Wealth, Prices, And The Power To Requisition: The New Economic Policy In The Soviet Union

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Disciplines
Economic Policy | Economic Theory | Income Distribution | International Economics | Political Economy

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ABSTRACT

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Thanks to the pathbreaking work of Bettelheim, scholars now take seriously the notion of class struggle in the U.S.S.R. The peasant struggle for power makes the period of the New Economic Policy (N.E.P.), 1921-1930, unique in Soviet history. Unlike the preceding period, War Communism, the N.E.P. saw no direct requisition of grain by the state, although the threat of such requisition lingered. Instead, the state allowed a free market for grain and met its needs by open market purchases. Markets were active on a scale never seen before or since in the Soviet economy. At the same time, the style of party decision-making was relatively more open than during the Civil War. In fact, the decision to implement the N.E.P., taken by the Tenth Party Congress (1921), was the result of a majority vote. There was for a time considerable room for policy disagreement within the party, although this was to change drastically by the thirties.

The N.E.P. was, however, also a period of social upheaval and contradictory tendencies. Although the basic principle of the N.E.P. was the peasant-worker alliance, considerable tension arose between these two classes concerning major distributional questions - namely, party membership and income. In a one-party state, party membership and control had significant distributional consequences. This tension manifested itself during the course of the industrialization debate. Proponents of more rapid industrialization argued for the abandonment of the N.E.P., while proponents of the N.E.P. argued for a moderate rate of industrialization. The ultimate political victory of the former meant not only the end of the N.E.P., but also the political defeat of the peasants. Two important indicators of these contradictory tendencies were the falling ratio of peasants in the party and the rising rate of government grain procurement, especially after 1927.
What this paper argues is that these, far from being isolated tendencies, were rather intimately linked features of the Soviet redistribution system. The fall in the political power of the peasants led to the fall in their economic power, as signaled by the rising state grain procurements. The abandonment of the N.E.P. and the promulgation of a policy to exploit peasants at a maximal rate were the logical culmination of tendencies already deeply embedded in the N.E.P.
I. The Model

1. General Structure

The model has three types of agents—peasants, workers, and the party—and two different goods, money income and the agricultural good. All wages and consumption goods are subsumed under money income \( y \), which serves as the numéraire. The agricultural good \( w \) is traded on the open market at price \( p \), which is supposed to fluctuate freely according to market forces.

The society \( T \) equals \([0,1]\), the unit interval. There is a continuum of agents \( \mathbb{R} \) and an atom at zero for the population measure \( \mu \). \( \mu \) is the Lebesgue measure on \([0,1]\). The atom at zero represents the party center; the continuum consists of peasants and workers. The income distribution \( y \) is also continuous on \([0,1]\).

2. Peasants

A peasant \( dt \) is represented by a utility function \( u_t(x(t)) = x(t) \), where \( x(t) dt \) is the money value of \( dt \)'s final allocation, and an endowment \((m(t), w(t))\), representing \( dt \)'s cash and agricultural good holdings respectively. A peasant's initial income then is

\[
y(t) = m(t) + pw(t).
\]

The utility function expresses risk-neutrality; the model can be extended to encompass substantial amounts of risk aversion. The distinction between rich, middle, and poor peasants is expressed by differing levels of \( y(t) \).

Let \( P \) be the set of peasants, \( P \subseteq [0,1] \). We assume

\[
0 < \mu(P) < 1.
\]

Aggregate endowed peasant income, \( y(P) \), satisfies

\[
0 < y(P) = \int_P y(t) \, d\mu.
\]
3. Workers

A worker $d_t$ is represented by the utility function $u_t(x(t)) = x(t)$, and the endowment $y(t)$.

Let $W$ be the entire set of workers. Then $W \cup P = [0,1]$. One has
\[ 0 < \mu(W) < 1, \text{ and } \mu(W) + \mu(P) = 1. \]

For both peasants and workers, production has already taken place; the remaining economic function is purely distributive.

