from both the United States and France. Table 1 reports statistics obtained from the May 1979, January 1991 and February 1996 U.S. Current Population Survey. In particular, it tabulates means for the answer to the question of how many years the respondent has worked for his or her current employer. What makes these surveys particularly useful is that they simultaneously asked for information on earnings. For each of these surveys I first divided the data into cells corresponding to gender, to four educational attainment categories and to four age categories. For each of these 32 categories, I then computed the median level of hourly earnings, the average job tenure for those whose hourly earnings are below the median for the cell and the average tenure for those whose hourly earnings are above. I label those with earnings higher than the median for their cell as high income - recognizing that this abuses the language somewhat since those with low educational attainment tend to have incomes that are low relative to the population as a whole even if their income is above the median for their cell.[15] Table 1 presents, for each gender-education-age-income category, the average tenure in the three survey dates.

Table 2 presents analogous data from France. These data come from the Enquète Em-

[15] I control for education and other observable characteristics in this way both because these variables are known to affect tenure and because the model's income differences are due to signals that only employers observe. In an appendix available upon request, I also consider an extension which shows the model can also imply that increases in σ_w raise inequality across individuals that differ in observable characteristics like educational attainment.

ploi which was conducted yearly from 1982 to 1998 and includes observations on tenure, monthly earnings and hours. Francis Kramarz kindly computed median hourly earnings for 140 gender-education-age categories as well as mean tenure for those earning above and below this level of earnings. For the purpose of displaying these data, I have taken means across subcategories so that the age and education categories in the Table are somewhat less disaggregated.

Consistent with the literature on earnings and seniority (see, for example Abraham and Farber 1987), workers whose wages are relatively high given their age and education tend to have spent more time with their current employer. My model implies this as well, as individuals with $s_1 = 1$ receive a higher wager that reduces their probability of quitting.[16] Interestingly, higher levels of education are only weakly associated with higher levels of tenure (for given age).[17]

Consistent with the findings of Burgess (1998), average tenure levels tend to be considerably longer in France than in the U.S. This is true both for high income individuals (which is consistent with a lower σ_w in France) and for low income individuals. This latter fact is not consistent with the model I presented above if differences in σ_w are the only differences across countries. However, this fact might be consistent with an extension where firms make inferences about the quality of their employees from the fact that these have left their previous employer. If high-wage individuals tend to stay with their employers the pool of job changers is of lower quality on average and this might promote sufficiently low wages for job changers that low-wage individuals are also more reluctant to change jobs. Whether an extension along these lines can explain these relative tenure levels is a topic for further research. I now focus on the changes in tenure over time in the two countries.

[16] An alternative view is that this correlation results from the automatic escalation of wages with seniority. See Abraham and Farber (1987) for a discussion and evidence against this alternative view.

[17] For example, U.S. males between 35 and 44 who have attended college for some time have generally had lower completed spells of employment with their current employer than have males of the same age who have only complete high school. Still, there is a sense in which, on average, more educated individuals have slightly longer levels of tenure. In particular, consider the ratio for a given gender-age category of the average tenure of individuals in the two high education categories to the average tenure of the individuals in the corresponding two low-education categories. The average ratio of this sort (across gender and age categories as well as across years) is 1.04.

Table 3 provides some simple transformations of the data in Table 1 which permit one to visualize the changes in tenure both from 1979 to 1991 and from 1991 to 1996.[18] The first eight columns shows, for all the gender-age-education-income categories, the ratios of average tenure in 1991 to the average tenure in 1979 as well as the corresponding ratios for 1991-1996. With rare exceptions it is not the case that average tenure grew for low income individuals and shrank for high income individuals. A weaker implication of the model is that tenure for different categories of individuals ought to have grown differentially. This is analyzed in the last two columns. These give, for each category, the difference between the log growth rate of tenure for high wage individuals from 1979 to 1996 and the corresponding log growth rate for low-wage individuals. The theory implies that this ought to be negative in the United States.

This turns out to be true when one looks at females as a whole. It is also true on average for individuals who have stayed in school beyond high school whether they be male or female. Moreover, high-wage high-education individuals saw their tenure fall relative to that of low-wage high-education individuals not only overall from 1979 to 1996 but also over each of the two subperiods. The opposite turns out to be the case for individuals with less education.[19] As I suggested above, layoffs account for a disproportionate number of the separations of employees with low levels of education so that my model ought to be more relevant for high-education individuals. Whether the distinction between quits and layoffs is responsible for these contrary results awaits further research, however.

Interestingly, French tenure for individuals with high educational attainment evolved rather differently. This can be seen in the last two columns of Table 2. These show that, on average, tenure of high wage individuals (whether male or female) rose relative to tenure of their low-wage counterparts from 1982 to 1998 when one looks at groups with relatively high levels of education. The same is true for individuals with lower educational attainment, but

[18]According to Bernstein and Mishel (1997) inequality in the United States continued to grow in the second subperiod.

[19]The first two columns do show, however, that the tenure of high-income, low-education females grew less fast than the tenure of low-income low-education females in the period 1979-1991 (with the opposite being true in the period 1991-1996).

this is not distinctive to France since a similar pattern is observed in the United States for males, and for females from 1991 to 1996.

A broader view of the evolution of French tenure by income can be obtained by considering regressions which explain the evolution of a variable I call TENURERATIO_{it}. This variable equals the difference between the logarithm of average tenure at t of individuals within group i whose hourly earnings exceed median hourly earnings for the group and the logarithm of average tenure of those whose earnings are below the median. I consider, in particular, a regression of the form

$$\text{TENURERATIO}_{it} = c_i + \alpha\ t + \epsilon_{it}$$

where c_i is a fixed effect for the group while α is the coefficient on a time trend. A positive α thus indicates that tenure of high-wage individuals has been growing over time relative to tenure of low-wage individuals. Table 4 shows that, for various specifications, the estimated value of α is indeed positive. Interestingly, this coefficient is not very sensitive to the level of education of the groups that I include in the regression. In particular, it is positive and significantly different from zero also for groups with relatively high educational attainment and this provides a contrast with the U.S. results.

The estimate of α tends to be higher when one drops earlier observations. The highest t-statistic for α is obtained when one uses only the observations between 1988 and 1998, and I show the resulting estimate in Table 4. Samples that drop even more early observations tend to have even higher estimates (though the associated t-statistic is lower because the number of observations falls). Still, the point estimate using data only from 1982 to 1988 is positive as well.

The estimates from the subsample with somewhat less formal education are somewhat larger, particularly for women. One way to compare these results to those using U.S. data is to multiply the point estimate of α by 17 to compute the expected growth in the log difference in tenure between high and low wage individuals. In the case of women of relatively low educational attainment this expected growth is .19, which vastly exceeds the corresponding log difference in Table 3, which is only .04. Thus, for these women, it appears that tenure has been lengthening disproportionately for high wage workers in France, as one would predict if σ_w rose more in the United States. On the other hand, the point estimates predict a growth in the log difference of tenure for males with relatively low education of only .07 and this is much smaller than .201, the growth in this difference in the U.S. over the period 1979-1996.

