Queues, Rations, and Market: Comparisons of Outcomes for the Poor and the Rich

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This paper compares outcomes of alternative allocation systems (queues, convertible and nonconvertible rations, and unhindered market) to distribute limited quantity of a deficit good among heterogeneous individuals. It is shown that, for the poor, the ranking of systems (from better to worse) is convertible rations, nonconvertible rations, queues, and nonintervention. The rich are better off under nonintervention than under other systems. These and other positive results are robust to certain types of commodity taxes and administrative costs.

"Nonmarket" allocation systems such as rationing and queues are not only extensively employed in many less developed countries and centrally planned economies, but also their consequences are issues of important controversies. There is a wide range of features that such allocation systems exhibit; for instance, the rationed good is not convertible (i.e., individuals cannot exchange this good in secondary markets) in some rationing and queue systems, whereas it is partly or fully convertible in others.[1]

Each of the above allocation systems leads to a markedly different distribution of welfare among various individuals in the economy, and these welfare distributions are quite different, in turn, from the one that would emerge if the government were not intervening. The primary objective of this paper is to compare the welfare of specific groups of individuals (particularly the poor and the rich) when the limited supply of a good (the deficit good) is allocated through alternative allocation systems, including nonintervention. I do this in two steps: (*i*) I ascertain the utilities of various groups of individuals under each allocation system, and then (*ii*) I take each pair of allocation systems and attempt to determine whether a specific group of individuals is better off under one allocation system or another.

My analysis is *positive*, and it is not my objective here to determine the societal desirability of alternative allocation systems. I believe, however, that analyses of the kind developed in the present paper can contribute significantly to typical political or normative debates about whether, when, and how governments ought to intervene in markets. For instance, a main argument often given in favor of the queue or the ration system is that (since direct income subsidies to the poor are not feasible) these allocation systems might be effective ways of helping the poor. My comparisons of the welfare of the poor under alternative allocation systems can help to recognize some of the circumstances when such arguments are useful and when they are not.

The specific allocation systems which I compare here are: nonintervention, convertible and nonconvertible rations, and the queue system (without secondary trade).[2] I show that

(*i*) *For the poor, the ranking of allocation systems (from better to worse) is convertible rations, nonconvertible rations, the queue system, and nonintervention.* The queue system, thus, does not turn out to be rela-

[1] These systems have been employed and debated in developed countries as well, particularly in the context of external hostilities.

[2] See a more detailed version of the present paper (1986) for positive comparisons of some other systems such as the queue system with secondary trade, and the bundling system (where the deficit good is bundled with some other good).

tively as beneficial to the poor as it is often thought to be. Also, governments frequently attempt to enforce nonconvertibility of rations. Such an emphasis is potentially harmful to the poor.

(ii) *The rich are better off under nonintervention than they are under other allocation systems. Also, the rich are better off under convertible rations than they are under the queue system.* These results, as we shall see, are understandable consequences of the high wages and large endowments that the rich typically have.

It is often believed that no one can be worse off, and some individuals must be better off, under convertible rations than under nonconvertible rations, because there are gains to trade in the former system. But this view is incorrect because, as James Tobin (1952) had rightly argued, the convertibility of rations may alter individuals' incentives to buy the rationed good. Consequently, convertible rations are not always weakly Pareto superior to nonconvertible rations. I demonstrate this important aspect of rationing.

A methodological aspect of this paper is that the standard tools of marginal analysis are not usable here because alternative allocation systems result in equilibria which cannot be assumed to be in the neighborhood of one another. Yet, as we shall see, my results are robust not only to many parameters of the economy but also to certain types of commodity taxes and administrative costs. An additional strength of my pairwise comparisons among alternative systems is that the comparison between any two systems does not depend on whether a third system is considered feasible or not. For instance, nonintervention may not be a realistic alternative in centrally planned economies. In these contexts, the relevant comparisons are those among alternative government managed systems (i.e., among the rationing systems and the queue system).