4. The Party

The party consists of a center (the Central Committee or, more narrowly, the Politburo) and a periphery, the party membership.

The party center is represented by the point $0$ and is normalized to have weight $\mu(\{0\}) = 1$. The party center has income endowment $y(\{0\}) = 0$. The party membership consists of workers and peasants and is represented by the party membership measure $\nu$. The measure $\nu$ is constant on $P$ (respectively, $W$): each agent of a given class is assumed to have the same probability of belonging to the party.

Control of the party means control of the state. A coalition which can exercise control of the party is winning. A winning coalition must include the party center, and a proportion $\alpha$ of the membership,
\[ 0 < \alpha < 1. \]

The extreme values $\alpha = 0$ and $\alpha = 1$ represent dictatorship of the party center and unanimity rule respectively. The complement of a winning coalition is losing. A coalition which is neither winning nor losing is indecisive. Examples of indecisive coalitions are $\{0\}$ and $P \cup W$. $P$ is losing if $\nu(P) < \alpha$, for then the complementary coalition $\{0\} \cup W$ has the size required
to win. The party center plays the role of a veto player: it never belongs to a losing coalition.

The state is the chief purchaser of the agricultural good, which it resells to workers. State purchases are financed by the taxes it collects. The determination of the after-tax income distribution is the subject of the succeeding two sections.

II. Game Theory and Power Struggle

In the Aumann-Kurz model of distribution, the major aspect of the state is its tax policy. The state has unlimited tax powers: it can expropriate whom it pleases. On the other hand, those subject to expropriation can destroy their endowments and thus deprive their expropriators of their loot. In a cooperative game, the tax system which emerges has somehow to weigh the threats to expropriate and to escape expropriation in an overall compromise.

A cooperative game \((T,v)\) is a pair consisting of the set of players \(T\) and coalition function \(v\), which measures what each coalition can assure its members. There are cooperative games on two levels in the present model: the purely political struggle for power, and the economic struggle over the distribution of income.

The struggle for power is the easiest to describe. For \(S \subseteq T\), the coalition function \(v_I\) is given by

\[
v_I(S) = \begin{cases} 
1 & \text{if } S \text{ is winning} \\
0 & \text{otherwise.} 
\end{cases}
\]

A coalition has the full state power if it is winning, and not otherwise. This may seem to undervalue an indecisive coalition. One can also consider the game dual to \(v_I\), \(v_I^d\), defined by \(v_I^d(S) = v_I(T) - v_I(T/S)\). The dual power
struggle game is given by

\[ v^S(S) = \begin{cases} 
1 & \text{if } S \text{ is not losing} \\
0 & \text{otherwise.}
\end{cases} \]

Both these representations of the power struggle will prove useful.

The cooperative game concerning the distribution of income \( v^I \) is a more complicated affair. Clearly, for the grand coalition \( T \), \( v^I(T) = y(T) \).

Again, if \( S \) is indecisive, so is its countercoalition \( T/S \). In this case, the members of \( S \) can assure themselves of their own income and \( v^I(S) = y(S) \). Now suppose \( S \) is winning and \( T/S \) is losing. If \( S \) and \( T/S \) carry out their strongest threats, then \( S \) expropriates \( T/S \) and \( T/S \) destroys its entire endowment. This yields an outcome to \( S \) and \( T/S \) of \((y(S), 0)\), respectively. Consider this outcome as the disagreement point of the Nash bargaining problem for dividing \( y(T) \) between \( S \) and \( T/S \). The solution of the Nash bargaining problem is

for \( S \), \( 1/2 \left[ y(T) + y(S) \right] \).

for \( T/S \), \( 1/2 \left[ y(T) - y(S) \right] \).

These are taken to be the coalition function values for \( S \) and \( T/S \) respectively.

