U.S. STRATEGIC STOCKPILE POLICY: A CRITICAL ASSESSMENT OF ANTICIPATORY GOVERNMENTAL ACTION

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FOREWORD

Over the last several decades a number of economists, particularly in North America, have questioned the extent of government regulation and intervention in many economic sectors, claiming that the government often has gone far beyond what is necessary to protect the public and in the process seriously impaired efficiency. These concerns have actually stimulated significant reforms in certain countries, as the recent deregulation of the airline and banking industries in the United States illustrates.

In this study, Stephen Dresch moves further down this path by arguing that the government should leave to the private sector the stockpiling of strategic materials needed in the event of war. He contends that the private sector will be more efficient at this activity, and more likely to accumulate the optimal level of stocks. In addition, he suggests that reliance on private stockpiling may actually reduce the likelihood of war.

These conclusions, as the analysis makes clear, depend on a number of assumptions, whose validity many will want to question. But then, the purpose of a working paper is to stimulate discussion and debate, and thereby help the author and others understand their differences and clarify their own thinking.

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PREFACE

This paper draws upon and extends certain facets of an earlier study undertaken for the U.S. Federal Preparedness Agency [FPA] (now the Federal Emergency Management Administration [FEMA]).* However, while the prior study was concerned primarily with policy recommendations which would result in greater economic efficiency in stockpile activities and only ancillarily addressed the issue of the underlying justification for *any* governmental initiatives in this domain, the present paper is explicitly addressed to this more fundamental issue.

At the outset I must admit that the paper may be viewed primarily as performing a heuristic function. While its critique of U.S. strategic stockpile policy, and especially the conclusion that levels of inventories which would be accumulated by private speculators operating through competitive markets would be at least as socially optimal as those inventories which would be accumulated by a public agency, is intended seriously, the required institutional stipulations and related analytical assumptions (e.g., that speculators do not anticipate price controls, rationing and/or expropriation in the event of military hostilities) may well be considered so unlikely to be fulfilled as to render the analysis a purely academic exercise.

However, even if the study is judged to have little or no practical import with reference to strategic stockpile policy *per se*, it may yet have important derivative implications for comparable governmental action in anticipation of other types of contingencies. Specifically, if a strong, plausible case can be made against public *vis-a-vis* private action in this domain, in which required assumptions and institutional arrangements are most unlikely to be fulfilled, then arguments in favor of private action in other domains will have strong *prima facie* validity. Thus, the

*Stephen P. Dresch, *Allocations of Final Demand Expenditure in a Wartime Economy and Development of Strategic Stockpile Objectives: Assessment and Reformulation* (Final Report to the Federal Preparedness Agency by the Institute for Demographic and Economic Studies, September 1979).

study may have greater relevance to more general issues of anticipatory governmental action than with reference to the specific issues of strategic stockpiles.

Notwithstanding the foregoing, however, the paper is intended to provide a serious analysis of and recommendations concerning U.S. strategic stockpile policy.

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ACKNOWLEDGEMENTS

An earlier study of U.S. strategic stockpile policy (referenced in the Preface) was undertaken at the request and with the support of the U.S. Federal Preparedness Agency (now Federal Emergency Management Administration) to the Institute for Demographic and Economic Studies (Contract No. FPA-77-21). Critical reactions to this earlier work of Edward Zabrowski, Douglas Scott and Paul Kruger, all of FPA/FEMA, and of W. Allen Wallis (former chancellor of the University of Rochester; currently Under Secretary for Economic Affairs, U.S. Department of State), Milton Friedman (Hoover Institution on War, Revolution and Peace), Julian Simon (University of Maryland and Heritage Foundation), Wassily Leontief and Faye Duchin (both of the Institute of Economic Analysis, New York University), and Adair L. Waldenberg (Institute for Demographic and Economic Studies and Northwestern University) contributed significantly to the formulation of the analysis presented here. Wilhelm Krelle and John Tilton, of IIASA, provided invaluable comments and criticisms of an earlier draft of the present paper. None of these individuals, of course, is responsible either for the more formal aspects of the analysis or for the necessarily highly subjective substantive judgements which are expressed.

S. P. D.

PRECIS

Commenting editorially ("Remember Strategic Minerals?" February 17, 1982), *The New York Times* advocated development of a strategic minerals policy based upon "a close analysis, mineral by mineral, of the consequences of import dependence and the practical alternatives," concluding with three "principles" on which, *The Times* argued, such a policy should be based:

[1] Stockpiles should come first...

[2] Private solutions are preferable...

[3] Keep planning flexible.