A central contribution to the comparison of allocation systems is by Martin Weitzman (1977, pp. 517–19) in which he compared, based on a normative criterion of "satisfying the needs of the population," the allocation of a fixed quantity of the deficit good through nonconvertible rations versus a "price system." My analysis is different in not only the scope (I compare several important allocation systems in addition to the two that he does) and the emphasis (mine is on obtaining positive results, whereas his is on normative analysis based on a specific social criterion), but also in a critical aspect of the model of the price system (discussed later).

This paper is not related to the important literature which has extended the theory of second-best to instruments such as rations and queues. For instance, Roger Guesnerie and Kevin Roberts (1984) show that, starting from a second-best situation, a government can do better under certain circumstances if nonconvertible rations are partly introduced into an economy. Sam Bucovetsky (1984) shows that the same is possible if a queue system is partly introduced into an economy. The underlying economic reason is simple: the government cannot do worse by having additional policy instruments (whatever the instruments might be, provided it is assumed that there are no administrative costs) and it may do strictly better under some circumstances, regardless of what the social criterion might be.

The present paper has a different aim. My motivation here is not to study rations or queues as *additional* (and costless) policy instruments through which the government can do better, based on some criterion. Instead, my motivation is to examine and compare rations, queues, and market as *alternative* allocation systems.[3] In Section I, I derive the expressions for individuals' utilities under alternative systems. The method for comparing an individual's utility is summarized in Section II. Alternative systems are then compared to one another in Section III.

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[3] I do not consider mechanisms such as nonlinear pricing schemes (with arbitrary nonlinearities) because such schemes are not feasible for consumption goods. In fact, only simple allocation systems, such as those considered in this paper, are typically feasible because of reasons such as the unavailability of information, and the limitations on third-party enforceability. My forthcoming paper with Joseph Stiglitz discusses some of the sources and the consequences of the restrictions on policy instruments available in *LCD*s.

I. Individuals' Utilities under Alternative Allocation Systems

First, I determine the utility levels of different individuals under four allocation systems: nonintervention (market), nonconvertible rations, convertible rations, and the queue system. These systems are respectively denoted by superscripts $I = M$, R, C, and Q. Individuals are denoted by the superscript h. The variable n^h is the proportion of individuals of type h in the economy, $n^h > 0$, and $\sum_h n^h = 1$.

Denote the available supply (per capita) of the deficit good by X, and its unit cost by p. For individual h, x^h, and V^h, respectively, denote the demand function for the deficit good, and the indirect utility function. I assume that the market demand for the deficit good would exceed the available quantity (i.e., there would be a "shortage") if its market price were to be set equal to its unit cost.[4] That is,

$$(1) \qquad \sum_h n^h x^h(p, m^h) > X,$$

where m^h is the (full) income of individual h if the market price of the deficit good is p.[5]

Under nonintervention, therefore, private firms (owners of the deficit good) adjust the consumer price of the deficit good to equate its demand and supply. Under a government-managed system, the government procures the available quantity of the deficit good at its unit cost p, and distributes it through one or another allocation system.[6] I assume at present that the price of the deficit good that the government charges at its shops is also p; issues concerning administrative costs and commodity taxes are discussed later.

For individual h, let x^{hI} and V^{hI} denote the quantity of the deficit good consumed, and the utility obtained, under the allocation system I. The economywide consumption of the deficit good equals its available quantity under each system; that is,

$$(2) \qquad \sum_h n^h x^{hI} = X, \quad \text{for} \quad I = M, R, C, Q.$$

I now obtain the expressions for V^{hI} for various systems, which are needed for later comparisons.

A. Nonintervention

The individual h owns (through partial ownership of firms) $\alpha^h X$ units of the deficit good. Naturally, $\alpha^h \geq 0$, and $\sum_h n^h \alpha^h = 1$. If the market-clearing price is p^M, then the full income of individual h is $m^h + \alpha^h(p^M - p)X$.[7] Thus

$$(3) \qquad V^{hM} = V^h(p^M, m^h + \alpha^h(p^M - p)X)$$

$$\text{and} \quad x^{hM} = x^h(p^M, m^h + \alpha^h(p^M - p)X).$$

The market price p^M is obtained by substituting the expression for x^{hM} into (2). We restrict our analysis to those situations where the aggregate market demand curve for the deficit good is downward sloping in its price. The relevant implication of this restriction, from (1) and (2), is that the market price p^M is higher than p. This implication is consistent with the intuition that systems such as rationing are typically employed in those situations where the market allocation would entail a significant rise in the price of the deficit good.

