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The causes and economic consequences of envy

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Abstract In this lecture I first give an explanation for invidious preferences based on the (evolutionary) competition for resources. Then I show that these preferences have wide ranging and empirically relevant effects on labor markets, such as: workplace skill segregation, gradual promotions, wage increases that have no relation with productivity and downward wage flexibility. I suggest that labor and human resource economics can benefit from including envy into the standard set of factors considered in their theoretical and empirical models.
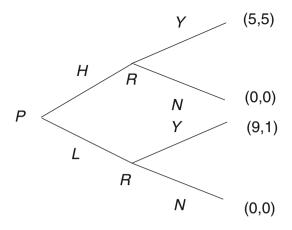
1 Introduction

My talk today will be about envy, which Merriam-Webster's online dictionary defines as: "Painful or resentful awareness of an advantage enjoyed by another joined with a

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Fig. 1 Mini-ultimatum game

desire to possess the same advantage." The recent interest of game theorists in the topic arises most probably from the experiments with the ultimatum game, first reported by Güth et al. (1982). The game has a simple structure, similar to the game in Fig. 1.

Two individuals have to divide an amount of money. One of them, the *proposer*, has the right to propose a split among several possible ones. His opponent, the *responder*, can accept the proposal or reject it. If he accepts, the split is implemented and both players get their rewards. If he rejects it, none of them gets any money. The experiments have been done in many different ways and with differing subject pools, including capuchin monkeys (Brosnan and de Waal 2003). The near universal result is that lop-sided offers in favor of the *proposer* get rejected very often (for a survey, see Roth 1995). This is surprising for many economists. The logic of backward induction suggests that a "natural" outcome of this game is that the *responder* should accept any offer that gives him a positive amount, since even a little bit is better than nothing. Expecting this, the *proposer* would offer something very large for himself and small for the responder. It is hard to understand these results unless a *responder* who rejects a positive offer is experiencing a "painful or resentful awareness of an advantage enjoyed by another". That is, the responder must be feeling envy.

The implications of this result extend well beyond the experimental laboratory. For example, there is significant field evidence that envy plays an important role in the life of organizations. Bewley (1999)[1] interviewed personnel managers from many different companies. About 78% of them[2] mentioned internal equity as an important concern for internal harmony and morale,[3] as well as to reduce turnover.[4]

In this talk, I will first answer a question that, in my view, has been somewhat neglected in the literature. After the initial *surprise* about the experimental result (and a period of *denial*) a robust literature has grown to explain it. This has been done

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[1] Other papers that offer survey evidence on the importance of equity concerns in organizations are Blinder and Choi (1990), Bewley (1995), Agell and Lundborg (1995, 2003) and Campbell and Kamlani (1997).

[2] Bewley (1999, Table 6.5).

[3] Bewley (1999, p. 42).

[4] Bewley (1999, Table 6.5).

mostly by showing that some utility functions with interdependent preferences can help us understand a variety of apparently puzzling experimental and field observations. I will argue that while this helps us to organize the results, it is not enough to properly make sense of them. Our preferences should be shaped by natural evolution. And Nature would not be kind to genes who "left money on the table". Why do they persist then? Just like natural scientists and game theorists have devoted (Axelrod and Hamilton 1981; Nowak 2006; Pennisi 2009) a large amount of effort to understand the emergence of cooperative traits in humans and other animals, we should devote some time to understand the emergence of invidious preferences.

After discussing how envy can be sustained over time, I will review some work I have done recently on the consequences of envy in labor markets. I conclude by briefly reviewing other people's findings on the economic effects of envy.

