Dipak Banerjee

ECONOMIC THEORY AND POLICY

Essays in Honour of Dipak Banerjee

Edited by
Bhaskar Dutta
Shubhashis Gangopadhyay
Dilip Mookherjee
Debraj Ray

BOMBAY
OXFORD UNIVERSITY PRESS
DELHI CALCUTTA MADRAS
1990

13. ——— (1976b): 'Exchange Processes with Price Adjustment', *Journal of Mathematical Economics*, 3, pp. 211–26.
14. Uzawa, H. (1962): 'On the Stability of Edgeworth's Barter Process', *International Economic Review*, 3, pp. 218–32.
15. Younes, Y. (1975): 'On the Role of Money in the Process of Exchange and the Existence of a Non-Walrasian Equilibrium', *Review of Economic Studies*, 42, pp. 489–502.

Envy

ABHIJIT VINAYAK BANERJEE

1. Introduction

Very few economists will dispute the fact that the happiness people get from consumption is affected by the consumption levels of other people. It seems unquestionable that, for some people at least, the pleasure they get out of a particular consumption bundle will be less if they feel that everybody around has more than them, than if they feel that they are pretty much on par with the rest of their group. In fact it would appear that this kind of interrelatedness in consumption, which one might call envy, is the most immediate example of what economists typically call an externality.

Externalities are taken very seriously by economists and large areas of public economics, resource economics, environmental economics and the economics of property rights are devoted to studying the implications of externalities and how policy may be taken to correct the distortions created by these externalities. Nevertheless very little scholarly attention seems to have been paid to the analytics of the particular externality we have called envy.[1]

Three explanations for this omission suggest themselves:

(i) *Envy is irrational*. Therefore economists feel there is no reason to take envy any more seriously than other deviations from rationality like errors in calculations.

In response to this we suggest first that there is no consensus that envy is irrational. It is true that this is the view of Rawls (1971,

* I thank Arundhati Banerjee, Ani Dasgupta, Ed Funkhauser, Jerry Green, Andreu Mas Colell, Eric Maskin and Andrew Newman for encouragement and helpful comments.

[1] The two outstanding exceptions to this are Duesenberry (1949) and Frank (1985) and some related work.

p. 530), but Rawls would defend it in terms of his general thesis about how human beings ought to think. Since most economists do not accept this general thesis, there seems no reason to treat Rawls' view on envy as the last word on the subject.

Secondly, the usual justification for disregarding errors in calculations is that they are uncorrelated across the population and therefore ought to cancel out in the large. The distortion caused by envy by contrast is likely to be highly correlated across the population and therefore will not wash out.

(ii) *Envy causes no distortions*. In general this is simply false. To see this consider the following two-good, two-person, example: the goods are labour and food; food is produced by using only labour and the production functions are $f(L)$ and $g(L')$ for the two agents, where L and L' are their labour inputs. There are consumption externalities and both persons' utility functions are defined on the complete social allocation $\{f(L), L, g(L'), L'\}$. Assume that the utility functions of the two agents are $U(.)$ and $V(.)$, respectively.

The natural concept of equilibrium in this context is a Nash equilibrium $\{L, L'\}$ in the two agents' labour inputs. A familiar exercise will convince the reader that the conditions for Nash equilibrium will be:

$$\begin{aligned} U_1.f'(L) + U_2 &= 0 \\ V_3.g'(L) + V_4 &= 0 \end{aligned} \qquad (1)$$

The condition for Pareto-efficiency is given by the solution to the standard programme:

$$\text{Max } U(.) \text{ subject to } V(.) = \bar{V}$$

The first order conditions for this will be:

$$\begin{aligned} & U_1.f'(L) + U_2 - \lambda.V_1.f'(L) - \lambda.V_2 = 0 \\ & U_3.g'(L) + U_4 - \lambda.V_3.g'(L) - \lambda.V_4 = 0 \\ & V(.) = V \end{aligned} \qquad (2)$$

It should be evident from inspection that typically these two-equation systems will have different solutions and thus in general the presence of the consumption externality will cause a distortion.

There is however an important special case where in fact this externality does not cause a distortion. In the appendix we show that the equilibrium will be Pareto optimal if each person is only affected by the other person's utility level (and his own consumption) and not by the separate components of the other person's consumption.

While from the formal point of view this is a very special formulation, it may be claimed that from the introspective point of view this is the only reasonable formulation of a consumption externality: why should I care about how much you work or how much you earn except to the extent that it makes you happier?

There is undoubtedly some plausibility to this argument. But the following example should persuade the reader that it does not eliminate all cases of interest.

Consider the thoughts of a hungry man who sees a lot of food being wasted in a rich man's house. Now, he might happen to know that the reason why the food is being wasted is because the rich man is in fact lovelorn and therefore unable to enjoy the food. The poor man is therefore aware that the rich man, despite his larger income, is no happier than him. According to the above argument, in this case the poor man's happiness should not be affected by the fact the rich man has more food than him. Yet it seems unreasonable to deny the hungry man the right to feel peeved at the arbitrariness of fortune which gives all the food to someone who does not want it.