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[4] In fact, it is under these conditions that governments typically intervene by employing allocation systems such as rations or queues.

[5] For notational convenience, an individual's wage rate and the prices of nondeficit goods are suppressed in the arguments of his demand function and his indirect (individualistic) utility function.

[6] In those contexts where nonintervention is not a feasible alternative (for instance, when the deficit good is produced in the public sector), p is the unit cost to the government.

[7] Where $\alpha^h(p^M - p)X$ is the profit from ownership which nonintervention brings to individual h. Weitzman's model of a price system assumes for simplicity that these profits disappear altogether. But as we shall see, these profits (no matter how they are distributed among individuals) play a critical role in determining not only the welfare and the consumption of individuals but also the market-clearing price.

B. Nonconvertible Rations

Under this system, individuals can buy (at government shops) up to a fixed quantity, X^R, of the deficit good, but no more, and resale is not permitted. Naturally, the population self-selects itself into two groups. The first group consists of those who wish to buy the deficit good in quantities smaller than or equal to X^R. These individuals are not constrained by rationing. For them,

$$(4) \qquad V^{hR} = V^h(p, m^h).$$

The second group consists of those who want to consume more deficit good than X^R, but are constrained to consume only X^R. A convenient representation of an individual's utility under a rationing constraint is to define the virtual price of the deficit good for person h to be p^{hR}, which is obtained from $x^h(p^{hR}, m^h + (p^{hR} - p)X^R) = X^R$. Then, this person's consumption behavior under rationing is the same as that in the hypothetical case when he faces price p^{hR}, receives an income transfer $(p^{hR} - p)X^R$, and faces no rationing. Therefore, the utility level of person h can be expressed as

$$(5) \quad V^{hR} = V^h(p^{hR}, m^h + (p^{hR} - p)X^R),$$

where $p^{hR} > p$.[8]

I assume that there are at least some individuals in the economy (the poorest persons are among them) who do not (or cannot) buy the maximum ration quantity X^R. This, I believe, is a more accurate representation in most situations (particularly in *LDC*s) than to assume that everyone buys the maximum ration quantity. It follows then that

$$(6) \qquad\qquad X^R > X.$$

C. Convertible Rations

If rations purchased from the government shops can be subsequently traded, and if the resulting equilibrium price of the deficit good is higher than p, then everyone would buy the full quantity of available ration. The ration per person is thus X. If p^C denotes the equilibrium price, then

$$(7) \quad V^{hC} = V^h(p^C, m^h + (p^C - p)X).$$

The price p^C is obtained by substituting $x^{hC} = x^h(p^C, m^h + (p^C - p)X)$ into (2). Comparison of (7) with (3) shows, as one might expect, that the key difference between nonintervention and convertible rations is that, in the latter system, the government intervention has effectively equalized the ownership of the deficit good. Since the income distribution in these two cases is different, p^C and p^M are not the same, in general. But $p^C > p$, given my earlier restriction that the aggregate demand curve for the deficit good is downward sloping in price.

D. Queues

The wage rate for individual h is denoted by w^h. I assume for brevity that the waiting time per unit purchase, t, is not significantly affected by the quantity purchased. This representation approximates those cases where individuals make several purchases within a single decision period; for instance, because the deficit good is dispensed in small lots, or because private storage of the good is expensive.[9] The opportunity price of the deficit good to individual h is $p + tw^h$, and his

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[8] To see that $p^{hR} > p$, note from (5) that $\partial V^{hR}/\partial X^R = \mu^h(p^{hR} - p)$, where μ^h is the positive marginal utility of income for this person. Also, $\partial V^{hR}/\partial X^R$ is positive because this person wants to consume more of the deficit good. Hence, $p^{hR} > p$. See J. Peter Neary and Roberts (1980) for additional details of this representation.