2 The causes of envy

As I have already mentioned, a usual "explanation" for the experimental and field results, not only in bargaining, but also for games of voluntary contributions to public goods, or for the prisoners' dilemma, is that people have interdependent preferences. To be more precise, consider a two player game, and let x_i be the *monetary* payoff of player $i \in \{1, 2\}$ in that game, and x_{-i} the monetary reward of i's opponent. Then, the preferences proposed by Bolton and Ockenfels (2000), Fehr and Schmidt (2000a) or Charness and Rabin (2002), can be expressed:

Bolton–Ockenfels preferences

$$v_i = x_i - \alpha_i \left(\frac{x_i}{x_i + x_{-i}} - \frac{1}{2} \right)^2,$$

Fehr–Schmidt preferences

$$v_i = x_i - \alpha_i \max \{x_{-i} - x_i, 0\} - \beta_i \max \{x_i - x_{-i}, 0\},$$

Charness–Rabin preferences

$$v_i = x_i - (\alpha_i - \theta_i \phi_j) \max \{x_{-i} - x_i, 0\} - (\beta_i + \theta_i \phi_j) \max \{x_i - x_{-i}, 0\}$$

where $\phi_j = -1$ if j "has misbehaved", and $\phi_j = 0$ otherwise.

Both Bolton and Ockenfels (2000) and Fehr and Schmidt (2000a,b) make special emphasis in the fact that their models can give account of a large number of experimental phenomena. But since today I am not particularly interested in the evolution of altruism, the crucial feature for me is that when $x_i < x_{-i}$

$$\frac{\partial v_i}{\partial x_{-i}} < 0 \tag{1}$$

Following the dictionary definition with which I started my talk, I will consider (1) to be my formal definition of *envy*, the "painful or resentful awareness of an advantage enjoyed by another." A formal definition, while satisfactory to study the economic implications of envy, is still somewhat unsatisfactory. I think we need to dig a bit more to understand the origins of the phenomenon. After all, every time that our evolutionary ancestors left unused resources on the table, their genes would not replicate as well as those of others who took the money. And remember that even capuchin monkeys do leave money on the table. Since they are cousins of those ancestors of ours, it seems likely that the observation is not simply a maladaptation that follows from our modern way of life, which is hopelessly removed from the one in our evolutionary past.

Let me now sketch a model that I think can shed light into the reasons why we prefer to reject lopsided offers in ultimatum bargaining. After I describe the model, I will also sketch some empirical implications which can be derived from it. This will serve as an introduction for the section reviewing the economic effects of envy.

The main assumption with which I will work is that any bargaining game is a part of a much larger *game of life*. In more technical terms, ultimatum (or any other kind of) bargaining is a subgame of the *game of life*. The key idea is that the outcome of the first stage influences payoffs in second stage. Let us now define one such game:

The *game of life* has two players and two stages, which we call:

1. Bargaining.
2. Consumption and *competitive* mating.

The first stage payoffs are denoted x_i where $i \in \{1, 2\}$.

In the second stage, each player i has to decide: c_i and e_i, where c_i is consumption and e_i is the effort made in obtaining a mate. The first stage payoffs are also the resources available in the second stage. These resources are distributed between consumption and effort, so that $x_i = e_i + c_i$.

The utility/fitness (number of successors) of player i is:

$$u_i(c_i, e_i, e_{-i}) = u_i(x_i - e_i, e_i, e_{-i}) \equiv v_i(x_i, e_i, e_{-i})$$

Assumption 1 (i) $\partial^2 v_i / \partial x_i \partial e_i > 0$ and $\partial^2 v_i / \partial e_i \partial e_{-i} > 0$. (ii) $\partial v_i / \partial e_{-i} < 0$

This implies that v_i is supermodular (e_i and e_{-i} are strategic complements). Let x_i^*, e_i^* for $i \in \{1, 2\}$ be the equilibrium values of the choice variables, and v_i^* the equilibrium payoff.

Proposition 1 (1) *The equilibrium value of e_i is increasing in x_i and x_{-i}.*
(2) *The equilibrium payoff is decreasing in x_{-i}.*

Proof 1 (1) Immediate from supermodularity.
(2)

$$\frac{\partial v_i^*}{\partial x_{-i}} = \frac{\partial v_i}{\partial e_{-i}} \frac{\partial e_{-i}^*}{\partial x_{-i}} < 0$$

since by assumption (1) (ii) $\frac{\partial v_i}{\partial e_{-i}} < 0$ and $\frac{\partial e_{-i}^*}{\partial x_{-i}} > 0$ by (1)

Remark 1 The equilibrium payoff is increasing in x_i when

$$\frac{\partial v_i^*}{\partial x_i} = \frac{\partial v_i}{\partial x_i} + \frac{\partial v_i}{\partial e_{-i}} \frac{\partial e_{-i}^*}{\partial x_i} > 0$$

Let us now give two examples of utility functions which satisfy the conditions in Assumption (1). In both of them α_i is a parameter which denotes the relative importance for the fitness of individual $i \in \{1, 2\}$ of competitive mating.