To summarize, for the income redistribution game, the coalition function \( v^I \) satisfies

\[ v^I(S) = \begin{cases} 
1/2 \left[ y(T) + y(S) \right] & \text{if } S \text{ is winning} \\
y(S) & \text{if } S \text{ is indecisive} \\
1/2 \left[ y(T) - y(T/S) \right] & \text{if } S \text{ is losing}
\end{cases} \]

It is also convenient to introduce a related cooperative game defined by \( q(S) \)

\[ q(S) = \begin{cases} 
y(S) & \text{if } S \text{ is not losing} \\
0 & \text{otherwise.}
\end{cases} \]
The relationship between $v_{II}$ and $q$ is that

$$v_{II}(S) = \frac{1}{2} [q(S) + q\hat{q}(S)].$$

It is important to stress that in the cooperative game, threats to expropriate or to destroy endowments are not actually carried out in the final compromise. The situation would degenerate into noncooperative behavior if such were the case. One reason to opt for a cooperative over a noncooperative model is the fact that such threats are not carried out.

III. Power Distribution and Income Distribution

A widely accepted measure of political and economic power in a cooperative game is the Shapley value $\phi$. The Shapley value has been given an axiomatic foundation; in particular, it satisfies axioms of linearity, symmetry, and Pareto efficiency. The Shapley value also satisfies the random order interpretation: the Shapley value of a player $t$ in a game $v$ is the expected marginal product of that player in a random ordering of all players. Formally,

$$\phi v(t) = E[v(S^R_t) - v(S^R_t/\{t\})]$$

where $S^R_t$ is the set of players up to and including $t$ in a random order $R$ on the set of players, and $E$ is the expectations operator when all random orders on $T$ are equally likely.

The Shapley value was originally defined for games with a finite number of players. For the present situation, which has one large player and a continuum of small players, Neyman has shown that there is an extension of the Shapley value which continues to satisfy the symmetry and efficiency axioms, and the random order interpretation.
We now turn to the Shapley value for the political power and income distribution games.

**Proposition 1.** The Shapley value of the power distribution game $v_I$ satisfies

$$
\phi_{v_I}(\{0\}) = 1 - \alpha \\
\phi_{v_I}(P) = \alpha v \\
\phi_{v_I}(W) = \alpha(1 - v)
$$

**Proof:** By Shapiro and Shapley, the value of the atom in the $\alpha$-quota game is $1 - \alpha$. By Neyman, the power of a coalition is propositional to its voting size. Hence, the power of the peasants $\phi v(P)$ is proportional to $v$, and the power of the workers $\phi v(W)$ is proportional to $1 - v$. By the efficiency axiom, the proportionality constant is $\alpha$.

Under the assumption of equal likelihood of party membership, these Shapley values are uniformly spread over $P$ and $W$ respectively. An increase in $\alpha$, the quota needed to form a winning coalition, increases the power of both workers and peasants and decreases that of the party center. On the other hand, a decrease in $\alpha$ centralizes power. Further, an increase in a class's party representation increases its power. Finally, we note that for any game $v$, $\phi v = \phi v'$, by reversing random orders. Thus, the power distribution of proposition 1 also holds for the dual power game $v_I'$.

We now turn to the income distribution implied by the Shapley value of the income redistribution game. This income distribution is intimately connected with the distribution of power.

**Proposition 2.** The Shapley value $\phi$ for the income distribution game $v_{II}$ is given by
\[ \phi_1(q(\{0\})) = ((1-\alpha)^2/2)y(T) \]

\[ \phi_2(dt) \leq \int [(1+\alpha^2)/2]y(t) + \alpha(1-\alpha)v(P)y(T)]dt, \ dt \in P \]

\[ \phi_3(dt) = \int [(1+\alpha^2)/2]y(t) + \alpha(1-\alpha)v(W)y(T)]dt, \ dt \in W \]

**Proof.** By the linearity of the Shapley value, \( \phi_2 = (1/2)[\phi_1 + \phi_3] \).

Since \( \phi_q = \phi_q# \), it suffices to compute \( \phi_q \).