The movements in tenure that are most consistent with those predicted by the model remain those of highly educated individuals. Among this group, high wage workers have been reducing their tenure relative to low wage workers while the opposite is true in France. An alternative interpretation for this finding is that, for exogenous reasons, more opportunities have become available for high-wage high-education individuals in the United States and that these opportunities have led to "job-hopping." While this alternative cannot be dismissed, it should be kept in mind that an increase in σ_w which leads high-wage workers to be willing to move may thereby encourage the endogenous creation of these opportunities.

4 Conclusions

This paper presented an attempt at explaining widening income disparities in countries such as the United States by changes in the extent to which people believe that higher rewards to more productive individuals. It shows that these changes in beliefs can have a direct effect on the distribution of income even if they do not affect the inherent productivity or the effort of any worker.

For these beliefs to matter, employees must find it difficult to infer the wages they would ultimately obtain at alternate employers. This suggests that it would be worthwhile to model the extent to which individuals acquire this knowledge. Early in individuals' careers, there is a force which can lead individuals to acquire a reasonably large amount of information about wages at alternate employers. Suppose, as seems plausible, that individuals start out with inflated opinions about their abilities. If their first employer offers them a high wage after the initial screening period, they are likely to conclude that pay is highly correlated with productivity while they are likely to conclude the opposite if their first job offers a low remuneration.[20] Both of these inferences lead individuals to be quite willing to try alternative employers. This, in turn, leads them to acquire hard information both about their opportunities and about the extent to which wages offered at different employers are correlated with each other (which helps them calibrate employer accuracy). It would be worthwhile to understand these dynamics better. It seems reasonable to suppose that the cost of these moves makes this process end before individuals feel they know the relevant parameters. Moreover, as Tables 1 and 2 indicate, many individuals end up staying with single employers for a long time. Employers are likely to base their wage offers to these individuals on what these individuals expect to get if they do leave and these expectations may well rely increasingly on general information, including opinions about the accuracy of employers.

While the model assumes that beliefs are homogeneous - so as to focus on common changes in beliefs - more work deserves to be done under the assumption that communication is sufficiently difficult that beliefs remain dispersed. This dispersion is certainly consistent with the survey evidence. One might thus be able to use survey evidence to study whether individuals whose beliefs differ also act differently. Is it the case, for example, that high wage workers who believe that pay is not strongly correlated with productivity have stayed at their current jobs for a relatively long time?

In closing I ought to emphasize again that one advantage of the model is that it allows one to evaluate the extent to which changes in beliefs are responsible for widening income disparities in different countries by studying whether changes in tenure are consistent with these changed beliefs. I have looked at measures of average tenure for workers which fall within certain sex-age-education and income cells in the both the United States and in France and have found some support for the model. Clearly, much more deserves to be done along these lines. It would be better, for example, to compare the separation behavior of individuals taking into account both the history of their wages and the likely future wages at their employer. This might be done using data that identifies employees and employers

[20] This contrast is consistent with the observations of Hochschild (1981) mentioned earlier.

simultaneously as in Abowd, Kramarz and Margolis (1999). They show that employers differ in the extent to which they make their wages depend on seniority. Since workers ought to take this into account when they decide to quit, it would be useful to know whether quitting behavior has changed in the ways suggested by my model when this deferral of compensation is taken into account.

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Appendix

Proof of Proposition 6:

I first show that (31) implies that $\delta^0 < 2h$ so that w_2^0 is given by (24). This can be seen by noting that, because $\phi < 1$ and $\sigma \geq \phi$, the second inequality of (31) implies that

$$\frac{\delta^0}{2} + \frac{h}{4}(\delta^0)^2 < \frac{3}{2h}$$

The second inequality in (30) implies both the second inequality of (31) and $\delta^1 < 2/h$ so that w_2^1 is also given by (24). Using (17) and (26), we thus have

$$c_L^1 - c_2^1 = \frac{h(1-\phi)}{8}\left[1 - \left(\frac{\sigma-\phi}{1-\phi}\right)^2\right][(\delta^0)^2 - (\delta^1)^2].$$

This means that, using (19), (24) and (27), n_1^1 is given by

$$\begin{aligned} n_1^1 \;=\; & \frac{\delta^1 + c_2^1 - c_L^1}{2} + \frac{h}{8}(\delta^1)^2 \;=\; \frac{\delta^1}{2} + \\ & \frac{h}{8}(\delta^1)^2 + \frac{h(1-\phi)}{16}\left[1 - \left(\frac{\sigma-\phi}{1-\phi}\right)^2\right][(\delta^0)^2 - (\delta^1)^2]. \end{aligned} \tag{A.1}$$

This means that (30) is equivalent to the condition that $0 < n_1^1 < 1/h$. When this condition holds, changes in σ_w affect n_1^1. By contrast, n_1^1 simply remains equal to $1/h$ (or 0) in response to local changes in σ_w if the condition is strictly violated.

The analogous argument when s_1 equals zero (so that we use (16) to compute $(c_L^0 - c_2^0)$ implies that, when (30) holds so that second period wages are given by (24)

$$\begin{aligned} n_1^0 \;=\; & \frac{\delta^0 + c_2^0 - c_L^0}{2} + \frac{h}{8}(\delta^0)^2 \;=\; \frac{\delta^0}{2} + \\ & \frac{h}{8}(\delta^0)^2 + \frac{h\phi}{16}\left[1 - \left(\frac{\sigma-\phi}{1-\phi}\right)^2\right][(\delta^1)^2 - (\delta^0)^2] \end{aligned} \tag{A.2}$$

which, given (30) implies that n_0^1 is smaller than $1/h$ as well. Thus, assuming the expression in (A.2) is strictly positive, this cutoff also changes with σ_w. Given that both cutoffs change according to (23), replacing f by h and f' by zero, (29) becomes

$$\frac{d\Omega_1}{d\sigma_w} = \frac{\phi h(\sigma_w - \phi)}{1-\phi}(c_2^1 - c_2^0)\left\{[\delta^0 - n_1^0] - [\delta^1 - n_1^1]\right\}. \tag{A.3}$$

Using (A.1) and (A.2), the term in braces is

$$\frac{h}{16}[(\delta^1)^2 - (\delta^0)^2]\left[1 + \frac{1}{2}\left(1 - \left(\frac{\sigma-\phi}{1-\phi}\right)^2\right)\right] - \frac{v}{2}(r^1 - r^0).$$

When r^1 equals r^0, this is zero, The derivative of this expression with respect to r^1 is

$$\begin{aligned} v\left\{\frac{h}{4}(\delta^1)\left[1+\frac{1}{2}\left(1-\left(\frac{\sigma-\phi}{1-\phi}\right)^2\right)\right]-\frac{1}{2}\right\} &\leq v\left[\frac{3h}{8}(\delta^1)-\frac{1}{2}\right] \\ &< v\left[\frac{6h}{8h}-\frac{1}{2}\right]<0 \end{aligned}$$

where the first inequality follows from the fact that σ is no smaller than ϕ while the second follows from the fact that δ^1 is smaller than $2/h$. Thus $\frac{d\Omega_1}{d\sigma_w}$ is negative when (30) holds. Note that, if the expression in (A.2) is negative, all employees with s_1 equal to zero leave their first employer so that n_1^0 does not vary with σ_w. Thus, a fortiori, increases in σ_w lower Ω_1.