Whether we should call this feeling envy or not is not obvious. Indeed it seems more closely related to the concept of disappointment and regret which are espoused by the critics of the expected utility approach to choice under risk. (See, for example Tversky, 1975.) For our purposes, however, it suffices that this argument establishes the need to consider cases where one person's utility depends on another person's allocation of a particular good rather than the other person's utility level.

For those who are uncomfortable with this kind of argument by instance, it is also worth pointing out that the equilibrium will in fact cease to be efficient even if envy is only envy of utility levels, if there is some uncertainty about the utility functions the agents have. This result is also proved in the appendix.

We can therefore conclude that we cannot, on a priori grounds, rule out the possibility of distortions caused by consumption externalities.

(iii) *No relevant policy questions are raised by envy*. This claim is simply not true. We will argue later that certain types of tax policy may be welfare improving in the presence of envy. Also for those who prefer to think of policy issues in terms of whether there are an adequate set of markets or property rights Robert Frank (1985) argues that firms essentially provide their workers a way of trading in local positional goods (who is higher than who in the hierarchy). Again, later in this paper we will argue that there are a number of elements within any socio-economic system which affect the level of envy within the system and therefore should be included within the discourse of policy actions.

The above consideration of the possible objections to the study of envy in economics thus suggests that on a priori grounds at least there is no good reason why envy should not be taken seriously. Casual empirical observation definitely suggests the same conclusion as does the evidence from the various empirical studies of the relative income hypothesis (see Frank, 1975). The rest of the paper will therefore take envy as given and study the positive and normative implications of envy in a simple two-good model where other people's income enters negatively into each person's utility function.

The organization of the paper is as follows: in the next section we introduce a simple model within which we can make precise our ideas about how envy should be measured. We define two measures of envy: the extent measure and the intensity measure. We then examine how the equilibrium of the economy changes as we change the levels of envy. We will find that the most hard-working people will not usually be the ones who are most competitive and driven by envy.

Section 3 of the paper then uses the structure developed in section 2 to analyse some welfare issues. Since the equilibrium within the economy thus defined will typically be inefficient, a progressive tax policy turns out to be optimal. We then argue that it is useful to look at the level of envy as something that is endogenous to the system and therefore look at the welfare effects of changing the level of envy. We find that in general the deviation from the first best will not necessarily increase with increase in envy and in fact the actual level of welfare may be increased by increased envy.

We go on to focus on the work place as an important example of something that influences the level of envy. We argue that incomplete contracts are very likely in this context so that firms will typically encourage a higher level of envy than is desirable. Unionization and regulations requiring democracy in the work place may therefore be welfare improving.

2. Envy and Equilibrium

2.1. *The general model*

We assume a model in which there are only two goods, a consumption good, y, and labour, L. Assume that the population is given by an index set I which may be finite or a continuum. All members of the population are assumed to be identical and have the utility function

$$u(y, z) - v(L)$$

where y is the allocation of the consumption good for the particular individual j, z is the empirical distribution of the allocation of the consumption good in the entire population and L is the effort level of individual j. Obviously the $u(.)$ function represents utility from income (possibly income relative to others) and the $v(.)$ function represents disutility from effort with $v(0) = 0$, $v'(0) = 0$ and $v''(.) > 0$. Each person also has a random 'personal' production function $F(L, y)$ which gives for each level of L a probability distribution $F(L, y)$ on the levels of y, $y \in [0, \infty)$. Assume that $F_l(L, y)$ is non-positive for all y and that $f_l(L, y)$ is bounded for each L and almost every y, where $f(L, y)$ is the corresponding density function. We will assume that there are no insurance markets where the agents can obtain insurance against randomness in y. It should be relatively easy to see that in certain cases of extreme envy there will be no trade in insurance and therefore this assumption will not be restrictive. In general, however, that will not be true.

2.2. *Measures of Envy*

There is already a substantial literature on measures of envy.[2] However the aim of these measures is to provide a basis for distributional judgments with the basic idea that more unequal

[2] See Chaudhuri (1986) for discussions.

distributions generate more envy.[3] The degree to which people are envious, once defined, is taken as given and different distributions are compared on the basis of it. By contrast, in this paper we take a fixed distribution mechanism and compare the effects of people being more or less envious; in this sense the two lines of research are orthogonal.

Since in our model people are only envious about each other's incomes and income is a scalar, the range of possible measures of envy is quite limited. Within this class the two most obvious measures of the amount of envy in a social configuration are the number of people with whom each person compares himself and the amount of weight that each person places on having a high position in the income hierarchy. We may call these the extent measure and the intensity measure.