[9] My analysis is readily extended, however, to a more general specification in which t differs across individuals and it is determined in part by individuals' decisions concerning the quantity and the frequency of their purchases. In fact, it can be easily verified that if t^h denotes the waiting time per unit purchase, then a sufficient condition under which the results I derive later remain unaffected is that the waiting cost per unit purchase, $t^h w^h$, is very small (but positive) at the lower end of the wage distribution, and that this cost is relatively large at the upper end of the wage distribution.

utility level is

$$(8) \qquad V^{hQ} = V^h\big(p + tw^h, m^h\big),$$

where t is determined from $x^{hQ} = x^h(p + tw^h, m^h)$ and (2).

I assume that the prices of the nondeficit goods (i.e., of goods other than the deficit good) and the wage rate of any given individual are not significantly different under the four allocation systems described above. This would be the case if, for example, the supply elasticities of the nondeficit goods and the demand elasticities for different types of labor are large.

II. Method for Comparing an Individual's Utility

If I and J represent two different allocation systems, then I want to ascertain whether the individual h is better off or worse off under I; that is, whether V^{hI} is larger or smaller than V^{hJ}. For notational brevity, let p^{hI} and m^{hI} denote the price of the deficit good and the income, corresponding to individual h, under the system I. Let p^{hJ} and m^{hJ} denote the respective variables under the system J. Then the individual is obviously better off under the system I if $m^{hI} \geq m^{hJ}$ and $p^{hI} \leq p^{hJ}$, with at least one strict inequality. This is because a higher income or a lower price (or both) yield a higher utility.

To deal with the remaining cases, in which one of the two allocation systems entails a higher price but also a higher income for an individual, define the metric

$$(9) \quad \Delta^h(I, J) = \big(m^{hI} - m^{hJ}\big)$$
$$+ \big(p^{hJ} - p^{hI}\big) x^{hJ}.$$

Then it can be shown that

$$(10) \quad V^{hI} > V^{hJ}, \qquad \text{if} \quad \Delta^h(I, J) \geq 0.$$

A revealed preference argument underlying (10) is as follows. If $\Delta^h \geq 0$, then (9) implies that this individual could have purchased, in allocation system I, the same bundle of goods as he did in the allocation system J. The individual's actual purchase under the allocation system I, however, was different. Therefore, the individual h must be better off under I.[10]

Note that this method does not yield a verdict when the metric (9) is negative or when its sign cannot be ascertained based on the available information, but it is the best available method for comparing an individual's utility under two different situations, without restricting his preferences. In the analysis below, therefore, I compare as many pairs of allocation systems as are possible based on the above method.

III. Comparisons Among Alternative Allocation Systems

In this section, I compare the outcomes of the allocation systems described in Section I. I do this first for the poor, then for the rich. I then compare certain aspects of convertible vs. nonconvertible rations. Issues concerning commodity taxation and administrative costs are examined at the end.

A. Comparisons for the Poor

The poor are denoted by $h = 1$. Since the poor belong to the lower tail of the distribution of incomes and wages, their demand for the deficit good under nonconvertible rations is smaller than the per capita available quantity. That is,

$$(11) \qquad x^{1R} < X.$$

No special assumption is needed for the poor to behave this way; the budget constraint itself will generate such a demand behavior at sufficiently low incomes. Also, the poor do not get any part of the profit under nonintervention; this is a reasonable assumption because the poor do not typically possess ownership of firms. That is, $\alpha^1 = 0$, and from (3): $V^{1M} = V^1(p^M, m^1)$. I now derive the following result: The ranking of allocation systems for the poor (from

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[10] Expression (10) can also be established by using the standard concavity properties of expenditure functions. See my 1986 paper.

better to worse) is convertible rations, nonconvertible rations, the queue system, and nonintervention.

Begin by comparing convertible rations to nonconvertible rations. Expressions (4), (7), and (9) yield

$$(12) \qquad \Delta^1(C, R) = (p^C - p)(X - x^{1R}).$$

Using (11) and recalling that $p^C > p$, it follows that (12) is positive. Therefore, the poor are better off under the ration system with convertibility than they are if rations are nonconvertible. The reason for this is as follows. Convertibility of rations brings an income gain to the poor, but it also entails a higher price for the deficit good. On the whole, the poor are better off with convertibility because the (income-producing) ration quantity they can get under this system exceeds the quantity of the deficit good they consume under nonconvertible rations.

