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WHAT AFFECTS THE LEVEL OF HONESTY IN AN ECONOMY?

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ABSTRACT

This paper focusses on questions such as what determines the societal level of honesty (that is, the proportion of honest individuals in the economy), and why some economies may be more honest, or less honest, than others. A central feature of our model is that an individual's (Bayesian) behavior (to be honest or dishonest) is influenced by his own past experiences which, in turn, are determined by the behavior of others. Therefore, honesty encourages honesty, whereas dishonesty encourages dishonesty. Our formal analysis is conducted within an overlapping generations framework, in which individuals live for a finite amount of time, but the society is a going concern.

We show that there can be dishonesty in an economy even if the youngest generation is entirely honest, and that there can be honesty in an economy even if the youngest generation is entirely dishonest. We predict the effects (on the level of honesty) of parameters representing the characteristics of individuals and the economy. For instance, if the youngest generation believes that the level of honesty in the economy is higher then, indeed, the actual level of honesty is higher. In addition, we have been able to delineate intuitive conditions under which an economy is less honest (or more honest) if people live longer, and under which older persons are less honest (or more honest) than the younger ones.

WHAT AFFECTS THE LEVEL OF HONESTY IN AN ECONOMY?

The fault, dear Brutus, is not in our stars,
But in ourselves,...

Shakespeare

Raaj Kumar Sah*

March 1985

*Yale University. I thank George Akerlof for a useful discussion.

WHAT AFFECTS THE LEVEL OF HONESTY IN AN ECONOMY?

By Raaj Kumar Sah

Social scientists have often grappled with questions such as what determines the level of honesty in a society, and why one society may be more honest, or less honest, than another.[1] We present here a model within which such questions can be posed, and show that economic insights can be of significant help in ascertaining the answers.[2]

The aspect of human behavior which plays a central role in our analysis is that an individual's decision to be honest or dishonest depends, in part, on his own past experiences. For instance, if an individual's past experiences consist primarily of having been treated dishonestly, then he is likely to believe that there is a preponderance of dishonesty in the economy. Further, this belief may induce him to behave dishonestly if it appears harmful to him to be honest in a seemingly dishonest world. Thus, an individual is honest or dishonest in different phases of his life depending on the experiences which the passage of time brings to him, and depending on the relative costs of being honest versus dishonest.[3]

Next, consider the determination of collective honesty. The main feature of our model in this regard is that honesty reinforces honesty, whereas dishonesty reinforces dishonesty. This is because the beliefs (and the behavior) of each individual are affected by the behavior of others. Alternatively stated, honest persons generate an externality on others by making it more desirable for them to be honest. Dishonest persons generate an opposite externality. We study the properties of the equilibrium where these two opposing externalities are in balance with one another.

Our model of individual behavior is consistent with Bayesian optimization. In addition, it predicts patterns of behavior which have intuitive appeal. For instance, an individual changes his behavior (from being honest to being dishonest, or vice-versa) only if his last experience was in contradiction with his beliefs. We determine the societal level of honesty (that is, the proportion of honest individuals in the economy) within an overlapping generations framework, in which each individual lives for a finite amount of time, but the society lasts forever.

The organization of the paper is as follows. Rather than beginning with a general model, we first present a simple example in Section I. The main reason for presenting this example is that its simpler context makes it easier to focus on some of the features of our model. Though this example is based on a somewhat polar form of individuals' behavior, it is consistent with rationality under certain circumstances. Section 2 contains the main model for predicting individuals' behavior and for determining the level of honesty in the economy. Results are presented in Section 3. The last section contains concluding remarks.

I. AN EXAMPLE

We employ an overlapping generations framework in which an individual lives for n periods. $n \geq 2$, and it is finite. A new generation enters the economy in each period, and all generations have the same (large) number of individuals. y_k denotes the level of honesty in the k^{th} generation (that is, the proportion of honest persons among those who have already lived for $k - 1$ periods), and $k = 1, \ldots, n$. Clearly, $1 \geq y_k \geq 0$. The average level of honesty in the economy is y and

$$(1) \qquad y = \sum_{k=1}^{n} y_k/n \ .$$

The proportion of honest persons in the youngest generation is y_1. At present, we take y_1 as an exogenous parameter and show, later, that whether an individual begins his life as an honest or a dishonest person can be explained in terms of more fundamental characteristics of individuals.[4]

In each period, an individual encounters (trades with) another individual, and there is an equal probability of encountering any one of the individuals in the economy. Thus, the probability that an individual encounters an honest person is y.[5] After each period, every individual reconsiders the choice of his behavior, and decides whether to be honest or dishonest in the next period. A wide variety of individuals' behavior is (endogenously) determined in the next section. At present, we consider a specific example in which an initially honest person remains honest as long as he has encountered only honest persons; and an initially dishonest person always remains dishonest. This behavior reflects 'extreme caution' and, clearly, it is somewhat polar. But, as we shall see later, it is consistent with rational behavior under certain circumstances.