Consider first the atom 0. Denote by \( S \) the set of all agents up to and including 0 in a random order of all agents. The value \( \phi_1(q(0)) \) is the expectation of the contribution \( q(S) - q(S/\{0\}) \) of 0 to \( S \). Since the ordering is random and there are many agents, \( S/\{0\} \) is a perfect sample of the ocean, \( S/\{0\} = s(P \cup P) \) for some \( s, 0 < s < 1 \). If \( \mu(S/\{0\}) < 1-\alpha \), then the contribution of the atom is \( q(S) = y(S) = sy(T) \). If \( \mu(S/\{0\}) > 1-\alpha \), then the contribution of the atom is zero. Hence, the expected contribution is

\[ \int_{0}^{1-\alpha} sy(T)ds + \int_{1-\alpha}^{1} 0ds = ((1-\alpha)^2/2)y(T) \]

Consider next an infinitesimal peasant \( dt \) of the ocean, \( S \) being a random order as before. With probability 1/2, the atom is before \( dt \) in the random ordering. In this event, \( dt \)'s contribution to \( S \) is \( y(t) dt \). With probability 1/2, the atom is after \( dt \) in the ordering. The conditional probability then is \( 1-\alpha^2 \) that the coalition \( S \) is losing, in which case \( dt \) contributes nothing, and \( \alpha^2 \) that the coalition \( S \) is indecisive, in which case \( dt \)'s marginal contribution is again \( y(t)dt \). Finally, with probability \( \alpha v(P), dt \) is pivotal. In this case, \( dt \)'s marginal contribution is \( y(S) = y((1-\alpha)T), \) since \( \mu(S) = 1-\alpha \) for \( dt \) to be pivotal. Summing up, \( dt \)

\[ \text{contributes nothing with probability } \frac{1-\alpha^2}{2}, \ (1-\alpha)y(T) \text{ with probability } \alpha v(P)dt, \text{ and } y(t)dt \] with probability \( \frac{1+\alpha^2}{2} \), so his expected marginal contribution is
\[ \phi \nu(dt) = \left[(1+\alpha^2)/2\right]y(t) + \alpha(1-\alpha)\nu(P)y(T) \] \[ \text{II} \]

Similar reasoning leads to the result for the worker.

It is useful to aggregate these results over sectors. Integrating, one has

\[ \phi \nu(P) = \left[(1+\alpha^2)/2\right]y(P) + \alpha(1-\alpha)\nu(P)y(T) \] \[ \text{II} \]

and

\[ \phi \nu(W) = \left[(1+\alpha^2)/2\right]y(W) + \alpha(1-\alpha)\nu(W)y(T). \]

Note from these that as the peasant representation in the party falls, so does the peasant share in the income distribution:

\[ \frac{\partial}{\partial \nu(P)} \phi \nu(P) = \alpha(1-\alpha)y(T) > 0. \]

A class's share in the income distribution is directly related to its participation in the party. As power centralizes, the effect on peasant income depends on

\[ \frac{\partial}{\partial \alpha} \phi \nu(P) = \alpha y(S) + (1-2\alpha)\nu(P)y(T). \]

This is definitely positive as long as \( \alpha < 1/2 \); for a quite powerful party center, increasing centralization decreases peasant income. For \( \alpha > 1/2 \), the sign of \( \frac{\partial}{\partial \alpha} \phi \nu(P) \) is positive as long as

\[ \frac{\alpha}{\alpha - 1} < \frac{\nu(P)y(T)}{y(P)}. \]

In particular, if \( 1 < \nu(P)y(T)/y(P) \), then increasing centralization decreases peasant income for all \( \alpha \).