Now consider the case where (30) fails while (31) holds. Since it is no longer certain that $\delta^1 < 2/h$ (though this inequality is true when δ^1 is replaced by δ^0), (16) and (26) now imply that

$$c_L^0 - c_2^0 = \frac{h\phi}{8}\left[1-\left(\frac{\sigma-\phi}{1-\phi}\right)^2\right][\min\{\frac{4}{h^2},(\delta^1)^2\}-(\delta^0)^2].$$

Equations (19) and (27) thus imply that

$$n_1^0 = \frac{\delta^0}{2}+\frac{h}{8}(\delta^0)^2+\frac{h\phi}{16}\left[1-\left(\frac{\sigma-\phi}{1-\phi}\right)^2\right][\min\{\frac{4}{h^2},(\delta^1)^2\}-(\delta^1)^2].$$

Thus, (31) ensures that $0 < n_1^0 < 1/h$ so that changes in σ_w still affect n_1^0. Therefore,

$$\frac{d\Omega_1}{d\sigma_w} = \frac{\phi h(\sigma_w-\phi)}{1-\phi}(c_2^1-c_2^0)[\delta^0-n_1^0].$$

Using (A.2), the term in brackets is

$$\frac{\delta^0}{2}\left(1-\delta^0\frac{h}{4}\right)+\frac{c_L^0-c_2^0}{2}.$$

This is greater than zero because the last term is positive while δ^0 is less than $2/h$. This establishes that Ω_1 rises with σ_w when (30) fails while (31) holds. A small variant on the above calculations demonstrates that neither n_1^0 nor n_1^1 varies with σ_w when both the second inequality in (30) and the second inequality in (31) fail. ■

Proof of Proposition 8: From Bayes rule

$$\begin{aligned} P(r=1|s_2=0,s_1=1) &= \frac{P(r=1,s_2=0|s_1=1)}{P(s_2=0|s_1=1)} = \frac{P(s_2=0|r=1,s_1=1)P(r=1|s_1=1)}{P(s_2=0|s_1=1)} \\ &= \frac{\sigma(1-\sigma)(1-\phi)}{(1-\phi)^2-(\sigma-\phi)^2} = \frac{\sigma(1-\phi)}{1+\sigma-2\phi}. \end{aligned} \tag{A.4}$$

Thus, given (5) and (24)

$$\Delta = q_S + vP(r=1|s_1=1, s_2=0) - \frac{w_2^1 - w_2^0}{2} \geq \frac{q_S - q_N}{2} + v\left[\frac{\sigma(1-\phi)}{1+\sigma-2\phi} - \frac{\sigma}{4} - \frac{\phi(1-\sigma)}{4(1-\phi)}\right].$$

A strict inequality obtains if the second boundary condition in (3) is violated because this would mean that smaller wages are sufficient to keep workers with probability one. Thus

$$\frac{q_S - q_N + v\frac{(1-\sigma)\phi}{1-\phi}}{2v} + \frac{\sigma(1-\phi)}{1+\sigma-2\phi} - \frac{\sigma}{4} - \frac{3(1-\sigma)\phi}{4(1-\phi)} > 0 \Rightarrow \Delta = 0. \tag{A.5}$$

Multiplying through by $(1+\sigma-2\phi)(1-\phi)$ and manipulating, this condition becomes

$$2\{(1-\phi)((q_S-q_N)(1+\sigma-2\phi)/v+(1-\sigma)\phi)+(1-\sigma)\phi(\sigma-\phi)\}+(\sigma-\phi)[3-6\phi+\sigma(4\phi-1)] > 0.$$

Because σ must exceed ϕ and the zeros of the equation $4\phi^2 - 7\phi + 3 = 0$ occur at 3/4 and 1, the term in square brackets is positive if ϕ is less than 3/4. Since (5) ensures that the term in braces (which is proportional to the first term in (A.5)) is nonnegative, this is sufficient to imply that $\Delta > 0$. The term in square brackets can also be written as

$$(\sigma - \phi)(4\phi - 1) - 4(1-\phi)(3/4 - \phi).$$

It is thus also positive when $\phi > 3/4$ as long as iii) is satisfied. Moreover, for $\phi > 3/4$, the ratio $4(1-\phi)(3/4-\phi)/(4\phi-1)$ reaches a maximum of .0253 when ϕ equals .862. The last inequality above can also be written as

$$2\{(1-\phi)(1+\sigma-2\phi)\left\{(q_S - q_N) + \frac{v(1-\sigma)\phi}{1+\sigma-2\phi}\right\} + (\sigma-\phi)[3-4\phi+\sigma(2\phi-1)] > 0.$$

Given that the zeros of the equation $2\phi^2 - 5\phi + 3 = 0$ occur at 1 and at 1.5 whereas ϕ must be less than one, the term in brackets must be nonnegative. Therefore, it is sufficient for $\Delta > 0$ that the term in braces be positive.

When all three conditions are violated while h is also small enough that (25) holds for both types of employees, $\frac{d\Omega_1}{d\sigma_w} < 0$. ■

Appendix II
Observable Characteristics

In the body of the paper I have treated the signals s_1 and s_2 as observed privately by firms and their employees. Thus the increase in first period wage inequality I derived must be thought of as an increase in the inequality *within* groups with identical observable characteristics. Such increases have been observed in the United States (Levy and Murnane 1992) and their existence among college graduates poses something of a challenge to the view that increased inequality is simply the result of declines in the demand for low skilled labor which have been brought about by increases in computer use and international trade. It turns out, however, that one can extend the model so that it explains increased inequality across individuals who differ in the value of a publicly observable signal U. I demonstrate this by first extending the model and then considering a special case in which, while U is positively correlated with s_1, s_2 and r, it is irrelevant to the agents in the model because their own signals (s_1 and s_2) are much better indicators of r. To an outside observer, however, the difference in average income between individuals with high and low values of U increases whenever the income of individuals whose s_1 equals one rises relative to the income of those whose s_1 equals zero.

To show this, I start by ignoring the publicly observable signal U and describe a relatively general model of the connection between s_1, s_2 and r. As in Figure 2, each worker has a type i which can take eight distinct values which I denote by A, B, C, D, a, b, c and d. Productivity r equals one if i equals a capital letter (and otherwise equals zero). The signal s_1 equals one if i equals A, a, B or b while s_2 equals one if i equals A, a, C or c. In Figure 2, the outcomes with $s_1 = 1$, $s_2 = 1$ and $r = 1$ are depicted as overlapping circles.