The comparison between nonconvertible rations and the queue system is straightforward since, from (4) and (8), the poor have the same income under these two systems, but they face a higher price of the deficit good under the latter. This is because the queue system entails an *extra* cost of waiting, small though this extra cost may be for the poor. Thus, $V^{1R} > V^{1Q}$. Finally, compare $V^{1M} = V^1(p^M, m^1)$ to (8). The poor have the same income under the queue system and nonintervention, but the respective prices for the deficit good are $p + tw^1$ and p^M. Now recall that $p^M > p$. It follows then that a person with sufficiently low wage is better off under the queue system than under nonintervention.

B. Comparisons for the Rich

The rich are denoted by $h = r$, and they belong to the upper tail of the distribution of incomes and wages. As one would expect, the comparisons between nonintervention and other systems depend, in part, on the ownership of the deficit good that the rich have under nonintervention. I show here that: The rich are better off under nonintervention than under other allocation systems, if their ownership of the deficit good under

nonintervention is large; specifically if

$$(13) \qquad \alpha^r X \ge x^{rI}, \quad \text{for} \quad I = R, C, Q.$$

That is, if the rich own more deficit good under nonintervention than what they consume under other systems.

The condition (13) is automatically satisfied in a two-class economy because, in this case, the rich own all of the deficit good under nonintervention, but (regardless of the allocation system) the poor consume at least some of the deficit good. In fact, we expect the condition (13) to be satisfied in a multiclass economy as well, because the rich typically own proportions of firms' shares which are far in excess of the proportions of the outputs of firms that they consume.

To establish the above results, I obtain the following from (3), (5), (7), (8), and (9)

$$(14) \quad \Delta^r(M, R) = (p^M - p)(\alpha^r X - X^R)$$

$$(15) \quad \Delta^r(M, C) = (p^C - p)(x^{rC} - X)$$
$$+ (p^M - p)(\alpha^r X - x^{rC})$$

$$(16) \quad \Delta^r(M, Q) = (p^M - p)(\alpha^r X - x^{rQ})$$
$$+ tw^r x^{rQ}.$$

Recall that $p^M > p$, and $p^C > p$. Using (13), thus, (14) and (16) are nonnegative. Further, under convertible rations, the consumption of the deficit good by the rich would typically not be less than the economywide average consumption; that is $x^{rC} \ge X$.[11] Hence, (15) is also nonnegative.

We can also show that those with very high wages (which includes the rich) are better off under convertible rations than under the queue system. Specifically, expressions (7), (8), and (9) yield:

$$\Delta^h(C, Q) = (p^C - p) X$$
$$+ [tw^h - (p^C - p)] x^{hQ}.$$

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[11] Sufficient conditions for this to be the case are that the deficit good is normal, and that the individuals' tastes are similar.

Since $p^C > p$, the preceding expression is positive if $w^h \geq (p^C - p)/t$.

C. Convertible vs. Nonconvertible Rations

To show that certain individuals are better off under nonconvertible rations than under convertible rations, I consider those whose consumption of the deficit good under convertible rations is between X and X^R; that is, $X^R \geq x^{hC} \geq X$. Among these individuals, there could be two types: those whose consumption is not constrained under nonconvertible rations, and those whose consumption is constrained. For the former type, expressions (4), (7), and (9) yield

$$(17) \qquad \Delta^h(R, C) = (p^C - p)(X^{hC} - X).$$

For the latter type, expressions (5), (7), and (9) yield

$$(18) \quad \Delta^h(R, C) = (p^{hR} - p)(X^R - x^{hC})$$
$$+ (p^C - p)(x^{hC} - X).$$

Both (17) and (18) are nonnegative because $p^C > p$, and $p^{hR} > p$. Thus, this entire group of individuals is better off under nonconvertible rations than under convertible rations.

The intuition behind this result can be seen in two steps. First, under convertible rations, everyone has an incentive to buy the maximum quantity of rations available; consequently, this quantity equals X. There is no corresponding incentive under nonconvertible rations. Therefore, the maximum ration quantity, X^R, is larger than X, because there are individuals who do not buy the maximum ration quantity. Second, recall that the convertibility of rations implies a higher price of the deficit good, but also an income gain $(p^C - p)X$. Thus, for those individuals whose consumption under convertible rations is larger than X but smaller than X^R, the loss due to higher price exceeds the income gain from convertibility.