An alternative way of looking at shifts in the distribution of power is in terms of the net collection rate applied to coalition \( S \), \( e(S) \),

\[ e(S) = \frac{y(S) - \phi \nu(S)}{y(S)} \]
When $e(S) > 0$, it represents the amount of income redistributed away from $S$ by the Shapley value compromise. For peasants $P$, the net collection rate is

$$e(P) = (1-\alpha)[(1+\alpha)/2 - \alpha y(P)(y(T)/y(P))].$$

Just as an increase in party representation raises peasant income, it lowers the collection rate. When increasing centralization decreases peasant income, then it raises the collection rate.$^9$

IV. Application to the N.E.P.

It may seem rather far-fetched to apply a formal model of game theory to any period of Soviet history, let alone the N.E.P. Therefore, I shall address in advance of a detailed application certain specific criticisms:

1. Threat structure. In the period immediately preceding the N.E.P. forced requisition and even expropriation of peasants' grain were acknowledged instruments of state policy. The peasant reaction included crop destruction, failure to plant, and other forms of sabotage. These events repeated themselves on a large scale after the demise of the N.E.P. To ignore their possibility during the N.E.P. would be a serious oversight.

2. Cooperative game. As Lenin repeatedly said, the basis of the N.E.P. was the worker-peasant alliance. Coalitions such as this are what distinguishes cooperative from noncooperative games. Marxian analysis in terms of classes is likewise in accord with a coalitional framework.

3. Political structure. This is probably the most controversial aspect of the present model. Both Western and Soviet authorities are wont to call the Soviet state a dictatorship, the only difference being whether or not the epithet "of the proletariat" is appended. Ideological descriptions notwithstanding, the party center was not a dictator in the 1920s.
This is not to deny that it wielded enormously greater power in the 1930s. Party membership did have considerable meaning in terms of political power in the 1920s. This helps explain the Lenin recruitment drives of 1924-5, with their avowed aim of ringing the proportion of benchworkers in the party up to 50%. However, even if the broad structure is defensible, two of its details are not. By treating the party center as an atom, a great deal of strategic information is lost. There was substantial turnover in the 1920s in the Politburo, for instance, with the expulsion of the "leftists" in 1926 and of the "rightists" in 1929. The sole justification for not modelling this is that it is adequately reflected in the society-wide trends. Treating the probability of party membership as uniformly distributed within classes is at best a simplification for computational reasons. Characterizing the Shapley value would be much harder without this assumption.

(4) Shapley value. The Shapley value has proved a useful approach to questions of power and income distribution in a variety of games and economies. In principle, there is no reason why the Shapley value should not apply to a socialist economy, as long as it is properly modeled.

We now turn to data relevant to the N.E.P. The first series, from Rigby, gives the values of \( v \) during the N.E.P.:
One witnesses here a definite tendency for the peasant representation in the party to fall, which is especially pronounced after 1927.

In the N.E.P., where peasants constituted about 80% of the population, the implied shift in power relative to the workers can be depicted by the Lorentz curves of figure 1. In 1921, a representative worker was about
\[
\frac{(1-v)/(\mu(w))}{(v/\mu(p))} = 9.3 \text{ times as powerful as a representative peasant.}
\]
By 1930, this factor had risen to 16.

No explicit data on $\alpha$ is available. A priori, one might be surprised by values of $\alpha$ much different from one-half. Moreover, one has the impression that the N.E.P. was a period of increasing centralization, especially toward the end of the period.

On the economic side, Karcz presents the following data on centralized procurement of grain:

<table>
<thead>
<tr>
<th>Year</th>
<th>Peasant Membership in the party, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921</td>
<td>28.2</td>
</tr>
<tr>
<td>1922</td>
<td>26.7</td>
</tr>
<tr>
<td>1923</td>
<td>25.7</td>
</tr>
<tr>
<td>1924</td>
<td>28.8</td>
</tr>
<tr>
<td>1925</td>
<td>26.5</td>
</tr>
<tr>
<td>1926</td>
<td>25.9</td>
</tr>
<tr>
<td>1927</td>
<td>27.3</td>
</tr>
<tr>
<td>1928</td>
<td>22.9</td>
</tr>
<tr>
<td>1929</td>
<td>21.7</td>
</tr>
<tr>
<td>1930</td>
<td>20.2</td>
</tr>
</tbody>
</table>
FIGURE 1. Relative Distribution of Power, Workers and Peasants, 1921-1930.
<table>
<thead>
<tr>
<th>Year</th>
<th>Harvest</th>
<th>Centralized procurement</th>
<th>Rate of procurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1925</td>
<td>72.5</td>
<td>8.9</td>
<td>12.3</td>
</tr>
<tr>
<td>1926</td>
<td>76.8</td>
<td>11.6</td>
<td>15.2</td>
</tr>
<tr>
<td>1927</td>
<td>72.3</td>
<td>11.0</td>
<td>15.3</td>
</tr>
<tr>
<td>1928</td>
<td>73.3</td>
<td>10.8</td>
<td>14.7</td>
</tr>
<tr>
<td>1929</td>
<td>71.8</td>
<td>16.1</td>
<td>22.4</td>
</tr>
<tr>
<td>1930</td>
<td>83.5</td>
<td>22.1</td>
<td>26.5</td>
</tr>
</tbody>
</table>

Since data on cash balances and other taxes are not available, this is the best proxy for the net collection rate for peasants ε(P). This rate rose rather dramatically by the end of the period.

Another useful piece of information is the reciprocal of the peasant share in GNP, y(T)/y(P). Fortunately, this is available, thanks to Bergson, for the year 1928, when GNP was 32.3 billion rubles, and income of Soviet farmers was 10.8 billion rubles. This implies a value of the reciprocal of about 3. Presumably, this ratio did not vary much over the N.E.P.

Figure 2 shows the scatter diagram of the collection rate ε(P) against the party membership ratio v. The negative relationship between these two predicted by the Shapley value is quite evident. This latter interpretation assumes, of course, that α and y(T)/y(P) are fairly stable. In the absence of more information on these two variables, it is not possible to test statistically the hypothesized relationship between ε(P) and v. To proceed, we shall assume that y(T)/y(P) is a constant = 3 throughout the period, and that α is constant at some undetermined value. Fitting a straight line to the equation
\[ e(P) = a + bv(P) , \]

one has that \( a = .57 \) and \( b = -1.6 \). Although this gives a reasonably close fit, it cannot be interpreted in terms of the underlying parameter \( a \), since neither \( (1-a^2)/2 = .57 \) nor \( -3a(1-a)v(P) = -1.6 \) has a real root between 0 and 1.

In light of the above result, one must explicitly recognize the nonlinear estimation problem for \( a \). A global search with the objective of minimizing the sum of squared residuals leads to the estimate \( a = .5 \).

If one examines the fitted line against the observations, it becomes clear that the residuals are highly disturbed. In the period 1925-28, all observations are below the fitted line; in the period 1929-30, above. Among the possible responses to this result, two will be entertained here, both involving possible changes in \( a \). In the first, \( a \) is assigned a value of .5 in 1928, and the worker share in political power is assumed to be constant throughout the period 1925-1930. A value of \( a = .5 \) in 1928 appears to be about in the center of the data. This hypothesis leads to the \( a \) series in column (2):
FIGURE 2. Scatter diagram of $e(P)$ versus $v(P)$, 1925-1930.
Under the second hypotheses, \( \alpha \) is again taken to be .5 in 1928, and assumed to fall by 2% each year during 1925-1930, a mild centralizing tendency.

To see the effects of these two hypotheses, simulations are computed and plotted against the realized values for the period 1925-1930. The simulations are carried back to 1921 for purposes of illustrations, \( \alpha \) assumed constant and equal to its 1925 value for 1921-1924. Both hypotheses track the observed series better than the constant \(-\alpha\) equation. The second hypothesis tracks slightly better than the first, which suggests that overall worker power may have eroded slightly in the period. Given the paucity of data, however, neither hypothesis can be explored further here. Both hypotheses reinforce the notion that peasant power fell significantly during the period of the N.E.P., not just relative to workers by the party composition effect, but also absolutely by centralization.

