THE USE OF THE MAXIMIN PRINCIPLE AS A CRITERION FOR JUST SAVINGS

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Abstract

In his work, *A Theory of Justice*, Rawls maintained that the "maximin" principle was not suitable for application to the problem of inter-generational justice. Several other authors have shown that the maximin principle does have undesirable properties when used to define a "just-savings" policy. In this paper, it is shown that, using Rawls' own assumptions, the maximin principle does not have the undesirable properties attributed to it. Thus, the generally accepted conclusion that *A Theory of Justice* is inapplicable to the problem of inter-generational justice is shown to be false.

I. Introduction

The development of optimal growth theory was for many years marked by an unquestioning acceptance of the maximization of a sum-of-utilities criterion as the objective of society. Although not usually stated by optimal growth theorists, one could fairly conclude that a sum-of-utilities criterion reflects a utilitarian philosophy. One might also conclude that the unanimity in use of a sum-of-utilities criterion did not reflect a deep-seated dedication to utilitarian theory. Rather such unanimity reflected the lack of alternatives to utilitarianism which could be directly interpreted in economic terms. Not suprisingly then, an author whose "aim is to work out a theory of justice that represents an alternative to utilitarian thought", can expect to catch the attention of optimal growth theorists; see Rawls (1971, p. 22). The author, Rawls, and his *A Theory of Justice* have indeed received such attention; see Arrow (1973), Calvo (1977), Dasgupta (1974), and Grout (1977).

The aspect of Rawls' theory which has had most significance for economic theory is his advocacy of the maximin principle. This principle states that a just society would attempt to maximize the welfare of the least well-off person in society. The maximin principle has been shown to have reasonable and appealing properties when applied to the problem of distribution between contemporaries. However, it has been claimed that the maximin principle has not performed satisfactorily when it has been applied to the problem of inter-generational distribution.

The alleged difficulty in applying the maximin principle to intergenerational distribution was one of which Rawls was aware: the possibility of zero net savings. In fact, he explicitly eschewed the use of the maximin principle in the formulation of a just savings policy:

... the [maximin] principle does not apply to the savings problem. There is no way for later generations to improve the situation of the least fortunate first generation. The principle is inapplicable and it would seem to imply, if anything, that there be no saving at all. [Rawls (1971, p. 291)].

The foregoing quotation contains Rawls' reasoning for disclaiming the applicability of the maximin principle to the formulation of a just savings policy. Therefore, if one could show that such reasoning is, in general, incorrect, one could claim that the application of the maximin principle to savings policy would be consistent with the essence of Rawls' theory.

II. The Just Savings Principle

Rawls was somewhat vague when discussing a just savings criterion. Thus, it has been left to optimal growth theorists to interpret what they feel is implied by his analysis. One approach has been to use the maximin principle, despite Rawls' objections, and combine with it a precept from Rawls' discussion of just savings. The precept is that: "... it is assumed that a generation cares for its immediate descendants, as fathers say care for their sons ..." [Rawls (1971, p. 288)]. The justification for using the maximin principle is that the logic which derives this principle for intra-generational distribution is equally applicable to the problem of intergenerational distribution; see Arrow (1973, p. 325).

Both Arrow (1973, p. 325) and Dasgupta (1974, p. 412) claim to show that, even using the precept that generations care for their successors, the maximin principle does not perform very well. Indeed, the problem in performance is exactly the one with which Rawls was concerned: that no permanent savings are generated. Dasgupta (1974, p. 412) is the most explicit in concluding that: "... it seems doubtful if the inter-generational maximin principle would be adopted within the framework of *A Theory of Justice*".

However, I will show that the results of Arrow and of Dasgupta are not inherent in the use of the maximin principle but rather follow from an inappropriate application of the Rawlsian precept that generations care for their successors. In doing so, I establish that the maximin criterion does not have the weaknesses which Rawls attributed to its application in intertemporal phenomena. Therefore, I conclude that one can use the argument of *A Theory of Justice* in advocating the maximin principle as a criterion for use in optimal growth models.

In order to reduce the argument to its basic essentials, I will make the stringent assumptions which are common in the optimal growth literature. There is one relevant amount of consumption, c_t, per capita consumption at time t. There is a stationary population and all individuals are alike. A person at time t values consumption at $u(c_t)$, where $u(\cdot)$ is a strictly concave utility function.