Example 1

$$u_i(c_i, e_i, e_{-i}) = c_i^{1/2} + \alpha_i \left(\frac{1}{2} + e_i - e_{-i}\right)^{1/2}$$

$$= (x_i - e_i)^{1/2} + \alpha_i \left(\frac{1}{2} + e_i - e_{-i}\right)^{1/2}$$

$$e_i^* = \frac{1}{\alpha_i^2 + 2}\left(\left(\alpha_i^2 + 1\right) x_i + x_{-i} + \frac{1}{\alpha_i^2} - \frac{1}{2}\right)$$

$$v_i^* = \frac{\alpha_i^2 + 1}{\alpha_i^2 + 2}\left(x_i - x_{-i} - \frac{1}{\alpha_i^2} + \frac{1}{2}\right)^{1/2}$$

Example 2

$$u_i(c_i, e_i, e_{-i}) = c_i^{1/2} + \alpha_i \left(\frac{1}{2} + e_i - e_{-i}\right)$$

$$= (x_i - e_i)^{1/2} + \alpha_i \left(\frac{1}{2} + e_i - e_{-i}\right)$$

$$e_i^* = x_i - \frac{1}{4\alpha_i^2}$$

$$v_i^* = \frac{1}{2\alpha_i} + \alpha_i \left(\frac{1}{2} + x_i - x_{-i}\right)$$

In words, an increase in the payoff of i's opponent payoff in stage 1 makes him more competitive in stage 2. For this reason, i's payoff in stage 2 is decreasing in $-i$'s stage 1 rewards. Hence, when analyzing the game in stage 1, the payoff of i has a similar structure to the one studied by Bolton and Ockenfels (2000), Fehr and Schmidt (2000a) or Charness and Rabin (2002). At this point a question may arise in some reader's mind. Given that the utility function v_i^* is an indirect utility function, is this really a model of envy? Or is it more a reasonable way to explain an empirical finding that people tend to interpret as envy? My reply would be that emotions, like envy, hunger or lust, are simply the mechanisms that our genes use to enforce behavior on our part which maximizes evolutionary fitness (this is what v_i represents). So envy is what induces in humans actions consistent with the fact that $\partial v_i^*/\partial x_{-i} < 0$.

Beyond a better understanding of the origins of the phenomenon, a model like the one I am proposing has the advantage that it can explain when it will happen. Gurven (2004), for example, has shown that among unrelated Amazon tribes, the ultimatum game is played as if players did not have interdependent preferences. Members of unrelated tribes are unlikely to compete for mates, or other evolutionarily important resources, using the proceeds of the bargaining stage in the game of life. Hence, they can simply maximize their monetary rewards when playing against one another. More in general, the degree of apparent interrelatedness between two players' payoffs should be connected with the extent to which they are perceived to compete using the resources obtained in the bargaining game. This is the main (and testable) implication of the model. An implication that is heavily used in what follows.

3 The effects: theory

I now describe in some (but not complete) detail a theoretical model which shows the usefulness of incorporating envy in the study of labor markets. The model is a simplified version of the one by Cabrales et al. (2008)[5] with just enough elements to illustrate the mechanics of the more complicated model.

3.1 The model

Workers' preferences   We assume workers are risk averse and live for three periods $t = 0, 1, 2$. These workers suffer *envy*, that is, they experience a disutility when they see colleagues getting paid more than they do. The per-period utility is

$$U(w, \bar{u}) = u(w) + \alpha \min \left(0, \ u(w) - \bar{u} \right),$$

where $u(\cdot)$ is a twice differentiable, and strictly concave function. In accordance with the model in Sect. 2, the reference utility, with respect to which an agent feels *envy*, that is, $\bar{u} = \mathbf{E}[u(w)]$ is the the expected (or average) wage for workers that are psychologically *close enough* to be considered evolutionary competitors in the *game of life*. We take this to be the workers who in the previous period were in the same firm and received the same wage as the worker.[6] We assume there is no discounting between periods.