The level of honesty in the generation $(k+1)$ is therefore given by

$$(2) \qquad y_{k+1} = y_1 y^k \ .$$

The sum of the above expression from $k = 0$ to $(n-1)$ can be rearranged, using (1), to yield

$$(3) \qquad f(y) \equiv y_1 \sum_{k=0}^{n-1} y^k - ny = 0 \ .$$

A solution of the above polynomial equation is a steady state equilibrium level of honesty in the economy. Substitution of this solution into (2) yields the level of honesty in various generations.[6]

If y is a solution of (3), then our interest is in examining its properties only if it is stable, and if $1 \geq y \geq 0$. The reason why stability is important is this. If the economy starts from an arbitrary disequilibrium situation, then it converges only to a stable equilibrium. Alternatively, if the economy is at an equilibrium then, after a small shock, it returns to this equilibrium only if the equilibrium is stable. In the present context, thus, we need not consider an unstable equilibrium.

The condition for stability is easy to obtain. A solution y of (3) is stable if and only if[7]

$$(4) \qquad f_y(y) < 0$$

where the subscripts of f denote the variable with respect to which a partial derivative is being taken. The economic intuition behind the condition (4) is as follows. From (3), $f(y)/n$ can be viewed as the difference between this period's average honesty in the economy and the last period's average honesty. This difference must be zero at an equilibrium. Now, if the economy is out of equilibrium, and if the above difference is positive (negative), then stability requires that the corresponding difference in the next period should be smaller (larger) than that in this period. But, this can happen if and only if (4) is satisfied.

It is instructive to look at some features of the equilibrium. First consider the case in which the youngest generation has honest as well as dishonest persons, that is, $1 > y_1 > 0$. Then (3) shows that $f(0) > 0$, and $f(1) < 0$. Therefore, there must be at least one <u>internal equilibrium</u>

(that is, the corresponding y is greater than zero but smaller than one), which is stable. In the present case, it turns out that this is the only stable equilibrium.[8]

A more important result is obtained in the case in which the youngest generation is entirely honest, that is, $y_1 = 1$.[9] In this case, it can be shown that if $n \geq 4$, then there is a unique stable equilibrium, and it is internal.[10] Thus: If individuals live for four or more periods, and if the youngest generation is entirely honest, then there must be some dishonesty in the economy.

This result may appear counterintuitive at first sight because, with a completely honest generation entering the economy in each period, one would expect that the economy would eventually become entirely honest. To see why this is not true, consider a disequilibrium situation in which there is a very small number of dishonest persons (say a dozen out of a million) in the economy. These dishonest persons, handful though they are, generate an externality in each period, and make other persons dishonest who, in turn, do the same. This process continues until the stable equilibrium, entailing some dishonesty in the economy, is attained.

Furthermore, there is an intuitive reason why the above result holds only if individuals' life span is four or more periods. If individuals live longer, then even a small number of dishonest persons have a greater potential for spreading dishonesty. Conversely, if the individuals' life span is short, say only two periods, then dishonesty becomes extinct before it acquires a permanent base in the economy.

We now turn to comparative statics analysis. If θ denotes an exogenous parameter, then it is obvious from (3) and (4) that the sign of $dy/d\theta$ is the same as the sign of f_θ. Now, $\partial f/\partial y_1 > 0$, from (3). We therefore obtain the following result which, as we shall see, holds also for the general model presented in the next section.

PROPOSITION 1: The economy-wide level of honesty is lower if the level of honesty in the youngest generation is lower.