Letting π_i denote the probability that a worker's outcome takes the value indicated by i, the conditional and unconditional probabilities that play a key role are

$$P(r=1) = \pi_A + \pi_B + \pi_C + \pi_D$$

$$P(s_1=1) = \pi_A + \pi_B + \pi_a + \pi_b \qquad P(s_2=1) = \pi_A + \pi_C + \pi_a + \pi_c$$

$$P(r=1|s_1=1)=\frac{\pi_A+\pi_B}{\pi_A+\pi_B+\pi_a+\pi_b} \qquad P(r=1|s_2=1)=\frac{\pi_A+\pi_C}{\pi_A+\pi_C+\pi_a+\pi_c}$$
$$P(r=1|s_1=0)=\frac{\pi_C+\pi_D}{\pi_C+\pi_D+\pi_c+\pi_d} \qquad P(r=1|s_2=0)=\frac{\pi_B+\pi_D}{\pi_B+\pi_D+\pi_b+\pi_d}$$
$$P(s_2=1|s_1=1)=\frac{\pi_A+\pi_a}{\pi_A+\pi_B+\pi_a+\pi_b} \qquad P(s_2=0|s_1=0)=\frac{\pi_D+\pi_d}{\pi_C+\pi_c+\pi_D+\pi_d}.$$

By setting the first three unconditional probabilities to ϕ and the following two conditional probabilities to σ, one can solve for the seven independent values of π_i after imposing the two independence assumptions in (13). I do not consider that special case here, however. Rather, I let the π_i's perceived by employers remain constant while I vary the beliefs of workers. Suppose workers believe that π_b and π_c increase while π_d declines correspondingly. This means that workers perceive s_1 and s_2 to be weaker signals so that their assessments of $P(r=1|s_1=1$ and $P(r=1|s_2=1)$ decline. The same is true of $P(s_2=1|s_1=1)$ and $P(s_2=0|s_1=0)$ so that the two signals are seen as less correlated with one another. This has the same effect as the decline in σ_w considered above: it makes workers with $s_1=1$ remain with higher probability with their first type S employer while those with $s_1=0$ become more keen to leave.

Now imagine that, for each value of i, the publicly observable signal U is equal to one with probability λ_i. For firms to ignore the value of this signal, it must be the case that the six conditional probabilities above are independent of whether U is equal to zero or one. The first of these requires that $P(r=1|s_1=1)=P(r=1|s_1=1,U=1)$ or,

$$\frac{\pi_A+\pi_B}{\pi_A+\pi_B+\pi_a+\pi_b}=\frac{\lambda_A\pi_A+\lambda_B\pi_B}{\lambda_A\pi_A+\lambda_B\pi_B+\lambda_a\pi_a+\lambda_b\pi_b}$$

which can also be written as

$$(\pi_a+\pi_b)(\pi_A\lambda_A+\pi_B\lambda_B)-(\pi_A+\pi_B)(\pi_a\lambda_a+\pi_b\lambda_b)=0.$$

The requirements that $P(r=1|s_2=1)$, $P(r=1|s_1=0)$, $P(r=1|s_2=0)$, $P(s_2=1|s_1=1)$ and $P(s_2=0|s_1=0)$ be independent of U can similarly be written, respectively, as

$$(\pi_a+\pi_c)(\pi_A\lambda_A+\pi_C\lambda_C)-(\pi_A+\pi_C)(\pi_a\lambda_a+\pi_c\lambda_c) \quad = \quad 0$$

$$
\begin{aligned}
(\pi_c + \pi_d)(\pi_C\lambda_C + \pi_D\lambda_D) - (\pi_C + \pi_D)(\pi_c\lambda_c + \pi_d\lambda_d) &= 0 \\
(\pi_b + \pi_d)(\pi_B\lambda_B + \pi_D\lambda_D) - (\pi_B + \pi_D)(\pi_b\lambda_b + \pi_d\lambda_d) &= 0 \\
(\pi_B + \pi_b)(\pi_A\lambda_A + \pi_a\lambda_a) - (\pi_A + \pi_a)(\pi_B\lambda_B + \pi_b\lambda_b) &= 0 \\
(\pi_a + \pi_b)(\pi_A\lambda_A + \pi_B\lambda_B) - (\pi_A + \pi_B)(\pi_a\lambda_a + \pi_b\lambda_b) &= 0
\end{aligned}
$$

This can be written compactly as

$$M\lambda = 0 \tag{A.6}$$

where M is a 6×8 matrix of coefficients that depend on the π_i's and λ is the vector given by $[\lambda_A\ \lambda_B\ \lambda_C\ \lambda_D\ \lambda_a\ \lambda_b\ \lambda_c\ \lambda_d]'$.

Now consider the position of an outside observer. This observer would see wages of individuals with $U = 1$ rising relative to wages of individuals with $U = 0$ when wages of employees with $s_1 = 1$ rise relative to those of employees with $s_1 = 0$ if a high value of U is more prevalent among individuals with $s_1 = 1$. This occurs if

$$P(s_1 = 1|U = 1) = \frac{\lambda_A\pi_A + \lambda_B\pi_B + \lambda_a\pi_a + \lambda_b\pi_b}{\sum_i \lambda_i\pi_i} > \pi_A + \pi_B + \pi_a + \pi_b = P(s_1 = 1)$$

or

$$(\pi_C+\pi_D+\pi_c+\pi_d)(\lambda_A\pi_A+\lambda_B\pi_B+\lambda_a\pi_a+\lambda_b\pi_b)-(\pi_A+\pi_B+\pi_a+\pi_b)(\lambda_C\pi_C+\lambda_D\pi_D+\lambda_c\pi_c+\lambda_d\pi_d) > 0 \tag{A.7}$$

In general, (A.7) is inconsistent with (A.6), though there is a broad set of π_i's such that they both hold simultaneously. In particular,

Proposition 9 *If M is of full row rank, (A.7) holds as an equality. By contrast, if M is of rank 5, one can find λ_i's such that both (A.6) and (A.7) hold.*

Sketch of Proof Inspection of the above equations shows that one can write each of the columns of M as linear combinations of the other columns with coefficients equal to +1 and -1. When arrayed in the same order, the coefficients of the λ's in (A.7) can be written as the same linear combination of the other coefficients of (A.7). This means that, if M has full row rank, there exists a linear combination of the rows of M which has the same eight coefficients as (A.7). Equation (A.6) implies that the inner product of this linear combination and the vector $[A\ B\ \ldots\ c\ d]'$ equals zero.

Even when M has full row rank, one can set two λ's to arbitrary values and find values for the remaining λ's that satisfy (A.6). In general, these need not be between zero and one. However, if the two λs that are chosen arbitrarily are set equal to one another, the only solution to (A.6) is to set all λ's equal to this common value. By continuity, setting the two arbitrary λ's both between 0 and 1 and close to one another ensures that the remaining λ's are between zero and one as well.

If M does not have full row rank, there generally is no linear combination of rows of M with coefficients equal to those of (A.6). This means that one can find λ's such that (A.6) holds with the left hand side being equal to any positive number. Moreover, if the left hand side is set equal to zero, and one sets two λ's equal to the same arbitrary value, the trivial solution to the combination of (A.6) and (A.7), is to set all other λ's to this value as well. This means that, by continuity, one can find λ's between zero and one that ensure that the left hand side of (A.7) is equal to a small positive number. ■

The proposition shows that, in general, knowing that the signal is uninformative to firms about the wages that they ought to pay as well as being uninformative to workers about the wages they can expect to receive implies that it is uncorrelated with wages. The case where this is not true is when the π's are such that the lack of informativeness of U for some agents follows automatically from its lack of informativeness for others. The requirement that the U's be uninformative to the agents in the model then imposes fewer restriction on the λ's so that it becomes possible to make U informative about s_1 (and r).