Workers' productivity   Information is symmetric but imperfect because production is random and depends on the type (*G*ood or *B*ad) of the worker. The proportion of G types in the population is λ. There are two possible levels of output (whose market values are normalized to 1 and 0), and p^i with $i \in \{G, B\}$ is the probability of a high

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[5] That model, itself, is a simplified version of Harris and Hölmström (1982) where the main change is the introduction of interdependent preferences.

[6] Another way to justify this assumption is that sociologists and social psychologists have argued that group identification arises through active interaction and fades away if not sustained (Coleman 1990). See also van Dijk and van Winden (1997).

outcome for a type i. We set $p^G = p > 0$. For bad types, on the other hand, there is no chance of a good outcome, i.e. $p^B = 0$. Hence a good realization immediately reveals the good workers.[7] The production realizations of all workers are observed by all firms in the market, which use them to make offers.

Firms   There is a (continuum of) competitive risk-neutral, firms which employ the workers with a constant returns to scale technology. The firms offer long-term, profit maximizing contracts specifying a sequence of non-negative payments contingent on observed history (which includes worker-firm assignments, production and types). There is full commitment from the firm on the terms of the contract.

Workers' action   In each period t, the worker decides whether to stay in the firm or accept an outside offer. If the worker decides to stay in the firm, he receives the wage promised by his employer. He then produces (hence revealing some information about his type). This new information is used by other firms (the market) to make job offers and by the old firm to pay its promised $t + 1$ wages (which takes into account the external labor market). Whenever a worker changes firm, he pays a fixed moving cost $k \geq 0$.

Histories   We will concentrate on symmetric equilibria, where all workers in a firm with the same observed history get the same wages.[8] This makes it important that we identify the relevant histories.

At the beginning of the world ($t = 0$), all workers are the same so that we call the unique history h^0. At $t = 1$ the two possibilities are denoted G or B. Finally at $t = 2$, since workers who at time 0 already revealed to be G stay that way, there are only three relevant histories: GG, BB, BG. The wages are then indexed by the history of the worker. So we have w^0 in $t = 0$, w^G and w^B in $t = 1$ and w^{GG}, w^{BG} and w^{BB} in $t = 2$.

Let P'_λ be the fraction of workers who did not produce in period 0 but produce in period 1, that is:

$$P'_\lambda = \frac{p(1-p)\lambda}{1 - \lambda + (1-p)\lambda}.$$

Notice that $P'_\lambda < p\lambda$.

3.2 Results

3.2.1 Contracts when all workers stay but some participation constraints are binding

Rather than completely characterizing the equilibrium, I concentrate in giving a detailed analytical intuition for some of its features.

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[7] Think of workers as academic economists and p^i as the probability of a publication in *SERIEs, Journal of the Spanish Economic Association*.

[8] This can be easily justified through anti-discrimination laws.

Since workers' output only depends on his type, maximizing profit for the firms is equivalent to minimizing period zero expected wage bills for each worker.

$$\min \ w^0 + p\lambda \left[w^G + w^{GG} \right] + (1 - p\lambda) \left[w^B + P'_\lambda w^{BG} + \left(1 - P'_\lambda \right) w^{BB} \right]$$

For this section we concentrate is studying the case where values of the moving costs are such that it is optimal to let the workers stay in the firm, but when participation constraints are binding for the workers in the different periods. We call U^G the (market) outside option for an agent with positive production in period 0, and U^B the one for a worker with no production in period 0.[9] Then we call it U^{BG} if the positive production is not observed in period 0 but it is in period 1. Finally, the outside option for an agent with no positive production in both periods 0 and 1 is U^{BB}.