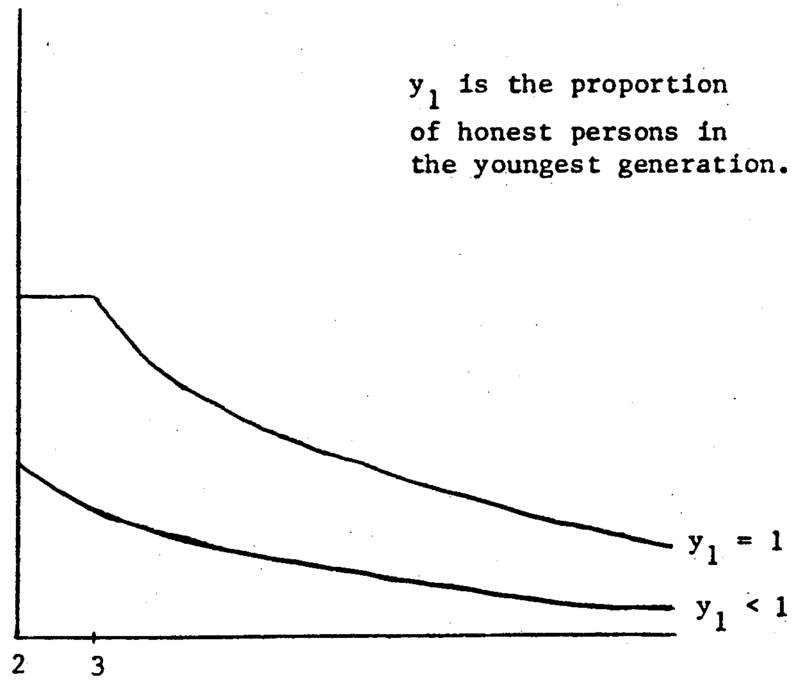
The reason for this result is simple. A lower initial honesty has a direct effect of reducing the average. In addition, it increases the incidence of those experiences in which individuals encounter dishonest persons. The indirect effect, therefore, also leads to a reduction in the economy-wide honesty.

The effect of an increase in the life span of individuals can be ascertained from (3), which yields $f(y, n+1) - f(y, n) = -y(1 - y_1 y^{n-1}) < 0$. Thus, the economy's level of honesty declines if people live longer. This is because the individuals' behavior in the present example is such that an older generation is less honest and, in fact, the oldest generation is the least honest of all generations. A longer life span, therefore, lowers the average honesty in the economy, and also creates a negative externality.

The above comparative statics results are depicted in Figure 1. Note, however, that the present result concerning the effect of individual's life span is, in part, due to the extreme caution underlying the individuals' behavior. This result is modified, and indeed it is less pessimistic, when more general forms of behavior are considered, to which we now turn.

Figure 1

The proportion of honest persons in the economy, y.



The life span of individuals, n.

II. THE MODEL

We begin with a model of individual behavior which is not only consistent with individual (Bayesian) optimization, but which also predicts appealing behavioral patterns. Individuals begin their lives with different beliefs (priors) concerning the extent of honesty in the economy, and these differences influence whether an individual begins his life as an honest or a dishonest person. Denote these two types of individuals by the superscripts $i = 1$ and 2, respectively.

An individual revises his beliefs in each period based on his past experiences, and chooses his behavior (to be honest or dishonest) depending on what he considers to be best for himself. m^{ik} denotes the <u>mean</u> estimate of the level of honesty in the economy, which an individual of type i makes when he has lived for k periods. We discuss the determination of m^{ik} below, but before that we look at the choice faced by an individual.

<u>Individual Choice</u>: The relative cost of being honest versus dishonest is determined as follows. In any single period, an honest person receives an (expected) utility U^{gg} if he encounters an honest person, and utility U^{gb} if he encounters a dishonest person. For a dishonest person, the corresponding utilities are U^{bg} and U^{bb}. We assume $U^{bb} > U^{gb}$, and $U^{gg} > U^{gb}$. That is, being dishonest is better if one encounters a dishonest person, but being honest is better if one encounters an honest person. The individual must, however, choose his behavior before the actual encounter.

It follows than that an individual of type i is honest in the period $(k + 1)$ of his life if

(5) $$m^{ik} \geq U ,$$

and is dishonest otherwise.[11] In (5), we have defined

$U = (U^{bb} - U^{gb})/[(U^{gg} - U^{bg}) + (U^{bb} - U^{gb})]$. Clearly, $1 > U > 0$. Also, as one would expect, U can be viewed as a summary parameter representing the relative cost (in terms of utilities) of being honest versus being dishonest.[12] It is this summary parameter which we shall use in the rest of the paper.

Two aspects of the individual's choice should be noted here. First, the decision criterion (5) shows that an individual's choice depends on the mean of his priors concerning the level of honesty in the economy, but not on the distribution of his priors. Second, we have assumed that, in determining his behavior, an individual believes that his own choice to be honest or dishonest does not affect the level of honesty in the economy. This assumption is justified in the present context in which the number of individuals in the economy is large.