Stated as such, however, these measures are not yet operational; typically they will not even generate a complete ordering, since for example it is entirely possible that one person is envious of more people in one situation but another person is envious of more people in another situation.

To operationalize our measures of envy we will therefore have to impose more structure on our model. Let us assume that each person's utility is affected by the income of the same number of other people. Call this number N, the intensity measure of envy. To operationalize the intensity measure of envy, we assume that:

$$u(y, z) = 1 \text{ iff } y \geqslant z_n$$
$$u(y, z) = 0 \text{ iff } y < z_n$$

where z_n represents the n^{th} percentile level of the distribution z. Then n, which is a number between 0 and 100, gives a natural measure of the intensity of envy.[4] If $n = 0$, the agents are happy having any position in the income hierarchy and therefore this can be taken as a situation of no envy. On the other hand if $n = 100$, the agents cannot be happy unless they are absolutely at the top of

[3] This characterization derives from the early work of Foley (1967) and Varian (1974).

[4] Clearly if the initial population is finite we may encounter an integer problem in using this definition; n per cent of the initial population may not be an integer. In this case we will assume that the n^{th} percentile level is arrived at by rounding off n per cent to the highest integer less than it.

the income hierarchy and therefore represents a situation of extreme envy.

Clearly the formulation adopted here is very restrictive. In particular we have a model in which there is no direct utility from consumption itself as distinct from consumption relative to the consumption of others. It should however be easy to see that the basic intuitions behind the results we derive using this pure envy model should still hold if we assume

$$u(y, z) = \tilde{u}(y, z) + h(y),$$

where $\tilde{u}(y, z)$ is exactly like the $u(y, z)$ defined above and $h(.)$ is an increasing, concave function representing direct utility from consumption.

A more serious restriction is the implicit assumption that the pleasure from winning the envy game (i.e. achieving the desired percentile level) is not increased as we increase the targeted percentile level or the number of people who are in competition with each other. It is tempting to say that this is clearly absurd since it is clearly more fun being top in a large group than in a small group. This however is not quite right. After all we are comparing the happiness of an individual in two cases, in each of which he has won what he considers to be the only game in town. Or, put differently, is there any reason to believe that the king of some tiny island tribe which believes it is the only tribe on earth takes less pleasure in being king than Louis XIV did?

The only instance where there seems to be an obvious case against our formulation is when there is only one person around (i.e. $N = 1$). Our definition implies that in this case the person would be as happy as he would be if he was the richest among 1 million people, which seems dubious. It may therefore be more sensible to assume that $u(y, z) = 0$ when $N = 1$. Wherever this assumption becomes relevant we will therefore consider both alternatives.

In the rest of this section we will use some simple examples to look at how the equilibrium of this simple economy changes when we change the levels of envy (measured by the two definitions we have introduced).

2.3. *Equilibrium and comparative statics*

The extent measure case. Here we are looking at the impact of increasing the level of the extent measure of envy. To do this we will fix the intensity of envy at $n = 100$. This is clearly arbitrary but in any case the results we are looking for in this paper are meant to be suggestive rather than definitive and making this assumption makes the exposition very much simpler.

It should be obvious that there is one case when we do not need this assumption. For all values of n the unique equilibrium in the case when $N = 1$ has $L = 0$: there is clearly no point devoting any extra effort as one would only be competing with oneself. Making the alternate assumption, i.e. $u(y, z) = 0$ for all n if $N = 1$, generates the same result.

The case where N is arbitrarily large is also straightforward to analyse if the support of $F(0, y)$ is unbounded.

Claim 1: If $F(0, y)$ has unbounded support, the equilibrium of the economy as N goes to ∞ goes to $L = 0$ for all L.

The proof of this proposition is simple but tedious and so we have chosen to exclude it. The intuition for the result is however very simple; as the number of people gets to be large it becomes certain that at least one person has an income greater than any specific number. This makes it practically certain that however hard one tries one will not be number one in the income hierarchy. However since the agents in this example only care about being number one this would effectively discourage all effort.

The next example focuses on how effort actually changes with changes in the level of envy. For this example we will assume that $n = 100$ and

$$F(L, y) = 1 - \exp[-y/(L+c)]$$

The corresponding density function is:

$$f(L, y) = 1/(L+c) \exp[-y/(L+c)]$$

To find the equilibrium we will assume that a symmetric equilibrium exists and then argue that this indeed must be the case. In a symmetric equilibrium everybody will have the same effort level, L. Let us now evaluate an individual's expected utility at effort level L' assuming that everybody else is fixed at effort level L. From what we have assumed this expected utility will be given by:

$$U^*(N) = \int_0^\infty 1/(L'+c)\cdot\exp[-y/(L'+c)]\cdot[1-\exp[-y/(L+c)]]^{N-1}dy - v(L')$$

First consider the case when $N = 2$. In this case some manipulation yields:

$$U^*(2) = (L'+c)/(L+L'+2c) - v(L')$$

The condition[5] that this expression should be maximized with respect to L' is:

$$(L+c)/(L+L'+2c)^2 - v'(L') = 0$$

Now to demonstrate the existence of a symmetric equilibrium all we need to do is to check that the equation above has a solution for $L = L'$. This amounts to asking whether one can find a solution to the equation

$$1/4(L+c) - v'(L) = 0$$

Now we know that this expression is positive for $L = 0$ (since $v'(0) = 0$) and negative for L very large. Therefore a solution to this equation exists and has the property that at the equilibrium $L > 0$.