This is easiest to illustrate in the special case where

$$\pi_A\pi_c = \pi_a\pi_C \qquad \text{and} \qquad \pi_B\pi_d = \pi_b\pi_D. \tag{A.8}$$

The first of these conditions requires that the odds of $r = 1$ given that $s_2 = 1$ be independent of s_1. Similarly, the second requires that the odds of $r = 1$ given that $s_2 = 0$ be independent of s_1.

Now suppose that λ_A, λ_B, λ_a and λ_b are all set equal to the same constant $\bar{\lambda} > 0$ while all other λ_i's are set equal to zero. Thus, U is greater than zero only if $s_1 = 1$ so that wages are clearly correlated with U. On the other hand, it is easy to check that all the conditions in (A.6) are satisfied. First, U does not convey information about r given s_1 because I have chosen the values of λ_i so that they depend only on s_1 and not on r given s_1. It also does not convey information about r given s_2 because (A.8) ensures that the odds of r given that both s_1 and s_2 equal one are the same as if only s_2 equals one. Since U is one only when s_1 is one and conveys no information about r given s_1, it also conveys no further information about r given s_2. Lastly, the reason U does not convey information about s_2 given s_1 is that, if $s_1 = 0$, U must be zero as well while, if $s_1 = 1$, (A.8) implies that the odds of $s_2 = 1$ are the same whether U equals one or not.

This is by no means the only possible outcome when (A.8) holds. It is also possible to choose λ's so that the difference between the probability that $U = 1$ given that $s_1 = 1$ and the probability that $U = 1$ given that $s_1 = 0$ is much smaller. For example, I computed numerically the solutions for λ that result from setting $\pi_A = \pi_a = .15$, $\pi_B = \pi_C = \pi_c = (\pi_b/2) = .08$ and $\pi_D = (\pi_d/2) = .1$ and letting the left hand side of (A.7) be equal to .01. After arbitrarily setting λ_c=.25 and $\lambda_d = .26$, the remaining λ's ensure that $P(U = 1|s_1 = 1)$ is about .27 while $P(U = 1)$ is only slightly above .25.

It is worth stressing that I am not suggesting that the assumptions in (A.8) are generally realistic.[21] Rather, it is likely that the proper assumptions regarding the π_i's depend on whether the Us represent gender, education, or other observable characteristics such as race. Hopefully, this appendix provides a basis for further research on the effect of these characteristics on wages.

Levy, Frank and Richard J. Murnane, "U.S. Earnings Levels and Earnings Inequality: A Review of Recent Trends and Proposed Explanations," *Journal of Economic Literature*, 30, September 1992, 1333-81.

[21] In fact, (A.8) is inconsistent with the assumptions I made earlier about the probabilities of s_1, s_2 and r. Consider again the case where $P(s_1 = 1) = P(s_2 = 1) = P(r = 1) = \phi$, s_1 and s_2 are independent of each other given r and $P(r = 1|s_1 = 1) = P(r = 1|s_2 = 1) = \sigma$. Then, $\pi_B/\pi_D > \pi_b/\pi_d$. The former equals $\sigma/(1-\sigma)$ while the latter equals $\phi/(1 - \sigma + \frac{(\sigma-\phi)(2-\sigma)}{(1-\sigma)^2})$