Remember that

$$U(w, \bar{u}) = u(w) + \alpha \min \left(0, \ u(w) - \bar{u} \right),$$

is the per-period utility function of the workers, where $\bar{u} = \mathbf{E}[u(w)]$ is the expected wage for workers workers who in the previous period were in the same firm and received the same wage as the worker. This means that any worker who produces a positive amount will not experience envy after that moment, and hence $\min(0, u(w) - \bar{u}) = 0$. With this in mind, the ex post participation constraints for the workers whose first positive production happens, respectively, in period 1 and 0 are:

$$u \left(w^{BG} \right) \geq U^{BG} \tag{2}$$

$$u \left(w^G \right) + u \left(w^{GG} \right) \geq U^G \tag{3}$$

and we call ϕ and μ the multipliers associated, respectively, with constraints (2) and (3). The constraints for workers who did not produce in period 0, and those who did not produce either in period 0 or in 1 are:

$$u \left(w^B \right) - \alpha p\lambda \left(u \left(w^G \right) - u \left(w^B \right) \right) + P'_\lambda u \left(w^{BG} \right) + \left(1 - P'_\lambda \right)$$
$$\times \left(u \left(w^{BB} \right) - \alpha P'_\lambda \left(u \left(w^{BG} \right) - u \left(w^{BB} \right) \right) \right) \geq U^B$$
$$u \left(w^{BB} \right) - \alpha P'_\lambda \left(u \left(w^{BG} \right) - u \left(w^{BB} \right) \right) \geq U^{BB}.$$

The period zero constraint is:

$$u(w_0) + p\lambda \left(u(w^G) + u(w^{GG}) \right) + (1 - p\lambda) \left[u \left(w^B \right) - \alpha p\lambda \left(u(w^G) - u(w^B) \right) \right]$$
$$+ (1 - p\lambda) \left[P'_\lambda u(w^{BG}) + (1 - P'_\lambda) \left[u \left(w^{BB} \right) - \alpha P'_\lambda \left(u \left(w^{BG} \right) - u(w^{BB}) \right) \right] \right] \geq U^0 \tag{4}$$

and we call ξ the multiplier associated with constraint (4).

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[9] In the full version of the model, all these outside options are, of course, endogenous equilibrium objects.

Guessing (which can be shown to be right) that in the case we are analyzing (when workers stay in the firm but some participation constraints are binding) the binding constraints of the problem are (2), (3) and (4) the first order conditions for this problem are:

$$w^{GG} : p\lambda - (\mu + \xi p\lambda)\, u'(w^{GG}) = 0 \tag{5}$$

$$w^G : p\lambda - (\mu + \xi p\lambda)\, u'\left(w^G\right) + \xi\,(1 - p\lambda)\,\alpha p\lambda u'(w^G) = 0 \tag{6}$$

$$w^{BB} : (1 - p\lambda)\left(1 - P'_\lambda\right) - \xi\,(1 - p\lambda)\left(1 - P'_\lambda\right)\left(1 + \alpha P'_\lambda\right) u'(w^{BB}) = 0 \tag{7}$$

$$w^B : (1 - p\lambda) - \xi\,(1 - p\lambda)\,(1 + \alpha p\lambda)\, u'(w^B) = 0 \tag{8}$$

$$w^0 : 1 - \xi u'\,(w_0) = 0 \tag{9}$$

Using the equations above, we have an analog to one of the main results in Cabrales et al. (2008).

1. *Gradual promotions $w^G < w^{GG}$.* Since $\xi\,(1 - p\lambda)\,p\lambda\alpha > 0$ we have from equations (5) and (6) that $w^G < w^{GG}$. That is, in order to save suffering, the planner increases gradually the wage of the G workers. Notice that if $\alpha = 0$ (as in Harris and Hölmström 1982) consumption smoothing demands that $w^G = w^{GG}$. With interdependent preferences, firms trade off consumption smoothing of the G workers for *morale enhancing* for those not found out to be G yet. That is, an increase in wages for period 1 and another for period 2 is not first-best for workers who performed well already in period 0. But, on the other hand, raising their wage slowly exploits the fact that by the end of period 1 the G workers go out of the reference group of those who stay unproductive both in period 0 and 1 and hence the pain caused on them by envy is smaller.

2. *Productivity unrelated wage increases $w^0 < w^B$.* Since $\alpha p\lambda > 0$ then from equations (8) and (9) we have that $w^0 < w^B$. Again, from intertemporal smoothing considerations alone (for example when $\alpha = 0$), we would have $w^0 = w^B$. But since all workers stay in the firm, the B workers will suffer from the fact that others are G and, because of market pressures, their wage needs to rise. So firms must trade off the intertemporal smoothing with the envy considerations.