In other words, the equilibrium effort level increases as we increase N from 1 to 2 but then eventually decreases again as N becomes very large. The intuition for this is straightforward. In this model only envy motivates agents to work, so that some envy is necessary to get any effort; but if your envy can only be assuaged when you are at the top of a very large group of people, you will probably figure that you will never make it and give up.

Once one accepts this intuition it is tempting to extend it to the following stronger conclusion: as N increases it becomes increasingly unlikely that you will 'win' the envy game; therefore effort should be maximized when N=2. This however is not correct and the reason is that, as often in economics, marginal benefits do not move the same way as absolute benefits do. It is true that each level of effort must yield less benefits in this case than in the previous case but exactly for that reason an increase in effort might actually yield a larger marginal benefit to the agent. Calculations using the same model but $N = 3$ and $N = 4$ yield equilibrium conditions of $5/18(L+c) - v'(L) = 0$ and $13/48(L+c) - v'(L) = 0$ respectively. It is easy to see that these imply that the effort level actually increases quite sharply as N goes from 2 to 3 and then declines slightly as N goes from 3 to 4. A smaller chance of 'winning' as in the case where N goes from 2 to 3 may lead to people trying harder to win.

[5] This is, actually just the first order condition. It is however easy to check that the second order condition is also satisfied.

There may be some question whether our conclusions survive when we do not require that $n = 100$. The intuitions above do not quite extend to this case since now you only care about being above *some* people rather than above *everybody*. When N increases, the number of people (nN) that must have less than you (for you to be happy) does go up but so does the number of possible combinations of people who could have less than you. As a result increasing N does not necessarily reduce the chances of 'winning'[6] in the envy game as it did in the case where $n = 100$. As a result it is no longer obvious that the equilibrium outcome when N becomes very large is the no-effort outcome.[7] However the fact that there are two effects of increasing N which go in opposite directions (see above) suggests that in general we should expect that the effort-maximizing level of N will be finite but not necessarily equal to 2. Some examples we have considered support this view.

The intensity measure case. Since, as we have said before, our aim in this paper is to locate suggestive possibilities rather than provide an exhaustive categorization, we will once again adopt the strategy of confining ourselves to a tractable extreme case. Specifically we will assume that the population with which each individual compares himself (instead of being a number N) is represented by a uniform distribution on the compact interval, [0, 1]. One hopes this is a reasonable approximation to the case when N is large and finite.

Let us otherwise essentially keep the model exactly as it was in the previous section. Once again in looking for a symmetric equilibrium let us choose an index $i \in [0, 1]$ and fix the effort levels of agents indexed by $j \in [0, 1] - i$ at the level L. Let us now ask what is the best response effort level for agents indexed by i. Now the advantage of our continuum assumption for the population is that the 'sample' distribution of realized output levels of agents in $[0, 1] - i$ will be the same as the population distribution. Thus we can write the expected utility to agents indexed by i from an effort level L':

$$U^* = 1 - F(L', z_n) - v(L')$$

where z_n is the n^{th} percentile level of the distribution $F(L, y)$.

[6] That is, getting more than the requisite number of people.

[7] Actually in general the outcome for $n > 100$ and N large will not be the no-effort outcome.

Substituting in the form for $F(\cdot,\cdot)$ we have assumed we get:

$$U^* = \exp[-z_n/(L'+c)] - v(L') \text{ and}$$
$$1 - \exp[-z_n/(L+c)] = n/100 = n' \text{ (say)}$$

which yield

$$U^* = \exp[(L+c)/(L' + c) \log_e (1-n')] - v(L')$$

The first order condition for utility maximization with respect to L' when evaluated at $L' = L$ yields:

$$-(L + c)^{-1}. (1-n') \cdot \log_e (1-n') = v'(L).$$

It is easy to see that this must have a solution $L > 0$ as long as $0 < n < 100$. So a symmetric equilibrium with positive effort always exists. When $n' = 0$ the outcome is obviously $L = 0$. Also as n' goes to 1, L'Hopital's rule tells us that

$$\lim_{n' \to 1} (1-n') \cdot \log_e (1-n') = 0$$

so that at that end also the equilibrium value of 1 approaches 0.[8] Further:

$$\frac{d}{dn'} [- (1-n') \cdot \log_e (1-n')] = \log_e (1-n') + 1$$

As n' goes from 0 to 1 the above expression changes sign from positive to negative. As a result the equilibrium value of 1 must increase and then decrease as we increase n' and the effort-maximizing value of n' will be $n' = 1 - \exp[-1]$.