V. Aftermath of the N.E.P.

The N.E.P. came to an abrupt end in 1930, with the forced collectivization of peasants and liquidation of the rich peasant class. One witnessed a return to forced grain collection, often without compensation, and a return
to peasant sabotage, most strikingly in the destruction of livestock. During the period 1931-33, the rate of grain collection rose to its highest levels — .328, .266, and .330 respectively. These events culminated in famine and the reinstatement of the collective farm market and small private plots in 1933.\textsuperscript{15}

The present model helps to explain some of these events. It has argued that, from the point of view of the Shapley value, the N.E.P. was a period of falling political power on the part of the peasants, both relative to workers and absolutely. There is some evidence for an increasing centralization of power. With the defeat of the rightists at the end of 1929 and the creation of a Stalin-dominated party center, these two tendencies converged. The peasants were by now sufficiently weak that a counter-coalition could abandon the N.E.P. With their political defeat, the subsequent economic sufferings of the peasants were inevitable. From the standpoint of the game theory of power, the events of the early 1930s appear a logical culmination of tendencies already working within the N.E.P.

All of this is not to say that the present model could be applied directly to the Stalinist period, even if data were available.\textsuperscript{16} The central modeling feature, that of cooperative game theory, would have to be foregone. The carrying out of threats and concomitant social losses signal the breakdown of the compromise that underlay the N.E.P. Only a noncooperative theory could do justice to these events. In addition, the strategic meaning of collectivized peasants is much different from that of autonomous peasants, selling on the open market and paying a money tax. Again, the distinction between workers and employees, or between party and nonparty members looms much larger in the 1930s than before. It is precisely for these reasons that a different model applies to the aftermath of the N.E.P.
Appendix. A rigorous proof of Proposition 2

It follows from the result of Neyman [10] that \( q \) has an asymptotic value. Hence, since all limiting values converge to the asymptotic value, it suffices to compute a single limit.

Let \( S_1, \ldots, S_n \) be disjoint coalitions with \( \mu(S_i) = 1/n \) and \( \bigcup S_i = \{0,1\} \). Let \( \{0\} \) be as before.

Let \( B_1, \ldots, B_{n+1} \) be a random order of these coalitions.

We consider first the expected marginal contribution of \( \{0\} \) in a random order.

With probability \( \frac{1}{n+1} \), \( \{0\} = B_i \), in which event his marginal contribution is 0. With probability \( \frac{1}{n+1} \), \( \{0\} = B_2 \), in which case his marginal contribution is \( y(B_1) \). With probability \( \frac{1}{n+1} \), \( \{0\} = B_3 \), in which case his marginal contribution is \( y(B_1) + y(B_2) \) and so on until \( \mu(B_1 \cup \ldots \cup B_n) > n - an \), at which point \( B_1 \cup \ldots \cup B_n \) is not losing and \( \{0\} \) makes no further contribution.

Since the order is random and \( B_i \) for any \( i \) could be any of the \( S_i \),

\[
E[y(B_1)] = \frac{1}{n} y(S_i)
\]

\[
= \frac{1}{n} y(T).
\]

Hence, \( \{0\} \)'s expected marginal contribution is

\[
\sum_{h=1}^{n} \frac{y(T)}{n} + o(n),
\]

\[1 \leq h \leq n - an\]

the error term arising when \( an \) is not an integer. In the limit as \( n \to \infty \), one has
\[ \phi_{\mathcal{N}_1}([0]) = \lim_{n \to \infty} \frac{(n-an)(n-an+1)}{2n(n+1)} = \frac{(1-a)^2}{2}. \]

We now consider the expected marginal contribution of \( S_i \) in a random order.