Note that the above result is based on my assumption that some individuals in the economy do not (or cannot) buy the maxi-

mum ration quantity under the nonconvertible ration system. Under the less realistic assumption that everybody buys the maximum quantity under the nonconvertible ration system, on the other hand, it is easily verified that convertible rations are weakly Pareto superior to nonconvertible rations.

D. Commodity Taxes and Administrative Costs

An important generalization of the results presented earlier is that they remain unchanged if there is a tax (or subsidy) on the deficit good, provided the same tax applies under all allocation systems. To see this, let s denote the tax per unit of the deficit good. That is: (i) under a government-managed system, the price of the deficit good at government shops is $p + s$; (ii) under nonintervention, s is the difference between the market price of the deficit good and the price which firms owning this good receive; and (iii) the resulting budget surplus (or deficit) to the government, in each case, is sX per capita. Then, it can be verified that my comparisons among alternative systems are unaffected, regardless of what s is. This is because s cancels out when an individual's utility under alternative systems is compared.

My results are also unaffected by administrative costs, if these costs are not significantly different under alternative systems (i.e., the sum of storage, personnel, and other transaction costs accruing to the government as well as private intermediaries depends primarily on the total quantity of the deficit good), and if these costs are passed on to consumers through the price of the deficit good. This is simply because the effect of administrative cost, in this case, is analogous to that of a commodity tax.

Additional generalizations of the following kind are, therefore, straightforward. Suppose we find that $V^{hI} > V^{hJ}$ when systems I and J are hypothetically assumed to have the same administrative cost, then the same conclusion holds if in fact the system J has a higher administrative cost than that of I. As a specific example, my result that convertible rations are better for the poor than

nonconvertible rations holds not only when these two systems entail the same administrative cost, but also when the latter system entails a larger administrative cost (for instance, if the cost of enforcing nonconvertibility exceeds the cost of transacting secondary trades).[12]

IV. Concluding Remarks

Allocation systems such as rationing and queues are extensively employed in many *LDC*s and centrally planned economies. In this paper, I have compared the outcomes of such systems with one another, and with that of unhindered market. My analysis has concentrated on *positive* comparisons: I have attempted to ascertain, for each pair of allocation systems, whether a specific group of individuals (particularly the poor and the rich) is better off under one system or another. The results and insights obtained from these comparisons are valid, as well as informative for policy debates on these issues, regardless of the social criterion or political pressures (resulting, for instance, in an unwillingness to allow the market price to increase) based on which a government might want to choose an allocation system.

I recognize that there is a great diversity in the structures and the economic outcomes of the allocation systems that are employed in different contexts.[13] In this paper, I have used relatively simple models to depict alternative allocation systems and have focused on the comparisons of their outcomes within a narrow but important class of circumstances when the supply of a good is limited.[14] Within this class, however, most of my results are robust not only to parameters such as the cost and the quantity of the deficit good available in the economy, and the nature of heterogeneity in individuals' tastes, but also to certain types of commodity taxes and administrative costs. Moreover, my comparisons among alternative government-managed systems are relevant even when the quantity of the deficit good to be distributed among individuals is a policy choice, rather than a datum for the economy.

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[14]Supply responses, on the other hand, have critical implications (for prices as well as individuals' earnings) in many situations. See, for instance, my paper with T. N. Srinivasan (1986) for an analysis of the role of supply responses in determining the distributional consequences of partial food rationing in *LDC* cities.

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[12]Note that this paper does not take a position on whether the total administrative cost under a particular system is larger or smaller than that in another system. This is because the empirical or conceptual basis for such a generalized assertion appears to be inadequate at present. Attention to administrative costs is nevertheless a step in the right direction because these costs are important in practice but, as I indicated earlier, they have been ignored in much of the literature.

[13]See Janos Kornai (1980) for a description of some of the effects of nonprice controls in centrally planned economies; this work, however, does not emphasize a comparison of the outcomes of alternative controls.

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