Now one must introduce the precept that a generation cares for its immediate descendants. Both Arrow and Dasgupta take this precept to mean that the welfare of a person at time t can be expressed as:

$$u(c_t)+\beta u(c_{t+1}) \tag{1}$$

where β represents the strength of caring by a generation for its immediate descendants. (In (1) an additively separable formulation is used. I will make this assumption also.) However, (1) represents a generation caring for the consumption of the next. It would seem to be much more appropriate that a generation cares for the welfare of the next generation. Therefore,

$$\begin{aligned}\text{Welfare of generation } t &= u(c_t)+\beta(\text{welfare of generation } t+1)\\ &= u(c_t)+\beta[u(c_{t+1})+\text{welfare of generation } t+2]\\ &= \sum_{s=0}^{\infty}\beta^s u(c_{t+s}) \qquad (2)\end{aligned}$$

Thus, in being concerned about the welfare of the next generation, one is concerned about the consumption of all future generations.[1]

Dasgupta (1974, p. 409) claims that (1) captures the minimum of concern for future generations. The claim is incorrect. The formula (2), in fact, captures the minimum of concern for future generations. If generation t cared *directly* for the interests of generation $t+2$ then one would need to add a second infinite sum to (2). However, for the present argument it is only necessary to include the minimum of inter-generational concern: parents caring for the *welfare* of their children.

It should be immediately obvious that the foregoing argument casts doubt on the correctness of Rawls' argument that the maximin principle is not an acceptable savings principle. In his argument, which was quoted in Section I, Rawls made two points against the use of a maximin savings principle. First, it was claimed that there is no way for later generations to improve the situation of the first generation. Using (2), it is seen that this claim is incorrect. Future generations can improve the situation of the first generation by agreeing to use a just savings principle based on (2). (This agreement is much easier to imagine when all the generations are in Rawls' 'original position' rather than being spread out over historical time.) Secondly, Rawls claimed that the maximin principle would lead to zero savings. This claim must be examined with

[1] Arrow (1973, p. 333) has suggested (2) as a possible way of measuring individual welfare within a maximin growth context. However, he does not interpret (2) as being directly implied by Rawls' assumptions.

the use of formula (2). In the next section, it will be shown that this claim is incorrect in the most common growth model of all: the one-sector neoclassical model. Thus, the results of the next section, combined with the analysis of the present section, show that the just savings principle

$$\max\left\{\min_t\left[\sum_{s=0}^{\infty}\beta^s u(c_{t+s})\right]\right\}$$

is indeed consistent with all the analysis of *A Theory of Justice.*

III. Just Savings in the Neoclassical Model

In this section, the maximin principle is applied to the one-sector neoclassical model of economic growth. It is shown that, when the maximin principle is interpreted as in Section II of this paper, the intuitively unappealing characteristics, which have caused previous authors to be dissatisfied with the maximin principle, are not present.

The model of production can be represented by the equation:

$$k_{t+1}=f(k_t)+k_t-\delta k_t-c_t$$

where

k_t = per capita capital stock at the beginning of period t
δ = depreciation rate on capital
$f(\cdot)$ = a strictly concave per capita neoclassical production function and k_1 is given exogeneously.

Any particular growth path can be defined by the consumption stream. Therefore, denote any path C by $C=\{c_1, c_2, \ldots\}$.

Define $V_t(C)=\sum_{s=t}^{\infty}u(c_s)\beta^{s-t}$.

Therefore, the maximin principle causes one to choose a path C' such that:

$$\min\{V_t(C')\}\geqslant\min\{V_t(C)\}$$

where C is any other feasible path. Such a path, C', will be called a maximin path. Similarly, one can define the utilitarian path as the path C'' such that:

$$V_1(C'')\geqslant V_1(C)$$

where C is any other feasible path.

In order to facilitate the characterization of maximin paths define two important values of capital stock. First, the golden rule capital stock, $\tilde{k}$, is defined implicitly by:

$f'(\tilde{k})-\delta=0$

Secondly, the modified golden rule capital stock of optimal growth theory, k^*, is defined by:

$f'(k^*)-\delta=(1-\beta)/\beta$

In the remainder of this section, I will present three theorems which collectively serve to characterize the maximin paths for all possible initial values of capital stock, k_1. Comment on the results will be reserved until after all results have been presented and proved.