3. *No downward rigidity $w^{BB} < w^B$.* Even though the ex-post participation constraint is not binding for B workers, since $0 < P'_\lambda < p\lambda$, we have from equations (8) and (7) that $w^{BB} < w^B$ (again, when $\alpha = 0$, we would have $w^{BB} = w^B$). Here the reason for allowing the wages to go down from w^B to w^{BB} is as follows. The wage goes up from w^0 to w^B because the B workers suffer when they see others that were just like them in the previous period have their wages increase. By the end of period 1, the workers that remain unproductive (those with BB histories) have "forgotten" about those promoted at the end of period 0. And since there are less promotions from 1 to 2 than from 0 to 1 because $P'_\lambda < p\lambda$ (in other words, the *ex-ante* probability of this event is smaller) the need to compensate for this event is smaller.

Summarizing, $w^0 < w^{BB} < w^B$ so that for individuals with B or BB histories insurance is traded off versus suffering from envy. This yields a *non-monotone* contract, which differs from the no-envy standard, under which $w^0 = w^{BB} = w^B$.

Additionally the individuals with a G observation have that $w^G < w^{GG}$ so that their insurance is traded off for the *forgetting* of the individuals with a B history.

Empirical implications for internal labor markets

Observation 1 is a well-accepted empirical finding. Wage increases are indeed serially correlated in firm data (see Baker et al. 1994 and Gibbons and Waldman 1999).

Observation 2 implies that wage changes need not be connected with productivity changes. Insurance motives would insulate wage from productivity, but in our model, wages can *increase* even when worker expected productivity declines. Medoff and Abraham (1980) and Flabbi and Ichino (2001) find that although (a proxy for) productivity[10] in a job is negatively related to experience, wages in fact increase with experience. This is hard to obtain in a standard model,[11] but it can happen in ours, and it should be associated with a concomitant increase in the wages of a reference peer group.

Observation 3 shows that we can have real wage cuts. The fact that in Harris and Hölmström (1982) wages are downward rigid is considered to be one of the major drawbacks of that model, because it is inconsistent with the substantial frequency of negative real-wage changes found by Baker et al. (1994).

3.2.2 Mobility between firms and skill segregation

The model has also some predictions about mobility of workers between firms, which we briefly discuss here.

Mobility without moving costs If $k = 0$, then firms hire from only one skill pool and they only have either G or B workers (BB or BG if in the third period). There is no intra-firm wage dispersion for workers of the same cohort, but inter-firm's dispersion is maximal. When there are no costs of moving between firms, they can save on the cost of envy by segregating workers into different companies. This is different from what happens in other models of worker segregation by skill level, such as Kremer and Maskin (1996). In our case there is no direct externality created by others' types. Our agents do not experience "pain" directly from what others are, but rather from an indirect effect through economic forces. In turn, these forces shape the firms' responses when costs are higher.

Mobility with moving costs Cabrales et al. (2008) also show that *turnover affects workers of only one type* at any period. These turnover can be either quits (for high-productivity G types) and layoffs (for low-productivity B types), but not both. Moreover, the affected group is the one with less workers. Interestingly, in the case of layoffs of low productivity workers, the firm will pay a *severance payment transfer*. This happens because those workers have been promised, for insurance reasons, a high wage. When efficiency indicates they need to go, the market will

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[10] Worker performance ratings.

[11] Gibbons and Waldman (1999) (as well as Harris and Hölmström) argue that the productivity measure of Medoff and Abraham (1980) is not good. Flabbi and Ichino (2001) use other indicators (recorded absenteeism and misconduct episodes) and they obtain the same result.

not pay for this insurance. This payment is, of course, not made when *G* workers leave.

Empirical relevance of mobility results   A lot of research has gone into connecting a rise in wage inequality across firms and sorting of workers by ability (the earliest we learnt of are Brown and Medoff 1989 and Davis and Haltinwanger 1991).[12]

As I have already mentioned, earlier theories that explained this fact tended to assume technological complementarities between people with the same skill.[13] Our externality arises because of envy. This leads to some different empirical predictions between the models. Both our model and Kremer and Maskin (1996) predict a connection between an outflow of *B* workers and a wage increase for those remaining in the firm. But in our model, the flow would happen *after* the increase in productivity. In the Kremer and Maskin model, the worker flow must happen *before* the increase in wage.