With probability \( \frac{1}{n+1} \), \( S_i = B_i \) in which case its marginal contribution is 0. With probability \( \frac{1}{n+1} \), \( S_i = B_2 \), in which case \( B_i = \{0\} \) with probability \( \frac{1}{n+1} \) and \( S_i \) contributes \( y(S_i) \) or \( \{0\} \) with probability \( \frac{1}{n+1} \) and contributes 0. Continuing this pattern, for \( h < n - an \), \( S_i = B_n \) with probability \( \frac{1}{n+1} \), in which case \( \bigcup_{i=1}^{h-1} B_i \neq \{0\} \) with probability \( \frac{h-1}{n+1} \) and \( S_i \) contributes \( y(S_i) \) or \( \bigcup_{i=1}^{h-1} B_i \neq \{0\} \) with probability \( \frac{n-h+2}{n+1} \) and \( S_i \) contributes 0. For \( (1-a)n < h \leq (1-a)n + 1 \), \( S_i \) is pivotal when \( \bigcup_{i=1}^{h-1} B_i \neq \{0\} \) and contributes \( \bigcup_{i=1}^{h} y(B_i) \) with probability \( \frac{n-h+2}{n+1} \). Otherwise, for all \( h > (1-a)n \), \( S_i = B_n \) with probability \( \frac{1}{n+1} \) and contributes \( y(S_i) \).

Summing up, \( S_i \)'s expected marginal contribution is

\[ \frac{1}{n} \sum_{h=n+1}^{(1-a)n+1} y(S_i) + \frac{n-[(1-a)n+1]}{n+1} y(S_i) + \frac{1}{n} \frac{n-(1-a)n}{n+1} (1-a)ny(T) \]

\( 1 \leq h \leq (1-a)n+1 \)

\[ + o(n). \]

The two expressions on the left are \( S_i \)'s contributions when \( S_i \) is not pivotal; in the limit as \( n \to \infty \), these amount to \( \frac{1+\alpha^2}{2} y(dt) \). The next expression is \( S_i \)'s contribution when \( S_i \) is pivotal. In the limit as \( n \to \infty \), \( S_i \) is a peasant with probability \( \frac{ny(P)}{n+1} \); here, the limit becomes
\( v(P) \, dt \, \alpha(1-\alpha) \, y(T) \).

The limit thus is

\[
\frac{1+\alpha}{2} \, y(\, dt) \, + \, \alpha(1-\alpha) \, v(P) y(T) \, dt
\]

for

\( S_i \) approaching \( dt \) a peasant in the ocean, as was to be shown.

The same limit achieves the result for \( S_i \) approaching \( dt \) a worker in the ocean, the only difference being that \( S_i \) is pivotal with probability

\[
\frac{n \cdot \mathbb{E}(W)}{n+1}.
\]

This completes the proof.
FOOTNOTES

1. See Bettelheim [5], pp. 355-360 for details.
4. Aumann and Shapley [3], Appendix A, presents this axiomatization, as well as the random order interpretation of the Shapley value.
5. See Neyman [10], Theorem A.
7. Neyman, op. cit.
8. The proof which follows is based on the main result in Gardner [7]. A more rigorous proof is given in the appendix.
9. Their peasant collection rate is here measured in terms of money income. Aumann and Kurz [2], Theorem B, shows that no generality is lost by measuring this rate in terms of money income rather than in terms of goods.
10. Rigby [12], p. 116 ff., discusses these drives. This goal was never achieved.
11. Rigby, op. cit., p. 116. Following Soviet sources, Rigby divides the data into three classes: workers, peasants, and employees. For present purposes, no generality is lost by aggregating workers and employees. Concerning the quality of this data, Rigby says, "While the precision of these percentages should not be exaggerated, being distorted not only by error and misinformation, but also by changes of classification, as we shall see below, they appear to be accurate enough to give a reliable impression of general trends." It is
interesting to note that the Party Census for 1927 gives the peasant membership figure of 19.0%, compared to 27.3% from the Great Soviet Encyclopedia series.

12. For instance, [14], p. 654. This figure appears to have been fairly stable over the period.


14. See Bergson [4], p. 154-56. By 1937, this reciprocal had risen to 5.7 [4, p. 118]. A higher \( y(T)/y(P) \) would lead to lower collection rates.

15. This description of events closely follows Bettelheim [6], Lewin [9], and Nove [11].

REFERENCES