Individual's Beliefs: The total number of honest persons which an individual encounters during his k past periods is clearly a binomial distribution. We assume that the initial priors of an individual (concerning the level of honesty in the economy) are distributed according to a beta distribution with parameters (u^i, w^i) .[13] Therefore, a standard result in statistics[14] allows us to express m^{ik} as

$$(6) \qquad m^{ik} = \frac{u^i + s^i(k)}{u^i + w^i + k}$$

where $s^i(k)$ is the number (score) of honest persons which this individual has encountered during the k past periods. By substituting (6) into (5), we can express an individual's decision criterion in terms of his initial beliefs and his past experiences.

Now recall that we had defined individuals of type $i = 1$ and 2 to be respectively those who are initially honest and dishonest. From (5), this means: $m^{10} \geq U$, and $m^{20} < U$. From (6), therefore, the above definition can be equivalently expressed as

$$(7) \qquad \frac{u^1}{u^1 + w^1} \geq U \text{ , and } \frac{u^2}{u^2 + w^2} < U \text{ .}$$

It follows then that y_1 is simply the proportion of individuals who have initial beliefs specified by the first part of expression (7).[15]

<u>Properties of Individuals Behavior</u>: The decision criterion (5) can be expressed in a much simpler form by defining

$$(8) \qquad c^i(k) = (u^i + w^i + k)U - u^i$$

as the <u>reservation level</u> for being honest. From (5) and (6), then, an individual's decision to be honest or dishonest in the period $(k+1)$ of his life is determined by the following decision rule.

(9) Be honest if $s^i(k) \geq c^i(k)$, and be dishonest otherwise.

An individual thus determines his optimal behavior in each period by simply comparing the score of honest persons he has encountered in the past to the reservation level for that period. The decision rule is clearly parsimonious in the use of memory.

A useful feature of the above model is that it is capable of generating a wide variety of individuals' behavior, depending on the parameters (u^i, w^i, U) representing initial beliefs and the relative cost of alternative behaviors. Furthermore, the model predicts patterns of behavior which have attractive properties. Some of these properties are described below;

particularly those which will be helpful in deriving the results in the next section.

First: An individual changes his behavior (from being honest to dishonest, or vice-versa) only if his last experience has contradicted his belief. To see this, note that if an individual was honest in the last period, and if his last encounter was with an honest person, then he remains honest in this period. This is because if $s^i(k-1) \geq c^i(k-1)$, and if $s^i(k) = s^i(k-1) + 1$ then, from (8), $s^i(k) > c^i(k)$. A parallel argument shows that a person remains dishonest if he was dishonest in the last period and if he encountered a dishonest person. Therefore, a necessary condition for a change in an individual's behavior is that his last experience should be in contradiction with his beliefs.

Second, it is obvious from (8) that the reservation level is higher for an older person, that is

$$(10) \qquad c^i(k+1) > c^i(k)$$

Third, expressions (7) and (8) yield

$$(11) \qquad c^2(k) > c^1(k) \; .$$

In other words, the reservation level for an initially dishonest person is higher, at any stage in his life, than the corresponding reservation level for an initially honest person.

Finally, the effects of exogenous parameters on reservation levels can be seen directly from (8). They are

$$(12) \qquad \frac{\partial c^i}{\partial u^i} < 0 \; , \quad \frac{\partial c^i}{\partial w^i} > 0 \; , \quad \text{and} \quad \frac{\partial c^i}{\partial U} > 0 \; , \quad \text{for any } k \; .$$

Now, note from (7) that a smaller u^i or a larger w^i implies a smaller m^{i0}.[16] From (12), therefore, the reservation level is higher for either type of individual if he initially believes that the level of honesty in the economy is lower, or if the relative cost of honesty is higher. All of the above properties are clearly in agreement with what we would expect the nature of human behavior to be.

The Level of Honesty in the Economy: The proportion of individuals of type i who are honest in the generation $(k+1)$ is the probability of (9) being satisfied. This, in turn, is the probability of $c^i(k)$ or more successes in k independent Bernoulli trials, where y is the probability of success in each trial. To calculate these probabilities, we use $C^i(k)$ to denote integer valued reservation score corresponding to (8). Specifically, $C^i(k)$ equals $c^i(k)$ if the latter is an integer, and $C^i(k)$ equals the number which is the closest higher integer to $c^i(k)$, otherwise. The decision rule (9) now implies that an individual is honest in generation $(k+1)$ if $s^i(k) \geq C^i(k)$. The corresponding probability can be calculated from binomial distribution; we denote this probability as $B^i(k)$, where[17]

$$(13) \qquad B^i(k) = \sum_j \binom{k}{j} y^j (1-y)^{k-j}, \quad \text{where} \quad j = C^i(k), \ldots, k .$$