We thus once again find, that while some envy is necessary to get some effort, increasing envy does not necessarily raise effort. The intuition is similar to the above case; beyond a certain level of envy the agents tend to feel that they cannot get what they wanted and give up trying.

Such clean results are too much to expect in the case where N is finite, but it appears the same general intuitions should continue to hold. Most of the time an intermediate level of envy will maximize

[8] This actually sheds some light on the question of whether the results we derived in the previous section assuming $n = 100$ are robust to changes in the value of n. In particular assuming that the continuum of agents case is a reasonable approximation to the countably large case, we see that as long as n is close to 100 the equilibrium continues to be close to the no-effort outcome that we showed will obtain in the $n = 100$ case.

the level of effort independent of which of the two measures of envy we use.

The careful reader has probably already noted that in deriving this conclusion we do not really need a general increase in envy. The argument for Claim 1 above suggests that a low level of effort will be a dominant strategy in the N large case and therefore does not depend on the actions of other agents. In general, if we increase the level of envy of an individual (measured by either measure) keeping the effort levels of other agents fixed, we will typically find that an intermediate level of envy maximizes the individual's effort level.[9]

This conclusion is of some independent interest. We often make statements which imply that a more competitive person works harder. If we equate being more competitive to having a higher level of envy then this conclusion turns out to be only half true; a person can be so competitive that he actually gives up trying.

A second reason for looking at the nature of the equilibrium is that it allows us to consider welfare and policy issues in the presence of envy. This is what we attempt in the next section.

3. Welfare and Policy Issues

3.1. *Envy and welfare*

We have already noted that the presence of envy causes deviations from the first best. However our discussion in the last section suggests a somewhat surprising relation between envy and the extent of deviation from the first best; in the class of models we have been looking at, the symmetric Pareto optimum involves all agents choosing $L = 0$. But we saw that the only cases where the equilibrium will be close to the optimal $L = 0$ outcome will be cases where there is a very low or a very high degree of envy. In fact the deviation from the first best will typically be largest at intermediate levels of envy. Envy causes deviation from the first best but more envy need not engender a larger deviation from the first best.

The obvious welfare question in this context would be whether a

[9] The reader may now legitimately ask why we do not focus more on this case. The reason, which will become clearer later in the paper, is that the more interesting welfare questions do depend on the gaming elements which arise when we allow the other agents to respond optimally.

tax-transfer scheme can improve the agent's expected welfare. A simple example illustrates how this may indeed happen.

Consider the example introduced in section 2 with $n = 100$, $N = 2$ and

$$F(L, y) = 1 - \exp[-y/(L+c)]$$

Assume also that the entire population of this economy consists of 2 people. Consider an income tax scheme which, for any realizations y_1 and y_2, taxes one and makes a transfer to the other in such a way as to equalize the after-tax income of both the agents. It is easy to see that this scheme will generate the first best outcome $L_1 = L_2 = 0$.[10]

The intuition behind this example is very simple: each agent realizes that he cannot have more than the other agent and stops trying. Following that intuition it is easy to see that the possibility of there being a welfare-improving tax policy does not depend on the specifics of the model we have been using. However it does depend crucially on the very egalitarian nature of the tax policy. Any tax policy which will leave the post-tax ordering of income levels the same as the pre-tax ordering will not generate any welfare improvement since people only care about relative income levels.

Welfare-improving tax policies in the context of this model must therefore necessarily be ones which are *super-redistributive* in the sense that if $y_1 > y_2$ pre-tax, then with some positive probability we get $y_1 \leq y_2$ post-tax. As implied in the last sentence these super-redistributive policies may include *random tax policies*.

It is possible that this reliance on super-redistributive policies may be relaxed when, unlike in the model we have been considering, agents also get some utility from direct consumption. We have not however analysed this case.

It also seems likely that a less radical tax policy may be found to be welfare-improving if people also care about the distance (in terms of income levels) between them and other people. Our analysis therefore suggests that a part of the explanation of why income taxes are widely used may be found in the pervasiveness of a desire for relative standing in modern capitalist societies.

[10] We assume that the agents compare their post-tax incomes. This may or may not be reasonable. If one believes that it is conspicuous consumption that the agents are interested in (rather than just the fact that they make more money than others) then our formulation seems better than comparing pre-tax incomes.

The basic intuition to take away from this section is that progressive taxation works in the opposite direction of increasing envy. In our model this implies that highly progressive taxation will maximize welfare. However in this case taxation improves welfare by reducing effort, and opponents of redistributive taxation may take solace in the fact that it remains true that making taxes less progressive causes faster growth.[11] However while this conclusion is true for the extreme redistributive policies we described above, we also know that over a range increased envy discourages effort and therefore growth. Since, as we noted above, making taxes more progressive works as reducing envy it should be possible to find instances where redistributive taxation increases effort and growth.