Theorem 1. If $k_1 \leqslant k^*$, *then the maximin path is given by the utilitarian path.*

Proof. The utilitarian path is, of course, the path which optimal growth theorists have focused on. Therefore, it is not necessary to provide any proof of the basic properties of the utilitarian path. The reader is referred to Heal (1973, Chapter 12) for an exposition. The utilitarian path is a path C such that $c_t > c_{t-1}$ and $k_t > k_{t-1}$. This path has the property that if $\{k_1, k_2, k_3, ...\}$ is the sequence of capital stocks along a utilitarian path starting at time 1 given k_1, then $\{k_t, k_{t+1}, ...\}$ is the sequence of capital stocks along a utilitarian path starting at time t given k_t. Thus, $V_1 < V_2 < V_3 ....$ Hence, the utilitarian path is such that for all t: V_t is maximized given k_t and $V_t = \min\{V_t, V_{t+1}, ...\}$. Therefore, the utilitarian path is the maximin path.

Theorem 2. *If* $k^* < k_1 < \tilde{k}$, *then the maximin path has capital stock constant at its initial value.*

Proof. Let $k_1 = \bar{k}$, $\bar{c} = f(\bar{k}) - \delta\bar{k}$, and $\bar{C} = \{\bar{c}, \bar{c}, ...\}$. $\bar{c}$ is the constant level of consumption on the constant capital path. The constant capital path is feasible, therefore,

$$\min\{V_t(C)\} \geqslant \sum_{s=1}^{\infty} \beta^{s-1} u(\bar{c}) = \frac{u(\bar{c})}{1-\beta}. \tag{3}$$

Hence, one can conclude immediately that any path starting from k_1 will have $k_t > k^*$ for all t. This conclusion, which is needed at a later stage of the proof, follows immediately from theorem 1 which implies that if $k_t \leqslant k^*$ along a path C, then

$$\min_{s \geqslant t}\{V_s(C)\} \leqslant \sum_{s=1}^{\infty} \beta^{s-1} u(f(k^*) - \delta k^*).$$

Proof of Theorem 2 will be by contradiction. Therefore, let C be a path which is better than the constant capital stock path. Therefore,

$$\min\{V_t(C)\} = \frac{u(\bar{c})}{1-\beta} + M, \quad \text{with} \quad M > 0. \tag{4}$$

Hence, C cannot have the same consumption levels as $\bar{c}$. Therefore, without loss of generality one may assume that $c_1 \neq \bar{c}$. It will then be shown that C must be infeasible. The method of proof is to construct, out of the sequence $\{k_1, k_2, ...\}$ a monotonically decreasing subsequence, $\{k_m, k_{m_1}, k_{m_2}, ...\}$, which has an element less than zero. If $c_1 \neq \bar{c}$, then either (i) $c_1 > \bar{c}$ and $k_2 < k_1$, and one may write $k_2 = k_1 - A$, with $A > 0$, in which case take $m = 2$ or (ii) $c_1 < \bar{c}$. In case (ii), an extended argument will be needed to find k_m, the first element in the subsequence.

In case (ii), let $c_1 = \bar{c} - \Delta k_1$ with $\Delta k_1 > 0$.

$$k_2 = f(k_1) + k_1 - \delta k_1 - \bar{c} + \Delta k_1 = k_1 + \Delta k_1$$

Let $c_2 = \bar{c} - \Delta k_2$, then by the strict concavity of the production function:

$$k_3 < f(k_1) + k_1 - \delta k_1 + \Delta k_1 [f'(k_1) + 1 - \delta] - \bar{c} + \Delta k_2$$

Thus, $k_3 < k_1 + \Delta k_1 [(1/\beta) - D] + \Delta k_2$ where

$$D = \frac{1}{\beta} - [f'(k_1) + 1 - \delta] > 0.$$

Now writing $c_3 = \bar{c} - \Delta k_3$,

$$k_4 < k_1 + [f'(k_1) + 1 - \delta] \left[\frac{\Delta k_1}{\beta} + \Delta k_2\right] - [f'(k_1) + 1 - \delta] [D \Delta k_1] + \Delta k_3$$