A reasonable analysis of the issue suggests, however, that only the second principle is necessary. Reliance on private (market) solutions could result, under achievable circumstances, in at least approximately optimal stockpiles of strategic minerals and would insure flexible adaptations of these stockpiles to evolving technologies and patterns of minerals availability. Moreover, *de facto* assignment of responsibility for strategic minerals availability to private investors would have potentially important (and beneficial) foreign and defense policy implications. The purpose of this paper is to defend these assertions. That defense is briefly summarized here.[1]

Superficially, a federal strategic stockpile seems to make substantial sense. If defense-related contingencies giving rise to shortages of particular materials can be anticipated, why should the government not take action in advance to reduce these potential shortages? However, there are two fundamental reasons for responding to this question in the

[1] Even in this rather lengthy summary it is possible, at most, only to allude to the many significant required assumptions and qualifications of the analysis. Thus, many of the objections which can be anticipated to the arguments advanced in this overview are at least discussed, if not overcome, in the body of the paper.

negative:

(1) Unless federal stockpile holdings are excessively large, they will have little or no effect on aggregate (public and private) inventories of strategic minerals.

(2) If federal inventory holdings are sufficiently large as to have an effect on aggregate inventories, they will not only result in levels of cost which are socially unjustified but may also increase the likelihood of international conflict.

Consider a situation in which the federal government maintains no stockpile of strategic minerals. This does not imply that there will be *no* inventories of these minerals. Rather, private speculators will invest in strategic minerals, balancing the substantial profits which will accrue in the (relatively unlikely) event of military mobilization (resulting in a rise in prices due to exceptional increases in demand or reductions in supply) against the more modest losses (interest and storage costs, physical deterioration) which will be incurred in the (more likely) event that hostilities do not occur (and, hence, that future prices are relatively lower than in the event of hostilities).[2] Private speculative investment will continue until the second just cancels (is equal to) the first. In general, private speculative investment will be greater (a) the greater the military requirements for the various minerals and (b) the higher the perceived probability that hostilities will occur and that supplies will be disrupted; conversely, speculative holdings will be lower the higher the costs (especially the higher the real interest costs) entailed by maintenance of the inventory.

The configuration of strategic minerals inventories which would be voluntarily chosen by private speculators will be optimal from a social perspective if the following conditions are met: (1) Speculators must correctly perceive the probability of hostilities and the effects of hostilities on demands for and supplies of the various minerals. (2) Inventory costs (including interest, or discount, rates and required risk premia) confronting private speculators must be no higher than those confronting the government. Within relatively narrow bounds the required conditions can be expected to be fulfilled. Thus, the inventory holdings of private speculators would approximate those which would be chosen by an omniscient stockpile czar, probably as closely as would the holdings selected by a less than omniscient stockpile bureaucracy.

If this is true, then what will be the effect of a decision to create a governmental strategic stockpile? If private speculators are aware of the government's action, as inevitably they will be, then increases in governmental inventories will be offset to a greater or lesser extent by

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[2] As will be discussed, a critical assumption here is that private speculators do not anticipate that government will confiscate strategic materials inventories (or, equivalently, impose price controls and mandatory rationing, in the event of hostilities. *Any* intervention of government into the functioning of private markets, current or prospective, may seriously undermine the argument developed here, that the private speculative solution to the problem of determining inventories of strategic materials will be, *ceteris paribus*, socially optimal.

reductions in private holdings, simply because the existence of governmental holdings will reduce the minerals prices which speculators expect to confront in the event of hostilities.

The extent to which increased governmental holdings will be cancelled by reduced private holdings will depend upon, first, the importance of defense-related contingencies as determinants of private inventories, and second, the expectations of speculators concerning the circumstances under which the government will release its stockpile holdings to producers. If military contingencies represent a minor motivation for private speculative investment in a particular mineral (by comparison to other anticipated sources of shortage, e.g., embargos, strikes, natural calamities), and if speculators are confident that the government will release its holdings to the market only in the event of military hostilities, then governmental inventory investments will have relatively little impact on private holdings.

Unfortunately, with reference to the prospective effectiveness of public stockpile policy, military demands represent in excess of twenty percent of total utilization of many strategic minerals, and military contingencies must constitute an important motive for private as well as public speculative investment. Moreover, the federal government's repeated recourse to the strategic stockpile in the face of shortages unrelated to military contingencies has served to reduce even those speculative private investments motivated by nonmilitary contingencies.

Thus, the existence of governmental strategic stockpiles must imply lower private holdings of the same minerals than would be observed in the absence of the public strategic stockpile. Only when governmental holdings become so large as to have eliminated military contingencies (and any other circumstances under which the government would release stockpiles to the market) as a motivation for private inventory investment will a given increment in governmental holdings represent an equal increment in aggregate national inventories, public and private.

Beyond that point, however, increased strategic minerals inventories have adverse consequences for foreign and defense policies. Any foreign policy entails some risk of military confrontation or war. The choice of a policy is to at least some extent a function of its costs, costs which include, among other elements, the costs of a potential conflict and of the economic dislocations which it would entail. If these costs can be camouflaged and apparently (but not in reality) reduced by excessively large strategic stockpile inventories,[3] then the adoption of policies with excessively high probabilities of eventuating in hostilities will be encouraged. The situation is distinct but not dissimilar in its effects to that which would be observed if a monopolist were in control of private inventories: He can draw upon future conflict-conditional speculative profits in order to raise the likelihood that conflict will in fact occur, e.g., by fanning popular sentiment against a potential adversary or by

[3]This argument assumes that there is an element of "temporal illusion" in social perceptions of the costs of governmental policy, i.e., that small costs distributed over time are politically acceptable while the equivalent (in present value) concentrated at a point in time would not be acceptable.

creating hostile incidents. In the present case the bureaucratic interests of the military and strategic stockpile authorities (and possibly of foreign policy authorities) may be jointly served by pursuing foreign-*cum*-defense policies which necessitate excessive stockpiles and by pursing stockpile policies which reduce the apparent costs of particularly provocative foreign-*cum*-defense policies.