Figure 1
The sequence of potential employers

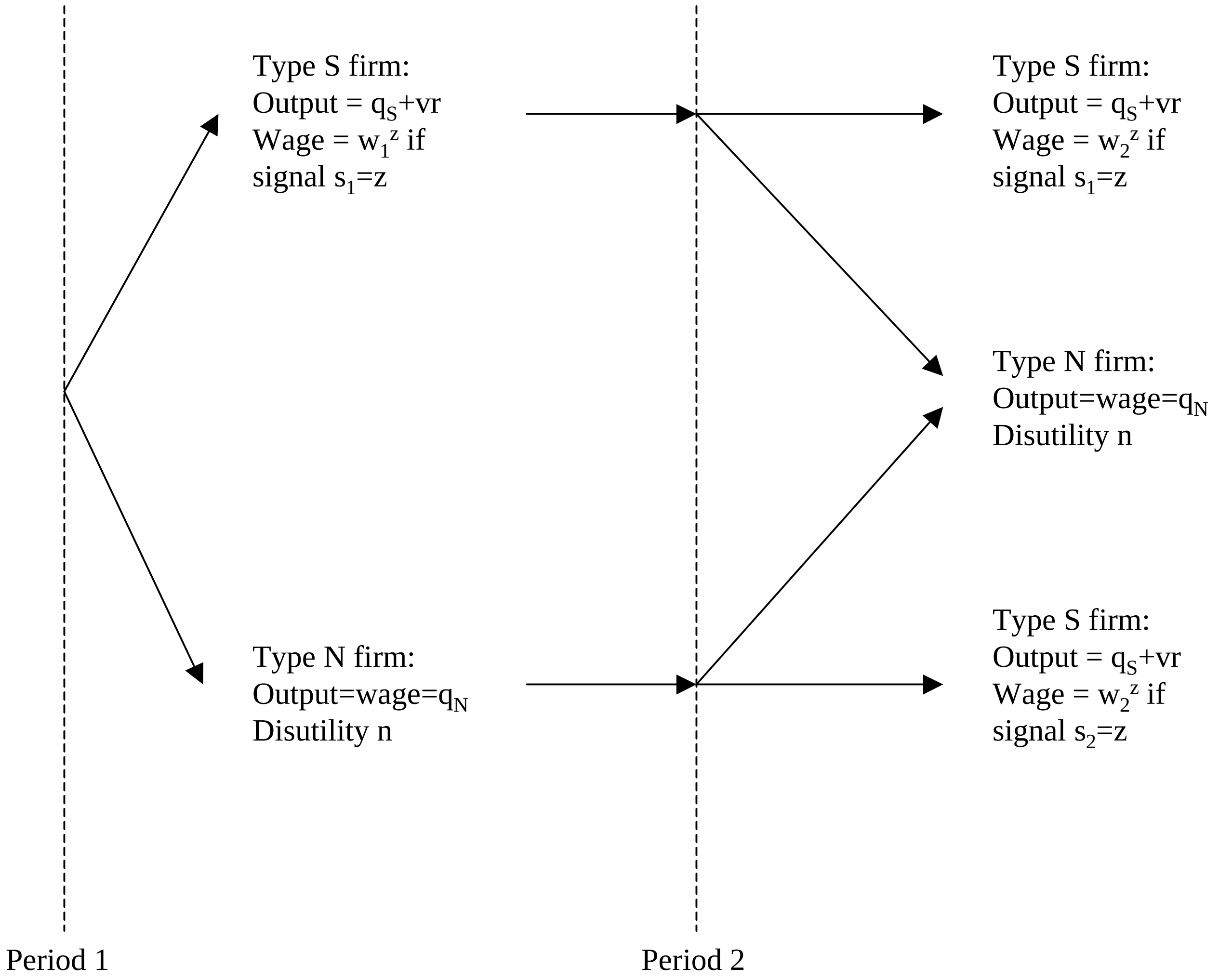


Figure 2
Wage Determination

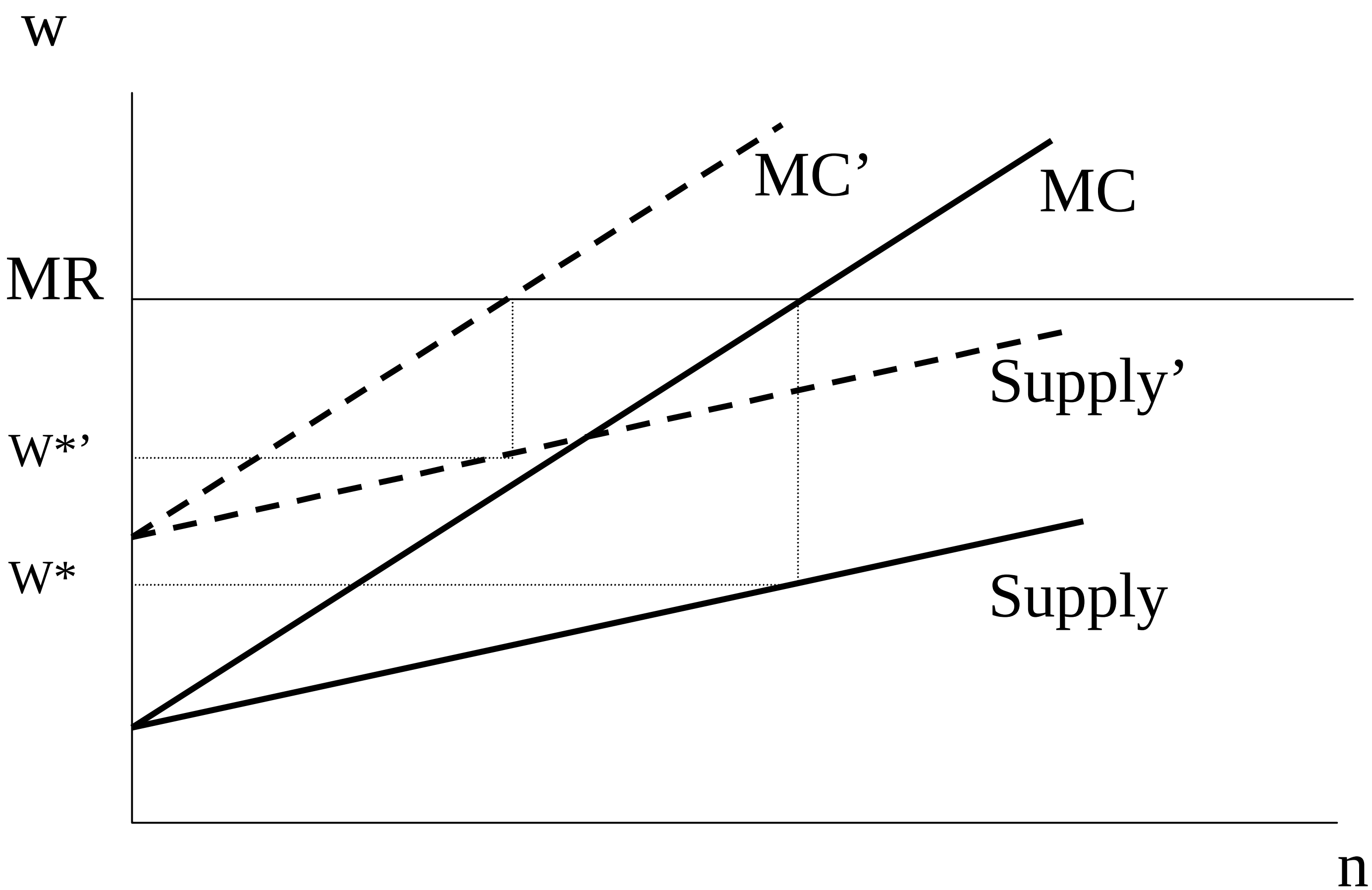


Figure 3
Actual and perceived inequality

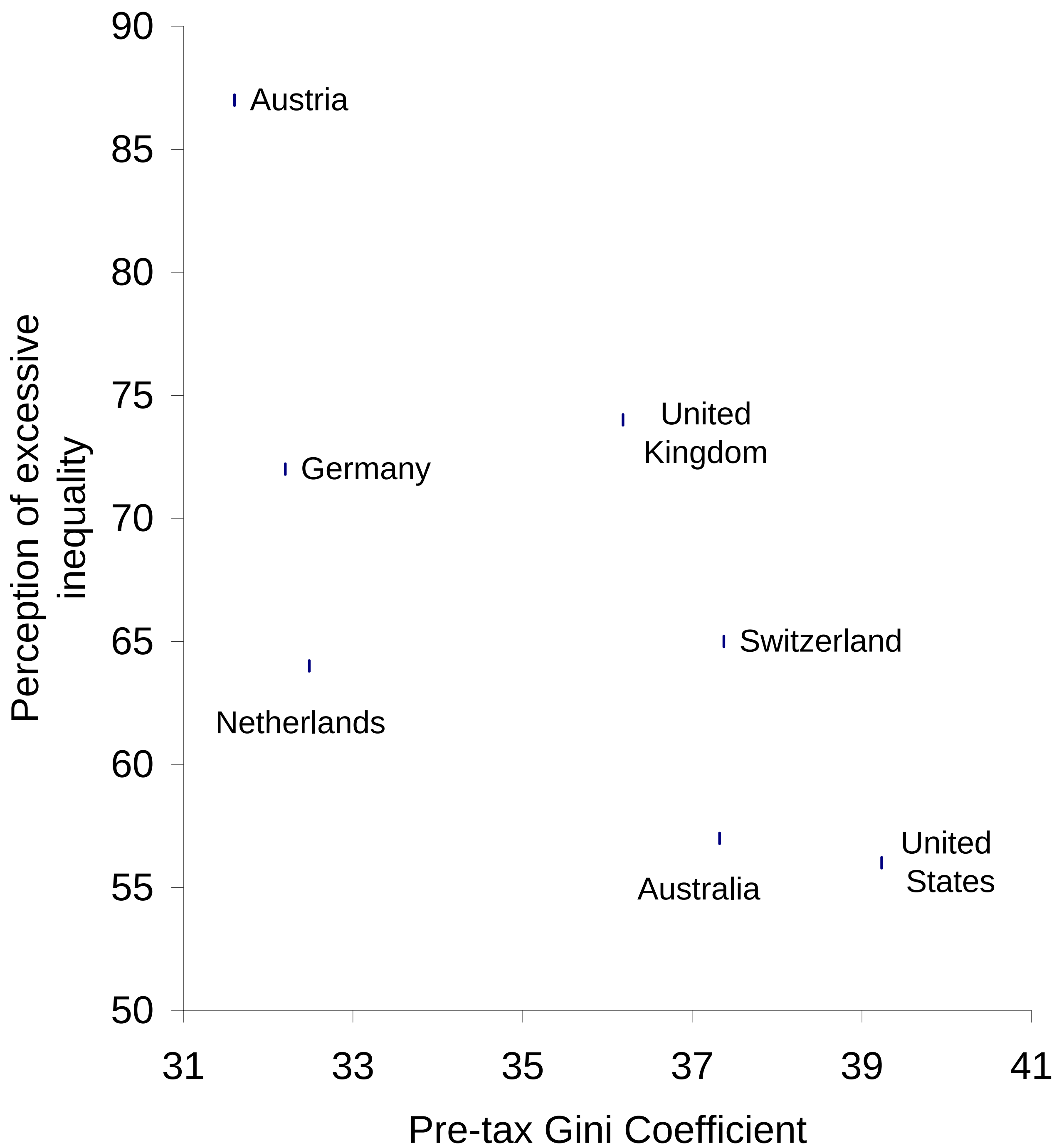
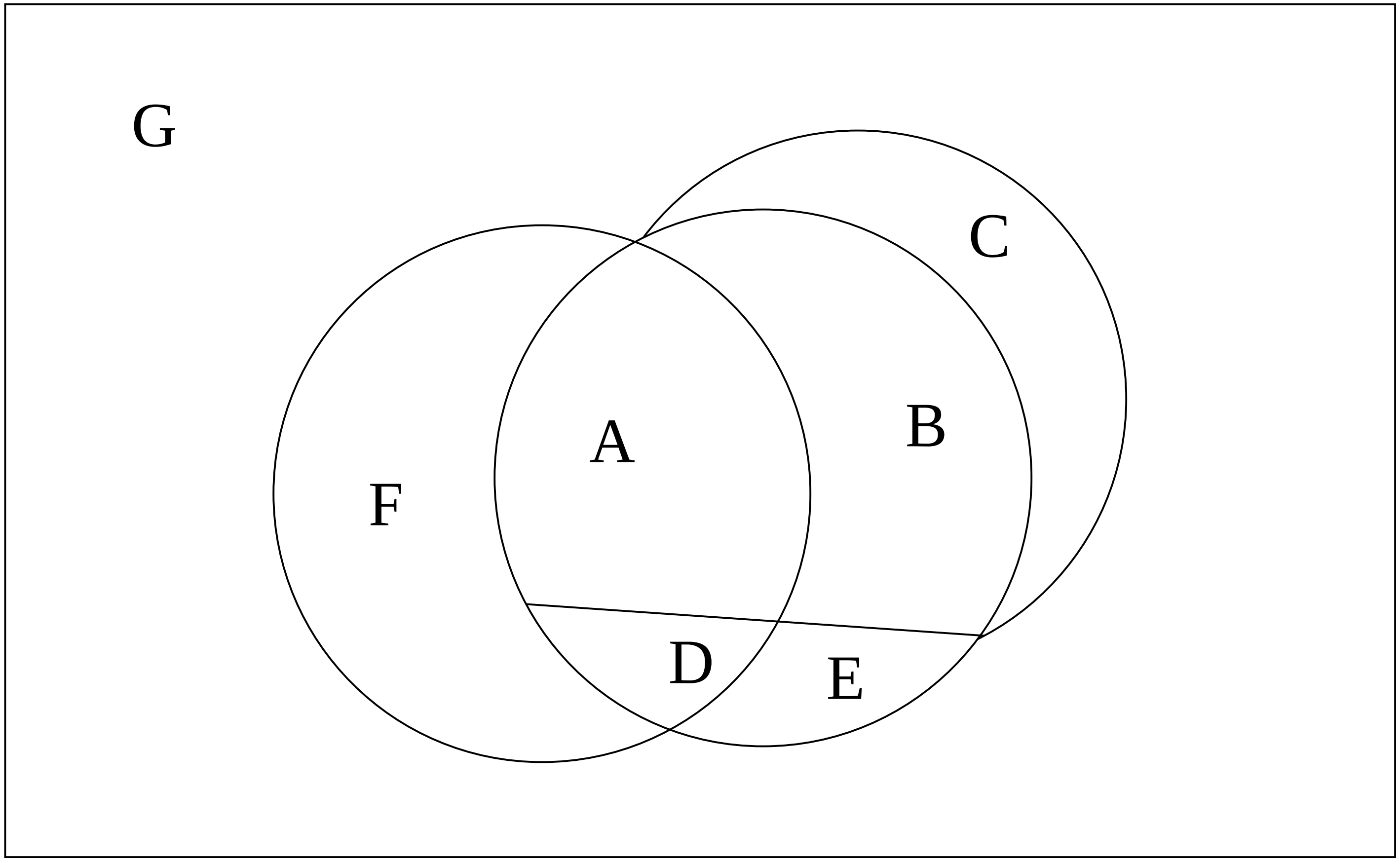


Figure 4
Observable Characteristics



r=1: A U D U F
s=1: A U B U D U E
e=1: A U B U C

Table 1
The Levels of Tenure in the United States

	MALES						FEMALES					
	Low income			High income			Low income			High income		
	79	91	96	79	91	96	79	91	96	79	91	96
High School not completed												
Age between 25 and 34	3.53	2.24	3.08	4.87	4.13	4.68	2.02	2.92	1.58	3.59	4.07	3.61
Age between 35 and 44	6.28	6.06	4.54	8.81	9.52	8.90	3.78	2.76	2.50	6.24	5.79	5.86
Age between 45 and 54	10.21	9.06	8.79	15.03	15.47	15.01	6.14	6.58	6.56	9.73	13.06	11.07
Age between 55 and 64	11.75	9.29	8.10	18.11	17.38	19.51	7.96	8.15	10.57	13.25	14.83	14.53
High School completed												
Age between 25 and 34	3.82	3.56	3.79	5.43	5.88	5.72	2.53	3.08	2.85	4.85	4.94	5.71