Therefore, the proportion of honest individuals in generation $(k+1)$ is

$$(14) \qquad y_{k+1} = y_1 B^1(k) + (1-y_1) B^2(k) .$$

Using (1), the sum of the above expression from $k = 1$ to $(n-1)$ can be rearranged to yield

$$f(y) \equiv y_1 + y_1 \sum_{k=1}^{n-1} B^1(k) + (1-y_1) \sum_{k=1}^{n-1} B^2(k) - ny = 0 \ . \tag{15}$$

As before, a solution of the above polynomial equation is a steady-state equilibrium level of honesty in the economy, and an equilibrium is stable if and only if it satisfies (4).[18] Also, the existence of equilibrium can be studied by using techniques parallel to those used in Section I. For instance, if y_1 is internal, that is $1 > y_1 > 0$, then (15) yields: $f(0) > 0$ and $f(1) < 0$. Therefore, corner equilibria (that is $y = 0$ or 1) are not possible, and at least one stable internal equilibrium must exist. This, in turn, has an implication which we would intuitively expect: If the youngest generation contains both honest and dishonest persons, then the economy can not be entirely honest or entirely dishonest.

It would be useful here to demonstrate our earlier claim that the example in Section I is a special case of the present model. To see this, note that if $C^1(k) = k$, and $C^2(k) > k$, then (13) implies: $B^1(k) = y^k$, and $B^2(k) = 0$. Substitution of these into (15) yields the special case (3). Further, the above reservation scores can be shown to be optimal for many sets of parameters (u^i, w^i, U); particularly those in which the relative cost of honesty, U, is high and the initial beliefs are such that 'extreme caution' is the rational behavior.[19]

III. RESULTS

Our objective in this section is to derive some of the important properties of the level of honesty in the economy. We first examine whether there can be dishonesty (honesty) in an economy if the youngest generation is entirely honest (dishonest). Clearly, the answer is yes, because, even when y_1 is zero or one, there would be many different sets of parameters for which the equation (15) has an internal stable solution. In Section I, we have already provided an example in which $\bar{y}_1$ is one, but the equilibrium is internal. We now present an example in which y_1 is zero, but the equilibrium is internal.

Consider the case in which an initially honest person remains honest throughout his life, and an initially dishonest person becomes honest, and remains so, if he encounters at least one honest person. That is, the reservation scores are: $C^1(k) \leq 0$, and $C^2(k) = 1$. These scores exhibit 'very little caution' and they can, once again, be shown to be optimal for many sets of parameters, particularly those where the relative cost of honesty, U , is low.[20] From (13), therefore, $B^2(k) = 1 - (1-y)^k$. Substituting this into (15) and setting y_1 at zero, it can be verified that: <u>If the youngest generation is entirely dishonest, then the unique stable equilibrium entails some honesty in the economy, provided individuals live for four or more periods.</u>[21] The reason for this counterintuitive result is parallel to the one explained in Section I.

Obviously, the above example and the one presented earlier in Section I are particular illustrations of the following proposition.

PROPOSITION 2: <u>There can be dishonesty in an economy even if the youngest generation is entirely honest, and there can be honesty in an economy even if the youngest generation is entirely dishonest.</u>

The level of honesty in the present model depends on the parameters (y_1, u^i, w^i, U, n) . For comparative statics analysis, recall that the sign of $dy/d\theta$ is the same as that of f_θ , where θ is an exogenous parameter. Now, $\partial f/\partial y_1 = 1 + \sum_{k=1}^{n} [B^1(k) - B^2(k)]$, from (15). Further, $C^2(k) \geq C^1(k)$, from (11), and B^i is decreasing in C^i from (13). Hence,

$B^1(k) \geq B^2(k)$, and $\partial f/\partial y_1 > 0$. Clearly, therefore, Proposition 1 holds in the present model. The reason for this is simple. An initially dishonest person is no more likely to be honest (at any stage in life) than an initially honest person. A lower level of initial honesty thus not only lowers the economy's average, but it may also decrease the level of honesty in the older generations. Both of these effects, in turn, have externality which lowers the level of honesty.

Next, recall from (12) that the reservation level $c^i(k)$ is smaller if u^i is larger. As a consequence, either $C^i(k)$ remains unchanged, or it decreases. Correspondingly, either $B^i(k)$ remains unchanged, or it increases. Thus $\partial f/\partial u^i \geq 0$. An exactly parallel argument shows that $\partial f/\partial w^i \leq 0$ and $f_U \leq 0$. These yield the following result.

PROPOSITION 3: <u>The level of honesty in the economy is nondecreasing in the initial beliefs of individuals concerning the economy's level of honesty, and it is nonincreasing in the relative cost of honesty</u>.