Another important difference is that their implications will be related to ex-ante observable skills. Our model makes predictions about ex-ante unobservable skills. Hence, our wage differential should occur after controlling for observables such as education and industry. Interestingly, the recent rise in inequality is mostly connected to unobservable factors.[14]

One implication of our model is that skill segregation should be decreasing with mobility costs. Hence, our model predicts that the rise in inter-firm wage inequality should be associated with a change in mobility costs. Rhode and Strumpf (2003) establish the existence of a secular decrease in mobility costs.[15] This is not only true of physical transportation costs and communication costs, but also of more intangible ones. For example, more homogeneous public goods across US counties, or increased similarity of cultures and working routines.

4 An experiment on mobility

4.1 The experiment

A more direct approach to check if worker-firm allocation is related to interdependent preferences is taken by Cabrales et al. (2010), who study a game which is a simplified version of the one in Winter (2004). A team of (in our case) 2 players has to undertake a project. The team members can choose to make an effort or not to make it. The effort, which has an individual cost *c*, makes the project succeed with a higher likelihood. The efforts of the players are complementary. To be more precise the project succeeds

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[12] Many others followed: Kramarz et al. (1996), Kremer and Maskin (1996), Abowd et al. (1999), Acemoglu (1999), Burgess et al. (2004), Dunne et al. (2004).

[13] Beyond Kremer and Maskin (1996), other papers in this vein are de Bartolomé (1990), Bénabou (1993), Saint-Paul (2001) and Legros and Newman (2002, 2004).

[14] Juhn et al. (1993) and Katz and Autor (1999) attribute between two-thirds and three-fourths of the rise in inequality to the within-group "residual".

[15] Mendez (2000) and Stewart (2002) show that rates of labor turnover have increased recently. This is an indirect measure of mobility costs.

with probability 0 if no team member makes an effort, with probability 1/4 if just one member makes an effort and with probability 1 if both team members make the effort. The principal, who earns a return of V if the project is successful, can only observe (or contract upon) the success or failure of the project. So he has to choose a pair of rewards (b_1, b_2) for the players in case of success. Under these conditions, the game G faced by the players is:

		Player 2	
G		E	N
Player 1 E	$b_1 - c, b_2 - c$	$\frac{1}{4}b_1 - c, \frac{1}{4}b_2$	
N	$\frac{1}{4}b_1, \frac{1}{4}b_2 - c$	$0, 0$	

Notice that if $b_2 > 4c$, G is dominance solvable in (E, E). But (E, E) is an equilibrium already with $3b_1 > 4c$, $3b_2 > 4c$ (and in that case (N, N) is also an equilibrium). Hence a game like this generates a tradeoff: efficient equilibrium selection vs. envy. In the experiment, a principal chooses b_1, b_2, and agents choose E or N. We wanted to answer several questions:

1. What is stronger: strategic uncertainty or "envy"?
2. Do interdependent preferences help organize the data?
3. Do interdependent preferences explain matching?

The design was chosen to help answer the questions. Subjects played three *phases*, P_1 to P_3 (24 rounds per phase).

P_1 : **Dictator Game (24 rounds)**

1. Players are randomly matched and allocated to a position $(1, 2)$ in the pair. They have four choices $c_k = (b_1^k, b_2^k)$, with $b_1^k > b_2^k$ in all.
2. Both players choose their favorite C_k and one of these is chosen randomly.

P_2 : **Effort Game (24 rounds)**
    Identical to P_1, but now subjects play game G with the chosen (b_1^k, b_2^k)

P_3 : **The Market (24 rounds)**

1. Within each group, 4 subjects are randomly chosen to act as "Principals".
2. Principals select one contract $c_k = (b_1^k, b_2^k)$ to be offered to the 4 teams of agents.
3. Agents have to choose and then play G.
4. The Principal earns $V - b_1^k - b_2^k$ when the two agents make effort, $(V - b_1^k - b_2^k)/4$ when only one makes effort, and zero otherwise.

4.2 The results

The results were organized in line with the questions motivating the research.