Now either $(\Delta k_1/\beta) + \Delta k_2 < 0$, in which case $k_3 < k_1 - D\Delta k_1$ and we may take $m = 3$, or one can deduce that

$$k_4 < k_1 + \frac{\Delta k_1}{\beta^2} + \frac{\Delta k_2}{\beta} + \Delta k_3 - D \Delta k_1$$

and one must proceed further to find k_m. Letting $c_s = \bar{c} - \Delta k_s$, then for any t, either

(i) $\displaystyle\sum_{s=1}^{r} \left(\frac{\Delta k_s}{\beta^{r-s}}\right) \geq 0$ for $r = 1, ..., p < t-2$, and $\displaystyle\sum_{s=1}^{p+1} \left(\frac{\Delta k_s}{\beta^{p+1-s}}\right) < 0$,

and then we know that $k_{p+2} < k_1 - D\Delta k_1$, so that we can set $m = p+2$ or

(ii) $\displaystyle\sum_{s=1}^{r} \left(\frac{\Delta k_s}{\beta^{r-s}}\right) \geq 0$ for $r = 1, ..., t-2$

and then

$$k_t < k_1 + \sum_{s=1}^{t-1} \left(\frac{\Delta k_s}{\beta^{t-1-s}}\right) - D\Delta k_1.$$

Hence,

$$\beta^{t-2}(k_t - k_1 + D\Delta k_1) < \sum_{s=1}^{t-1} \beta^{s-1}\Delta k_s \tag{5}$$

By the strict concavity of the utility function:

$u(c_1) < u(\bar{c}) - u'(\bar{c})\Delta k_1$

and $u(c_s) \leqslant u(\bar{c}) - u'(\bar{c})\Delta k_s$ for $s = 2, ..., t = 1$. Thus

$$\sum_{s=1}^{t-1} \beta^{s-1} u(c_s) < \sum_{s=1}^{t-1} u(\bar{c})\beta^{s-1} - u'(\bar{c}) \sum_{s=1}^{t-1} \Delta k_s \beta^{s-1} \tag{6}$$

Combining (5) and (6) gives:

$$\beta^{t-2}(k_t - k_1 + D\Delta k_1) < \left(\frac{1}{u'(\bar{c})}\right)\left\{\sum_{s=1}^{t-1} u(\bar{c})\beta^{s-1} - \sum_{s=1}^{t-1} \beta^{s-1} u(c_s)\right\} \tag{7}$$

Using (4) and the definition of a limit, one knows from (7) that there exists a t such that

$\beta^{t-2}(k_t - k_t + D\Delta k_1) = 0$

and hence that $k_t < k_1 - D\Delta k_1$.

Thus, in this case set $m = t$. In order to examine the cases when $c_1 < \bar{c}$ and $c_1 > \bar{c}$ simultaneously, one can write: $A = D\Delta k_1$. Hence, when $c_1 \neq \bar{c}$ one can find an integer m such that $k_m < k_1 - A$, with $A > 0$. Now, one must find the second element in the subsequence. If $c \geqslant \bar{c}$ then

$k_{m+1} < f(k_1) + k_1 - \delta k_1 - A[f'(k_1) + 1 - \delta] - \bar{c}$

$k_{m+1} < k_1 - A[f'(k_1) + 1 - \delta]$

In this case, let $m_1 = m + 1$.

An extended argument will be needed to find m_1 when $c_m < \bar{c}$. Let $c_m = \bar{c} - \Delta k_1'$ where $\Delta k_1' > 0$. Then $k_{m+1} < k_1 - A[f'(k_1) + 1 - \delta] + \Delta k_1'$. Let $k_1 - A[f'(k_1) + 1 - \delta] = k^+$.

If $c_{m+1} = \bar{c} - \Delta k_2'$, then

$k_{m+2} < f(k^+) + k^+ - \delta k^+ + \Delta k_1'[f'(k^+) + 1 - \delta] - \bar{c} + \Delta k_2'$

$$k_{m+2} < k^+ + \frac{\Delta k_1'}{\beta} + \Delta k_2'$$

Then

$$k_{m+3} < f(k^+) + k^+ - \delta k^+ + \left[\frac{\Delta k_1'}{\beta} + \Delta k_2'\right] \cdot [f'(k^+) + 1 - \delta] - \bar{c} + \Delta k_3'$$

if $c_{m+2}=\bar{c}-\Delta k'_3$.