A stronger result is obtained if the reservation score is affected by the parameters for either type of individuals in at least one generation. In this highly plausible case: <u>A higher (lower) initial prior or a lower (higher) relative cost of honesty must raise (lower) the economy's level of honesty</u>. The result is quite intuitive. If the youngest generation (of either type of individuals) believes that the level of honesty in the economy is higher then they can not be less honest at any stage in their life. Further, if this belief makes them more honest in even one generation (which is what we would normally expect) then, clearly, the belief has a direct as well as an indirect effect of raising the level of honesty in the economy. The effect of a higher (or a lower) relative cost of honesty can be understood similarly.

To assess the implications of the individuals' life span, we use (15) to obtain $f(n+1, y) - f(n, y) = y_1 B^1(n) + (1 - y_1)B^2(n) - y$, and note the following result.

PROPOSITION 4: <u>A longer life span of individuals lowers (raises) the level of honesty in the economy if</u>

$$y_1 B^1(n) + (1 - y_1)B^2(n) - y \tag{16}$$

<u>is negative (positive)</u>.

This proposition has a straightforward meaning. If, at present, the level of honesty in the oldest generation is lower (higher) than that in the economy, then a longer life span lowers (raises) the economy's level of honesty. Whether (16) is negative or positive depends, in turn, on whether the reservation scores are high or low. This can be seen by looking at (13). If the reservation scores are high then B's are small (closer to zero) and (16) would be negative. On the other hand, if the reservation scores are low, then B's are large (closer to one) and the expression (16) would be positive. Now, recall our earlier discussion of the determinants of the reservation scores. In a qualitative sense, then, an increased life span of individuals lowers (raises) the level of honesty if the initial priors are small (large) and if the relative cost of honesty is large (small).

We finally delineate the conditions under which an older generation is less (or more) honest than its younger generation. This depends directly on the sign of $y_{k+1} - y_k$. Using (14), we obtain the following result.

PROPOSITION 5: The $(k+1)^{st}$ generation is less (more) honest than the k^{th} generation if

$$(17) \qquad y_1[B^1(k) - B^1(k-1)] + (1-y_1)[B^2(k) - B^2(k-1)]$$

is negative (positive).

The qualitative implication of this proposition is that the effect of age on the honesty level of a generation depends solely on whether the older generation's reservation scores are higher than or equal to that of the succeeding generation. To see this, note from (8) that a unit increase in the age increases $c^i(k)$ by less than one. As a consequence: either $C^i(k) = C^i(k-1)$, or $C^i(k) = C^i(k-1) + 1$. In the former case, $B^i(k) > B^i(k-1)$ because if two successive generations have the same reservation scores, then the older generation must be more honest. In the latter case, on the other hand, $B^i(k) < B^i(k-1)$ because if both the reservation score as well as the age increase by one, then the probability of meeting the reservation score is lower.[22] Thus, if the reservation scores of both types of individuals increase (remain unchanged) with the passage of a period, then they are more (less) dishonest than their younger generation. The effect of age on honesty is ambiguous, in general, in the intermediate case in which the reservation score increases for one type of person but nor for the other type.

IV. CONCLUSION

There has been an increasing awareness in the literature of the possible effects of dishonesty, opportunism and other similar forms of human behavior on the level of economic activity. It is then natural to ask questions such as what determines the level of honesty in a society, and why one society may be less honest, or more honest, than another. In this paper, we have presented an economic model within which these questions can be posed and analyzed.

Our model is based on some of the most natural ways of thinking about individuals' decisions to be honest versus dishonest, and about the collective determination of honesty in society. An individual is honest or dishonest in different phases in his life depending, in part, on his own past experiences (that is, on how much honesty and dishonesty has been done to him in the past). Further, each person's experiences are determined by the behavior of others. At the societal level, therefore, honesty encourages honesty, whereas dishonesty encourages dishonesty. Our model not only admits these ideas, but also allows us to investigate how the societal level of honesty is influenced by the characteristics of individuals and the economy. The formal model presented in this paper is, of course, not the most general model that one can construct but, I believe, it provides a potentially fruitful direction for further extensions and concomitant qualifications.

We have shown that if the youngest generation believes that the level of honesty is higher in the society then, indeed, the actual level of honesty in the society is higher. But, at the same time, there can be dishonesty in the society even if the youngest generation is entirely honest, and there can be honesty in the society even if the youngest generation is entirely dishonest. In addition, we have delineated intuitive conditions under which the society is less honest (or more honest) if people live longer, and under which the older persons are less honest (or more honest) than the younger ones.