Age between 35 and 44	8.48	6.70	6.88	10.23	10.95	10.55	4.10	4.40	4.66	7.26	8.18	8.30
Age between 45 and 54	13.31	10.63	10.27	17.76	16.09	16.93	5.90	6.85	7.10	11.40	10.57	12.99
Age between 55 and 64	14.25	9.83	10.11	20.99	18.81	18.21	8.87	9.23	8.00	15.50	13.54	14.76
Attended College												
Age between 25 and 34	3.47	3.56	2.98	5.14	5.49	4.40	2.65	3.13	2.78	4.26	4.76	4.34
Age between 35 and 44	6.87	7.54	6.70	10.12	9.24	9.93	3.03	4.31	5.44	6.60	8.76	8.08
Age between 45 and 54	11.76	10.35	10.42	16.49	14.91	14.47	6.63	5.67	7.14	10.65	10.64	11.53
Age between 55 and 64	12.85	10.51	10.04	20.34	19.45	15.38	7.89	9.28	10.43	13.96	16.21	15.21
Post-College education												
Age between 25 and 34	3.17	3.34	3.80	4.48	4.77	3.78	2.37	3.10	3.39	4.27	3.72	3.47
Age between 35 and 44	7.56	7.26	6.31	9.48	9.20	8.60	5.06	6.50	6.88	8.01	8.33	7.83
Age between 45 and 54	11.82	12.56	11.00	15.03	14.02	14.06	8.75	8.83	9.67	12.56	11.74	14.85
Age between 55 and 64	14.49	16.27	11.69	18.53	19.02	14.82	13.44	11.25	12.61	16.94	16.32	16.92