Then either

(i) $\dfrac{\Delta k'_1}{\beta}+\Delta k'_2<0$ and then $k_{m+2}<k^+$

and one may take $m_1=m+2$ or

(ii) $k_{m+3}<k^++\dfrac{\Delta k'_1}{\beta^2}+\dfrac{\Delta k'_2}{\beta}+\Delta k'_3$

Now the argument exactly parallels the argument in the first part of the proof. If one writes $c_{m+s}=\bar{c}-\Delta k'_{s+1}$, then one knows that for any p either (i) there is an $r<p$ such that $k_{m+r}<k^+$ and one may take $m+r=m_1$ or

(ii) $$\beta^{p-1}(k_{m+p}-k^+)<\left\{\frac{1}{u'(\bar{c})}\right\}\left\{\sum_{s=1}^{p}u(\bar{c})\,\beta^{s-1}-\sum_{s=1}^{p}u(c_{m+s-1})\,\beta^{s-1}\right\}$$

Thus, using the same logic as in an earlier part of the proof, one knows there is a p such that

$k_{m+p}<k^+$.

Then take $m_1=m+p$.

Hence the second member of the subsequence has been found. The other members can be shown to exist by a simple induction statement. Previously, it was shown that if $k_m<k_1-A$ then one could find an $m_1>m$ such that $k_{m_1}<k_1-A[f'(k_1)+1-\delta]$. By induction then, one can find a sequence of integers $m_1<m_2<m_3\ldots$ such that $k_{m_n}<k_1-A[f'(k_1)+1-\delta]^n$. Since $[f'(k_1)+1-\delta]>1$, one can find an m_n such that $k_{m_n}<0$. Hence, the path which was assumed to be better than the stationary capital stock path is in fact infeasible. The maximin path must therefore be one on which capital stock and consumption are constant.

Theorem 3. *If* $k_1\geqslant\tilde{k}$ *then the optimal program,* C, *has* $\min\{V_t(C)\}=\sum_{s=1}^{\infty}\beta^{s-1}u(\tilde{c})$ *where* $\tilde{c}=f(\tilde{k})-\delta\tilde{k}$.

Proof. From a result of Phelps (1965), we know that if $k_t\geqslant\tilde{k}+\varepsilon$ for all $t>T$ and for any $\varepsilon>0$ then the path is inefficient. Theorem 2 also tells us that $k_t\geqslant\tilde{k}$ because we know that the path $\{\tilde{c},\tilde{c},\ldots\}$ is feasible.

Let us suppose contrary to the theorem that $\min\{V_t(C)\}=\sum_{s=1}^{\infty}\beta^{s-1}u(\tilde{c})+M$, $M>0$. Now the analysis of theorem 2 can be immediately applied. If $k_t=\tilde{k}+\varepsilon$ then for $r>1$:

$$\beta^{r-1}\{k_{t+r}-\tilde{k}\}-\varepsilon<\left\{\frac{1}{u'(\tilde{c})}\right\}\left\{\sum_{s=1}^{r-1}u(\tilde{c})\,\beta^{s-1}-\sum_{s=1}^{r-1}u(c_{t+s})\,\beta^{s-1}\right\}$$

The limit of the right hand side is $-M/u'(\tilde{c})$, which means that for any θ such that $0<\theta<M/u'(\tilde{c})$ one can find an r such that

$$k_{t+r}-\tilde{k}<(\varepsilon-\theta)\beta^{1-r}.$$

As noted above for any ε, one can find a $k_t<\tilde{k}+\varepsilon$. Thus, ε can be chosen to be smaller than θ. Hence showing that one can find a $k_{t+r}<\tilde{k}$, which is a contradiction. Hence, the policy with consumption constant at $\tilde{c}$ is at least as good as any other feasible consumption path.