APPENDIX 1

Here we show that y is a stable solution to (3) or (15) if and only if $f_y(y) < 0$. The proof applies both to the example in Section I, as well as to the model in Section II. For the former case, simply substitute: $B^1(k) = y^k$, and $B^2 = 0$.

Time is denoted by t. At time t, the level of honesty in generation k is $y_k(t)$, and the economy-wide level of honesty is $y(t)$. If the economy begins with arbitrary numbers for $y_2(0), \ldots, y_n(0)$, then it can be verified that for $t \geq n-1$

$$ny(t+1) = y_1 + y_1 \sum_{k=1}^{n-1} B^1(k, y(t)) + (1-y_1) \sum_{k=1}^{n-1} B^2(k, y(t)) . \tag{18}$$

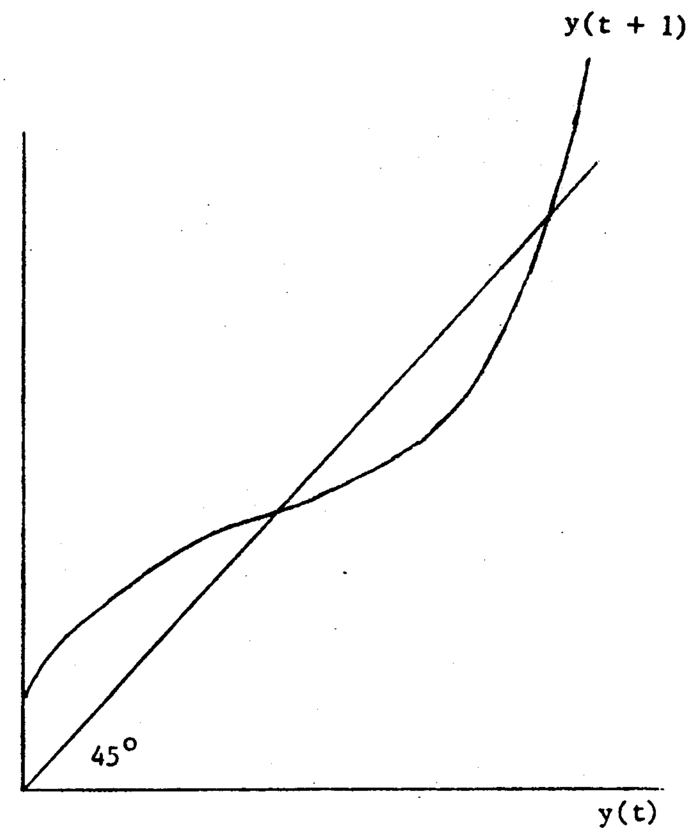
Now, define a function f such that the right hand side of (18) equals $f(y(t)) + ny(t)$. Therefore, the equation of motion is

$$y(t+1) = y(t) + f(y(t))/n . \tag{19}$$

Clearly, the steady state, $y(t+1) = y(t)$, requires that $f(y) = 0$. This is what we have used in the text.

The stability properties can be examined in Figure 2. Steady states are those points where $y(t+1)$ intersects the 45 degree line. By inspection, it follows that a steady state is stable (unstable) if $y(t+1)$ intersects the 45 degree line from above (below). Therefore, y is a stable steady state for (19) if and only if $f_y(y) < 0$. The same conclusion can also be reached by using more sophisticated arguments, for example, those outlined by Michael Safanov (1980), but they are not needed in the present simple case.

Figure 2



Only those steady states are stable where y(t + 1) intersects the 45-degree line from above.

FOOTNOTES

1. I use the word honesty in a generic sense, without distinguishing it from other expressions such as trust, guilelessness, truthfulness, low opportunism, etc.

2. The potential consequences of dishonesty have been increasingly studied in the economics literature. Oliver Williamson (1985) has succintly argued that a higher opportunism increases transaction costs which, in turn, victimize many transactions which would have otherwise taken place. Thus, the level of economic activity may be reduced. Also, see Kenneth Arrow (1974, p. 23) on this issue. The focus of this paper, however, is not on the consequences of honesty, but on what determines societal honesty.

3. This view parallels some aspects of the functional theory of learning. See Ernest Hilgrad and Gordon Bower (1966) for a review of this and other theories of learning.

4. We do not, however, go into the ultimate determinants of individuals' characteristics. This is in keeping with a standard economic approach in which the individuals' characteristics are parametrically specified, and their effects on the economy-wide variables are determined.

5. This involves a slight simplification. If N is the number of persons in a generation, then an honest person encounters an honest person with a probability $(nNy - 1)/(nN - 1)$, and a dishonest person encounters an honest person with a probability $nNy/(nN - 1)$. But since N is large, both of these probabilities are nearly equal to y. Also, we assume that N is an even number and, therefore, $nN/2$ is the number of pairs in the economy.