3.2. *Thou shalt not covet. . .*

There is another, obvious, kind of social policy which relates to envy. Hortatory pronouncements discouraging envy are at least as old as the Ten Commandments and the Horatio Alger doctrine of 'Aim high young man!' may be thought of as a modern antidote to these more traditional commandments. It is also well-known that a number of basic social institutions directly affect and mould our levels of competitiveness. The most obvious examples of this phenomenon are the school system and the sports arena.

Perhaps less obvious but, for an economist, a more interesting instance is the work place; firms design reward schemes to encourage 'healthy' but not 'cut-throat' rivalry between fellow workers. Army officers are encouraged to compete with other officers who graduated from the military academy in the same year, but not with their superior officers. It does not seem far-fetched to claim that these are natural examples of attempts to control the level of envy and to set it at intermediate levels. To the best of our knowledge however, to date, the implications of these considerations have not been looked at by economists. In fact, the standard methodological ground rules that economists go by will exclude looking at such questions; changing the level of envy formally represents changing a person's utility function and therefore violates the postulate of consumer sovereignty.

However it seems rather sophistical to avoid discussing these questions on such grounds. After all one can imagine a situation in which a particular individual is envious of all other people of his rank in his firm. Now if the firm decides to employ one more person at that rank the situation is as if that individual's extent measure of envy has changed. However there seems no good reason to suggest that as a result he has become a different person and his utility levels cannot be compared. We will therefore now look at the question of how an agent's welfare changes as we change the level of envy.

[11] This of course raises the question of whether growth *per se* is desirable.

Our discussion in section 2 should give us the basic intuitions for understanding this question. We know that increasing the level of envy must have a direct effect which is welfare-reducing, since one now needs more to be as happy as one used to be. However it also has an indirect effect involving its effect on the level of effort. To the extent that increasing envy leads to lower equilibrium effort it increases welfare, and it is possible that this indirect effect dominates so that increasing envy actually increases welfare.

In the intensity measure case an example of this is relatively easy to generate. Consider the example studied in section 2.3. Recall:

$$U^* = \exp[(L+c)/(L'+c) \quad \log_e (1-n')] - v(L')$$

At a symmetric equilibrium $L' = L$ so that the above expression yields:

$$U^* = 1 - n' - v(L)$$
$$dU^*/dn' = -1 - v'(L)\ dL/dn'$$

The condition for equilibrium from the above is:

$$-(L+c)^{-1}.\ (1-n').\ \log_e (1-n') = v'(L)$$

which yields

$$dL/dn' = [\log_e (1-n') + 1]/[v'(L) + k{\cdot}v''(L)\ [v'(L)]^{-1}]$$

where $k = -(1-n').\ \log_e (1-n') > 0$.
Therefore

$$dU^*/dn' = -1 - [\log_e (1-n') + 1]/(1 + k{\cdot}v''(L)\ [v'(L)]^{-2})$$

Now, we know that when $n' = 0$, U^* achieves its maximum value of 1, so that at $n' = 0$, U^* must be decreasing. On the other hand when $n' = 1$, U^* achieves its minimum value of 0, so that at $n = 0$ also U^* must be decreasing. So if U^* has to be increasing anywhere in that interval it must have two stationary values, i.e. the equation

$$-1 - [\log_e (1-n') + 1]/[1+k \cdot v'' (L(n')) [v' (L(n'))]^{-2}] = 0$$

must have two solutions. For an appropriate choice of the $v(.)$ function this should indeed be the case. So it is possible that an increase in envy is welfare-improving.

The same conclusion, that increasing envy generally leads to a reduction in welfare but might occasionally lead to an increase over some range, seems plausible when we increase N from 2 to infinity (intuition is exactly the same). In the only case where we have gone through with the calculations (the model in section 2.3—the extent measure case—with the assumption that the $v(.)$ function is linear), however, it turns out that increases in N are always welfare-reducing. What happens when we increase N from 1 to 2 depends on which definition we use. By the first definition clearly the welfare maximum is at $N = 1$. By the other definition $N = 1$ is a welfare minimum; the maximum may be at $N = 2$, but need not be.

The point of this exercise is of course not to claim that one should sometimes try to increase the level of envy; rather it is to get a clearer understanding of policies which affect the level of envy. Next we will briefly consider this question in the context of the theory of organizations.