Table 2
The Evolution of Tenure in France

	Levels of Tenure								Tenure 1996 / Tenure 1982			
	Males				Females				Males		Females	
	Low Income		High Income		Low Income		High Income		Low Income	High Income	Low Income	High Income
	1982	1996	1982	1996	1982	1996	1982	1996				
No diploma and CEP												
Age between 26 and 35	5.52	4.25	6.43	5.98	5.46	3.97	6.27	6.13	0.77	0.93	0.73	0.98
Age between 36 and 45	8.80	9.63	11.83	13.82	7.38	6.76	9.88	12.40	1.09	1.17	0.92	1.25
Age between 46 and 55	11.77	14.23	17.70	20.24	10.73	11.96	14.34	23.60	1.21	1.14	1.11	1.65
Age between 56 and 65	14.41	15.09	19.75	21.90	12.99	14.45	16.22	18.58	1.05	1.11	1.11	1.14
CAP and BEPC												
Age between 26 and 35	6.59	4.89	8.11	6.73	6.72	4.16	8.97	6.74	0.74	0.83	0.62	0.75
Age between 36 and 45	12.05	10.56	14.17	15.10	8.97	8.59	13.89	15.59	0.88	1.07	0.96	1.12
Age between 46 and 55	15.96	16.04	21.54	22.43	12.43	12.92	20.65	22.98	1.01	1.04	1.04	1.11
Age between 56 and 65	17.15	19.02	23.13	22.01	13.10	14.69	22.68	22.73	1.11	0.95	1.12	1.00
Baccalaureat												
Age between 26 and 35	5.96	4.14	7.18	5.92	5.92	4.37	7.83	6.61	0.69	0.82	0.74	0.85
Age between 36 and 45	11.41	10.04	13.01	14.23	10.97	9.72	14.10	15.09	0.88	1.09	0.89	1.07
Age between 46 and 55	16.34	18.03	20.68	21.90	12.50	15.20	21.35	22.70	1.10	1.06	1.22	1.06
Age between 56 and 65	17.64	17.52	25.64	20.26	16.79	16.33	27.12	25.47	0.99	0.79	0.97	0.94
University degree												
Age between 26 and 35	3.75	2.62	4.25	3.51	3.86	3.13	5.10	3.91	0.70	0.83	0.81	0.77
Age between 36 and 45	10.45	8.72	10.48	9.52	10.41	8.99	11.02	10.92	0.83	0.91	0.86	0.99
Age between 46 and 55	14.80	16.78	16.67	18.23	14.12	16.80	21.29	18.97	1.13	1.09	1.19	0.89
Age between 56 and 65	22.89	21.10	21.68	22.49	15.38	20.42	27.79	27.51	0.92	1.04	1.33	0.99
Unweighted Average									0.94	0.99	0.98	1.04
Low Education Average									0.98	1.03	0.95	1.13
High Education Average									0.91	0.95	1.00	0.94

Table 3

The Evolution of Tenure in the United States

	Tenure 1991 / Tenure 1979				Tenure 1996 / Tenure 1991				Log difference in tenure growth rates by income	
	Males		Females		Males		Females		1979 - 1996	
	Low Income	High Income	Low Income	High Income	Low Income	High Income	Low Income	High Income	Males	Females
High School not completed										
Age between 25 and 34	0.64	0.85	1.45	1.13	1.37	1.14	0.54	0.89	0.095	0.246
Age between 35 and 44	0.96	1.08	0.73	0.93	0.75	0.93	0.91	1.01	0.335	0.350
Age between 45 and 54	0.89	1.03	1.07	1.34	0.97	0.97	1.00	0.85	0.148	0.062
Age between 55 and 64	0.79	0.96	1.02	1.12	0.87	1.12	1.30	0.98	0.446	-0.192
High School completed										
Age between 25 and 34	0.93	1.08	1.22	1.02	1.06	0.97	0.92	1.16	0.059	0.046
Age between 35 and 44	0.79	1.07	1.07	1.13	1.03	0.96	1.06	1.01	0.239	0.006
Age between 45 and 54	0.80	0.91	1.16	0.93	0.97	1.05	1.04	1.23	0.212	-0.055
Age between 55 and 64	0.69	0.90	1.04	0.87	1.03	0.97	0.87	1.09	0.201	0.053
Attended College										
Age between 25 and 34	1.03	1.07	1.18	1.12	0.84	0.80	0.89	0.91	-0.004	-0.032
Age between 35 and 44	1.10	0.91	1.42	1.33	0.89	1.07	1.26	0.92	0.006	-0.382
Age between 45 and 54	0.88	0.90	0.85	1.00	1.01	0.97	1.26	1.08	-0.009	0.005
Age between 55 and 64	0.82	0.96	1.18	1.16	0.96	0.79	1.12	0.94	-0.033	-0.194
Post-College education										
Age between 25 and 34	1.05	1.07	1.31	0.87	1.14	0.79	1.09	0.93	-0.351	-0.565
Age between 35 and 44	0.96	0.97	1.28	1.04	0.87	0.94	1.06	0.94	0.084	-0.329
Age between 45 and 54	1.06	0.93	1.01	0.93	0.88	1.00	1.10	1.26	0.005	0.067
Age between 55 and 64	1.12	1.03	0.84	0.96	0.72	0.78	1.12	1.04	-0.009	0.063
Unweighted Average	0.91	0.98	1.11	1.06	0.96	0.95	1.03	1.02	0.074	-0.073
Low Education Average	0.81	0.98	1.10	1.06	1.01	1.01	0.95	1.03	0.201	0.039
High Education Average	1.00	0.98	1.13	1.05	0.91	0.89	1.11	1.00	-0.043	-0.179

Table 4 Regression Results

Specification	α	Std. Error.	Number of obs.	R^2 (within)
All Observations*	.0060	.00097	2193	0.019
High-education†	.0042	.0014	963	0.011
High-education, 1988-1998	.0130	.0025	623	0.045
High education, 1982-1987	.0045	.0063	340	0.002
Low-education, males	.0042	.0016	613	0.012
Low-education, females	.0109	.0022	617	0.040

Notes: * Excludes two groups which included either two non consecutive observations or one observation. The remaining groups contain at least seven observations and all of their observations are consecutive.

† Includes individuals who have either completed their baccaleureat or continued going to school after high-school.