What is stronger: strategic uncertainty or "fairness"?   The choices of the subjects were clear in this respect. They chose contracts that induced games with unique equilibria more than three fourths of the time. In this, they were being quite rational. The level of effort was much higher in those games.

Do interdependent preferences help organize the data?   Distributional preferences estimated with data from P_1 indeed explain behavior in P_2 and P_3. More precisely, the estimated preferences/beliefs predict 80% of observed effort choice.

Do interdependent preferences explain matching?   Agents are more likely to choose a contract offered by a principal with similar distributional preferences to his own. This result is connected with our theoretical prediction that without mobility costs worker-firm matching is related to interdependent preferences.

5 Other approaches to envy and the labor markets

As we mentioned in the introduction, the research on interdependent preferences arose to explain evidence that was hard to reconcile with material payoff maximization. We have discussed several models[16] in this vein, and the readers are referred to the surveys of Fehr and Schmidt (2000b) and Sobel (2005) for further discussion.[17]

The model I discussed in this lecture is, of course, not the only one to explore the labor market effects of envy. Frank (1984) is the first paper I know that explores this issue. He finds that wages can diverge from marginal productivity when preferences about others' wages are strong and heterogeneous. He assumed that people like being paid more than others and they dislike being paid less. With this in mind, the highly able workers would get "taxed" by the firm employing them with a lower wage for the pleasure of making more money than others. By the same token, the less productive people would be "subsidized" with a higher wage to compensate them for the pain inflicted by envy. Frank (1985) shows that the externality generated by interdependent preferences can explain many labor market regulations, such as: minimum wages, workplace safety rules or forced saving for retirement. Notice, though, that since his agents enjoy having a higher wage than others, his model would predict (counterfactually) the opposite of segregation by skill. This feature (as well as a static contracting approach) is shared with Fershtman et al. (2006).

Fehr et al. (2007) show experimentally and theoretically that workers' concerns for equality may be a reason why many real-life contracts are left deliberately incomplete in environments with hidden effort. Rey-Biel (2008) shows that an employer can exploit envy by "threatening" workers with inequality when outcomes are unsatisfactory (a threat that does not have to carried out in equilibrium).

Teyssier (2007) studies a model with hidden effort. She shows that agents with heterogeneous interdependent preferences segregate themselves into different firms. In that way the more egalitarian agents are exposed to less steep incentive schemes which generate less inequality. Teyssier (2008) provides an experimental test for the theory in her previous paper. Kosfeld and von Siemens (2009), von Siemens (2009) and

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[16] Bolton and Ockenfels (2000), Fehr and Schmidt (2000a) or Charness and Rabin (2002).

[17] The model of Cabrales et al. (2008) innovated by specifying the individuals with which agents compared themselves. Akerlof and Kranton (2000) also relate identity with incentive problems. The difference is that for them identification gives incentives to make effort, whereas in our case it creates a disutility when people with whom agents identify get paid more.

Bartling and Von Siemens (2010) also study how interdependent preferences create an incentive for agents to self-select into different firms.

6 Conclusions

In this lecture I have first tried to explain the existence of envy as a result of (evolutionary) competition for resources. Then I have shown that invidious preferences have important effects that are likely to show up in the labor markets and other parts of social life. Hence, many branches of economics and other social sciences can be improved by including envy in their theoretical and empirical models. To some extent this has already started to happen. For example, Bandiera et al. (2010) show, with data from a UK farm producer of soft fruit that "a given worker's productivity is significantly higher when she works alongside friends who are more able than her, and significantly lower when she works with friends who are less able than her." This is so even though there are no externalities among workers due to either the production technology or the compensation scheme in place. The authors themselves claim that "the results suggest that firms can exploit social incentives as an alternative to monetary incentives to motivate workers."

I think that we can learn a lot by looking at, for example, labor market data with the help of the ideas sketched in this paper. One possibility would be to look at large longitudinal databases, if they had detailed information about a worker's pay, as well as that of his colleagues, and mobility between jobs in the same company and also between companies. Alternatively, analysis of case studies like that of Bandiera et al. (2010) or Baker et al. (1994) could also be useful, particularly if researchers were allowed to observe the responses to controlled/experimental changes in the environment.

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