3.3. *Envy and the theory of organizations*[12]

As we have already suggested, it is very plausible that firms can influence the level of envy among their workers. Some possible ways in which they may do so are:

1. Over-emphasizing or de-emphasizing the importance of differences in rank within the firm. The military seems a classic example of over-emphasis. Japanese firms where everyone in supervisory positions has to be addressed by his rank may be another instance (or I may be betraying rank ignorance of Japanese culture).
2. Creating an excessive amount of titled posts. The easiest example is the huge proportion of vice-presidents in many U.S. firms.
3. Creating non-pecuniary awards for divisions in firms which perform best. This is supposed to encourage the workers to work hard by recognizing their achievement. But it seems equally plausible to interpret it as a way of making workers more sensitive to relative performances.
4. Changing the size of peer groups among workers.
5. Introducing someone who is more competitive into an existing peer group to 'shake up the others'.

[12] For a very different but insightful meditation on the same general topic see Frank (1985).

The key common feature of the list of possibilities given above is that they all involve influencing people's perception of their own social position while keeping their physical income possibilities unchanged. This is what distinguishes the kinds of things we are concerned with from the more standard question of whether a firm should adopt a rank-order tournament as its reward scheme (see Lazear and Rosen, 1981).

The fact that the kinds of things suggested above do not involve changing reward schemes does not imply that these things are costless. In fact it is very plausible that the marginal cost of changing the level of envy increases very fast as we move away from people's natural (socio-culturally determined) levels of envy.

None the less it is somewhat helpful to consider what levels of envy organizations would choose if changing the level was costless. For a profit-maximizing firm or performance-maximizing military organization the obvious answer is that it will choose the level of envy that maximizes the effort levels of its workers. As we have argued this will typically be some intermediate level of envy we might interpret as the so-called 'healthy level of rivalry'.

We know however that this effort-maximizing level may not be the welfare-maximizing level. In the case where the choice variable is n the welfare-maximizing level is $n = 0$. For the case where we are changing N the answer depends on which of the two definitions we choose. For the first definition clearly the $N = 1$ option is welfare-maximizing and the firm does not select N to maximize welfare. For the second definition, however, the welfare maximum will not be at $N = 1$. In fact in the exponential example considered in section 2.3 social welfare will be maximized at $N = 2$ but the effort-maximizing organization will pick $N = 3$.

In general, therefore, organizations will not choose to maximize the level of social welfare. However if people start with a high level of envy, the firm may actually try to get them to reduce their level of envy and make them better off. And there is also the perverse possibility that the firm, in the process of reducing people's level of envy, makes them worse off.

Now it may be argued that since the outcome of the interaction between the firm and the workers generates a socially bad outcome a contract between them could make both better off and achieve the social optimum. However while such a conclusion is tempting it should be realized that what we are discussing is a contract in which people have to anticipate how their preferences would change in specific contexts and bind themselves against it at a price.[13] Schelling (1960), among others, has discussed at length why this kind of decision may be problematic for the agents involved. Further it seems very hard to imagine a contract which can specify constraints on exactly how firms may try to influence levels of envy of its agents. Both private information and the sheer complexity of such a contract will make it almost impossible to come anywhere near the optimal contract.

In the absence of the requisite optimal contracts it is easy to see why labour unions and regulations requiring that workers be given a certain amount of power within the firm may serve a useful social purpose. In particular, if they create a sense of community and social confidence among the workers they will make the level of envy among the workers more difficult to manipulate and prevent the generation of suboptimalities due to excessive envy.[14]

4. Concluding Remarks

This paper is intended as an extended prologue to the study of equilibrium theory in the presence of envy. Within a class of simple models we provide definitions of measures of envy and use these definitions to shed light on what we mean when we say 'a firm encourages a *healthy* level of rivalry between its workers' or 'he is so competitive that he works all the time'. We find that the relation between welfare and levels of envy is potentially complicated; perverse outcomes like more envy being welfare-improving cannot be ruled out. We suggest that income taxation may have a connection with existence of envy. And we provide a tentative

[13] This is like a contract that smokers who would like to quit should sign with tobacco companies, requiring them to stop selling cigarettes.

[14] My thoughts on this point have been influenced by the interesting discussion of a related question in Frank (1985).

explanation of why the operation of many organizations may involve generating socially undesirable levels of envy. There are many other issues which come up in reflecting on the implications of envy, which have not been discussed in this paper. One very important example of such an issue is the existence of equilibrium. It seems likely that even with all the 'right' kinds of continuity and convexity properties equilibrium may not exist. The presence of envy introduces a serious nonconvexity: in a two-person game, as your opponent increases his effort you might increase your effort and try and match him but you may also decide that you would prefer to let go and take your leisure instead. The reaction function may therefore jump down and a pure strategy equilibrium may not exist.

A related concern is that in the presence of envy the equilibrium loses its equal treatment property. Asymmetric equilibria may exist and therefore agents with identical opportunity sets may end up with different levels of welfare.[15]

These are some of the questions we plan to study in a companion to this paper, and we hope that by doing so we will begin to get a sense of how much we need to modify our usual theoretical intuitions if we take envy seriously.

APPENDIX

Claim: The equilibrium will be Pareto optimal if each person is only affected by the other person's utility level (and his own consumption) and not by the separate components of the other person's consumption.