IV. Conclusion

In the previous section, it has been shown that, for an important subset of feasible initial values of capital stock, use of the maximin principle will imply positive net savings. Therefore, the argument offered by Rawls, in claiming that the maximin principle cannot be used to guide savings policy, is in fact incorrect. For a standard growth model, when the initial value of capital stock is low, the optimal maximin path will be the same as the utilitarian path and will imply that consumption levels rise over time.

One might argue that, because there is no net-saving when the economy starts off in a capital-rich situation (Theorems 2 and 3) Rawls' basic argument is correct. However, it is not in the capital-rich initial situations where the presence of zero net-savings is intuitively unappealing. It is when society is capital-poor, and when capital is therefore very productive, that one would deem positive savings to be essential. Arrow (1973, p. 324) has stated the case most succinctly;

> ... resources are productive, so that a transfer from an earlier to a later generation means, in general, that the later generation receives more (measured in commodity units) than the earlier generation gave up. In this case, our egalitarian presuppositions are somewhat upset; clearly, if we have any regard at all for the future generations (as justice demands) and if the gain from waiting is sufficiently great, then we will want to sacrifice some for the benefit of future individuals even if they are, to begin with, somewhat better off than we are.

When, in the one-sector model, an economy is capital poor, savings by one generation can directly help a later generation by such a large amount that, when there are ties of sentiment between generations, the earlier generation receives an indirect increase in welfare. Thus, the maximin principle, combined with an appropriate interpretation of the tie of sentiment (i.e. (2) instead of (1)), will induce a policy with positive net saving. The welfare of the least fortunate generation, the first, will actually be improved by this saving. In contrast, for capital rich economies, positive net-saving will damage the welfare of the least fortunate generation and thus will not be a policy which is intuitively appealing. Therefore, one can assume that zero net-saving in capital-rich countries is not inconsistent with Rawls' notion of the requirements to be satisfied by a just policy.

One may, therefore, conclude that use of the maximin principle for a just savings policy is consistent with the arguments of *A Theory of Justice*. Rawls' reasons for eschewing a maximin savings policy were in fact invalid. For those philosophically attuned to Rawls' notion of justice, the conclusion that the maximin principle can be applied to intergenerational policy is vitally important. The importance derives from the fact that it is difficult to embrace a philosophical principle if one has to exclude the principle from use in certain situations on an *ad hoc* basis. It is thus doubly reassuring to note that the maximin principle need no longer be excluded from use in calculating a just savings policy.

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EFFECTS OF THE SWEDISH SUPPLEMENTARY PENSION SYSTEM ON PERSONAL AND AGGREGATE HOUSEHOLD SAVING*

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Abstract

The effect of the Swedish supplementary pension system (the ATP) on aggregate household saving has been the subject of many empirical studies.[1] The models used in this research all have one thing in common—they lack an actual analysis of how the consumption and saving behavior of households is affected when voluntary household saving is supplemented by forced saving of the ATP type.[2] This study constitutes an attempt to answer this question. Using a simulation model based on the life cycle theory, the effect of the ATP reform on personal and aggregate saving is analyzed on the basis of the regulatory structure of the ATP.

I. Saving in the ATP

The old-age pension in the Swedish supplementary pension system (the ATP) functions as both insurance and saving. As opposed to the basic pension, which is the same for everyone (given marital status), the ATP depends on the pensioner's working income during his active years. According to ATP regulations, the pension to which a person is entitled should be an annual sum amounting to 60 per cent of his average pensionable income during his 15 best-paid years. In normal cases, 30 years during which pension points are collected are necessary in order to qualify for full pension. If an individual has worked only half as many years, then he receives half pension, etc. Pensionable income refers to working income between 16 and 64 years of age and between 1 and 7.5 base amounts. The base amount is an assessed sum based on the consumer price index, so that the pension is inflation indexed.[3]

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[1] See Ettlin (1976), Feldt (1958), Markowski & Palmer (1977), Kragh (1967) and *Kapitalmarknadsutredningen* (1978).

[2] Ettlin (1976) and Lybeck (1977), for example, allow households' consumption to depend on net saving in the ATP fund, which is unsatisfactory. The ATP system is constructed so that pension size is guaranteed according to certain regulations, independent of the ATP fund. Earned pension rights would be a more relevant variable, as households' saving would then be allowed to be influenced by the size of the pensions households expect to receive.

[3] The base amount in January, 1979 was equivalent to US 2975.