6. The calculation of the equilibrium level of dishonesty (that is, the proportion of dishonest persons in the economy) is straightforward. If b_k is the level of dishonesty in generation k, then $b_k = 1 - y_k$; and the economy-wide level of dishonesty is $b = 1 - y$.

7. See Appendix 1.

8. To see this, note that the polynomial equation (3) has two positive solutions because f changes sign twice. Also, f_y must be negative for one solution, and positive for the other. The latter solution is, therefore, unstable.

9. The case in which the youngest generation is completely honest can not be usefully analyzed within the present simple example. We examine this case in the next section.

10. With $y_1 = 1$, the expression (3) yields $f(0) > 0$, $f(1) = 0$, and $f_y(1) = n(n-3)/2$. There are two positive solutions of (3) and, clearly, $y = 1$ is one of them. But if $n \geq 4$, then $f_y(1) > 0$. This means $y = 1$ is an unstable solution, and also that the other solution is internal and stable.

11. We assume that an individual chooses to be honest if he is indifferent between being honest and dishonest.

12. This is because U is increasing in $(U^{bb} - U^{gb})$, and it is decreasing in $(U^{gg} - U^{bg})$. Also, note that the bounds on U rule out those cases in which every type of individual remains either honest or dishonest, throughout his life, regardless of his beliefs and past experiences.

13. u^i and w^i can take any positive values.

14. See DeGroot (1970, p. 160) and Rao (1973, p. 335).

15. The assumption that individuals can have only two kinds of initial beliefs has been made solely for expositional ease. Our qualitative results remain unchanged if, instead, a continuum of initial beliefs among individuals is posited.

16. For brevity, the effect of a simultaneous change in u^i and w^i on the reservation level and its consequences, in turn, on the level of honesty in the economy is not discussed in this paper.

17. It is obvious that $B^i(k) = 1$ if $C^i(k) \leq 0$, and $B^i(k) = 0$ if $C^i(k) > k$.

18. Clearly, there may be multiple stable equilibria. This should not be surprising because a multiplicity of equilibria is a common feature of problems dealing with economy-wide determinations. Two identical economies can, therefore, have different levels of honesty. Also, a comparison of the honesty levels between two different economies can not always be translated into possible differences in their respective characteristics. The number of stable equilibria, however, can not exceed $n/2$. To see this, note that (15) can not have more than $(n - 1)$ solutions, because the highest possible order of the polynomial f is $(n - 1)$. Further, by plotting f against y, it can be observed that stable and unstable solutions alternate in the present problem. Therefore, the number of stable equilibria can not exceed $n/2$.

19. For example, consider the following sets of parameters: $U = (\delta n - 1)/\delta n$, $u^1 = \delta(\delta - 1)n^2$, $w^1 = (\delta - 1)n$, and $w^2 = (u^2 + n)/(\delta n - 1)$, for any $\delta > 1$, $u^2 > 0$, and $n \geq 2$. Then (8) yields: $k > c^1(k) > k - 1$, and $c^2(k) > k$. Therefore, $C^1(k) = k$, and $C^2(k) > k$.

20. For instance, consider: $U = 1/\delta n$, $u^1 = (w^1 + n)/(\delta n - 1)$, $u^2 = (\delta - 1)n$, and $w^2 = \delta n u^2$, for any $w^1 > 0$, $\delta > 1$, and $n \geq 2$. Then from (8), $c^1(k) < 0$, and $1 > c^2(k) > 0$. Thus, $C^1(k) \leq 0$, and $C^2(k) = 1$.

21. In this example, (15) yields: $f(y) \equiv n(1-y) - \sum_{k=0}^{n-1} (1-y)^k = 0$, $f(0) = 0$, $f(1) < 0$, and $f_y(0) = n(n-3)/2$. Now, if f is viewed as a polynomial in $(1-y)$, then it changes sign twice. Hence, f has two solutions for which $y < 1$, and $y = 0$ is one of them. But if $n \geq 4$, then $f_y(0) > 0$. Thus, $y = 0$ is an unstable solution if $n \geq 4$, and the only stable solution is internal.

22. This and the last assertion follow from the standard properties of binomial distribution. Define $B(C, k, y) = \sum_j \binom{k}{j} y^j (1-y)^{k-j}$, where $j = C, \ldots, k$. Then it can be verified that: $B(C, k, y) > B(C, k-1, y)$, and $B(C+1, k, y) < B(C, k-1, y)$.

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