Proof: In this case each person's utility function takes the form:

$$U = \mathcal{U}(f(L), L, V) \text{ and } V = \mathcal{V}(g(L'), L', U)$$

These assumptions imply a special form for the partial derivative terms in equation systems (1) and (2). Specifically,

$$\begin{aligned}
U_1 &= \mathcal{U}_1/\,(1-\mathcal{U}_3.\mathcal{V}_3),\ U_2=\mathcal{U}_2/\,(1-\mathcal{U}_3.\mathcal{V}_3)\\
U_3 &= \mathcal{U}_3.V_3,\ U_4 = \mathcal{U}_3.V_4\\
V_1 &= \mathcal{V}_3.U_1,\ V_2 = \mathcal{V}_3.U_2\\
V_3 &= \mathcal{V}_1/(1-\mathcal{U}_3.\mathcal{V}_3),\ V_4 = \mathcal{V}_2/(1-\mathcal{U}_3.\mathcal{V}_3)
\end{aligned}$$

[15] Examples of this phenomenon are quite easy to construct.

Substituting the expressions for V_1, V_2, U_3 and U_4 into (2) we get:

$$(U_1.f'(L) + U_2).(1 - \lambda.\mathcal{V}_3) = 0$$
$$(V_3.g'(L) + V_4).(\mathcal{U}_3 - \lambda) = 0$$

It is evident that the Nash equilibrium defined by equation system (1) above will satisfy these conditions for Pareto optimality.

Q.E.D.

This result, however, depends crucially on the assumption of perfect information. Let us now consider the case in which the actions have to be taken in the presence of uncertainty about the actual realizations of the utility functions. Assume that the utility functions are of the form:

$$U = \mathcal{U}(f(L), L, V, \omega) \text{ and } V = \mathcal{V}(g(L'), L', U, \omega')$$

where ω and ω' are random variables with independent density functions $f(\omega)$ and $g(\omega')$.

Assume also that actions have to be chosen when ω and ω' are unknown but subsequently the realizations of both of them become common knowledge.

The conditions for equilibrium will be:

$$\underset{\omega,\omega'}{E}[dU/dL] = 0 \text{ and } \underset{\omega,\omega'}{E}[dV/dL] = 0$$

We will compare this equilibrium with what a social planner should choose under the same informational constraints which will be whatever maximizes:

$$\underset{\omega,\omega'}{E}[U] \text{ subject to } \underset{\omega,\omega'}{E}[V] = \bar{V}$$

The conditions for this maximization will be

$$\underset{\omega,\omega'}{E}[dU/dL] - \lambda . \underset{\omega,\omega'}{E}[\mathcal{V}_3.dU/dL]$$

Now if

$$\underset{\omega,\omega'}{E}[\mathcal{V}_3.dU/dL] = \underset{\omega,\omega'}{E}[\mathcal{V}_3] . \underset{\omega,\omega'}{E}[dU/[dL)$$

then indeed the equilibrium would be Pareto optimal. But since both $\mathcal{V}_3$ and dU/dL are functions of both ω and ω' this decomposition will not generally be possible. Therefore the equilibrium may not be Pareto optimal.

REFERENCES

1. Chaudhuri, A. (1986): 'Some Implications of an Intensity Measure of Envy', *Social Choice and Welfare*, 4, pp. 255–70.

2. Diamond, P. A. and J. A. Hausman (1982): 'Individual Retirement and Savings Behaviour', Presented at the SSRC-NBER Conference on Public Economics in Oxford, U.K.
3. Foley, D. (1967): 'Resource Allocation and the Public Sector', *Yale Economic Essays*, 7, pp. 45–98.
4. Frank, R. (1985): *Choosing the Right Pond*, OUP, New York.
5. Kahneman, D. and A. Tversky (1974): 'Judgments under Uncertainty: Heuristics and Biases', *Science*, 185, pp. 1121–31.
6. Lazear, E. and S. Rosen (1981): 'Rank-order Tournaments as Optimal Labor Contracts', *JPE*, October.
7. Mayer, T. (1972): *Permanent Income, Wealth and Consumption*, University of California Press, Berkeley.
8. Rader, T. (1980): 'The Second Theorem of Welfare Economics When Utilities are Interdependent', *Journal of Economic Theory*, 23, pp. 420–4.
9. Rawls, J. (1971): *A Theory of Justice*, Harvard University Press, Cambridge, Mass.
10. Schelling, T. (1960): *The Strategy of Conflict*, Harvard University Press, Cambridge and London.
11. Tversky, A. (1975): 'A Critique of Expected Utility Theory: Descriptive and Normative Considerations', *Erkenntnis*, 9, pp. 163–73.
12. Varian, H. R. (1974): 'Equity, Envy and Efficiency', *Journal of Economic Theory*, 9, pp. 249–60.