In short, the optimal strategic stockpile is not independent of the optimal foreign and defense policies. A stockpile policy which leads to excessive inventories can be the cause as well as the consequence of foreign and defense policies which entail excessively high probabilities of conflict. Only if stockpile inventories are accumulated by (private) parties who believe that they have no effect on the probability of conflict will the optimal stockpile be accumulated, while the optimal foreign and defense policies will be adopted only if policy makers believe that they have no control over stockpiles of strategic minerals other than through their influence (through their foreign and defense policies) on inventory investors' perceptions of the probability of conflict and the consequences of conflict for minerals markets. With governmental stockpiling the incentives of the stockpile, foreign policy and defense policy authorities to accumulate excessive inventories and to engage in excessively provocative policies will be mutually reinforcing. Only with private speculation can optimal inventories and foreign-*cum*-defense policies be anticipated.

Two particularly obvious and possibly highly significant objections to a policy of reliance on private speculation for the maintenance of strategic minerals inventories require consideration. First, if speculators fear that their inventories will be expropriated (with compensation at preconflict prices) or subjected to price controls and rationing in the event of a military contingency, then their motivation for holding these inventories will be destroyed. This is a fully justified concern, implying that a decision to rely on private speculation must be conjoined with inviolable guarantees that strategic inventories will not be expropriated or subjected to price controls and rationing.[4] Since the government will (virtually) always be able to bid these mineral inventories away from other would-be purchasers, such guarantees will not reduce the government's command over strategic minerals. In the event of conflict the prices paid by government will be higher, but the government will not have incurred the prior costs of accumulating and maintaining strategic inventories.

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[4]In principle, explicit Constitutional provisions would appear to offer a mechanism for such guarantees, *in explicitly constitutional political systems*. However, in a parliamentary democracy without a written constitution, such as the United Kingdom, in which the actions of one session of Parliament cannot constrain the actions of another, or, to a lesser extent, in a system such as that of the Federal Republic of Germany, in which the Constitution itself places constraints on the capacity of one legislative session to preempt the powers of another, explicit constitutional protections of speculative investors may be foreclosed. And, even when constitutional protections can be provided, a constitutional provision may itself be either altered or ignored. Thus, one can legitimately question whether there exist *any* circumstances under which investors could plausibly be expected to believe that an entity with the inherent powers of the state would eschew intervention into private markets were such intervention perceived to be in the interest of the state.

The second objection is that, in the event of hostilities and in the absence of expropriation or price controls and rationing, tremendous "windfall gains" will inure to the benefit of private speculators and that this would represent an undesirable redistribution of wealth. In the short run this may very well appear to be true. In the (admittedly *very*) long run, however, the substantial speculative profits which would be realized in the event of conflict will be eroded, in fact, cancelled, by the succession of losses which would be incurred in the absence of hostilities. Thus, issues of income and wealth distribution have no legitimate relevance to decisions concerning the assignment of responsibility for strategic minerals inventories.[5] Nonetheless, *conventional perceptions* of the income- and wealth-distributional implications of reliance on freely-functioning private speculative markets may render this policy infeasible, especially in times of war, when some classes of individuals (e.g., military personnel) personally bear especially high costs (even including death) while others (speculators) become (even temporarily) wealthy.[6]

Military mobilization or war would inevitably lead to the appearance of shortages of many minerals. However, a serious analysis of the problem suggests that these shortages are unlikely to be reduced by a governmentally-owned strategic stockpile. The interests of society, with reference to both economic preparedness and to the conduct of foreign and defense policy, would be better served by reliance on private speculative investment for the maintenance of stockpiles of strategic minerals. In short, and recalling the previously cited *New York Times* editorial, as a matter of government policy and (unless you are a private speculator) nongovernmental concern, *forget strategic minerals*.

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[5]Clearly, to impose a windfall profits or other tax on hostility-contingent speculative profits would vitiate the motives for strategic minerals investment. Even a conventional income tax will result in suboptimal strategic minerals inventories *unless* (1) the tax is imposed at a flat rate (i.e., is not progressive) and (2) inventory losses in periods of peace are fully deductible (i.e., result in negative tax liabilities).

[6]Note that this is an *apparent* but not a *real* moral or ethical argument against reliance on a private speculative solution. If the private speculative market were to function as outlined in this paper, then to profit from investment in strategic materials would not differ, on moral or ethical grounds, from profiting, in either peace or war, from the production of or investment in any other type of commodity or productive capacity.

CONTENTS

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1. Future Contingencies and Anticipatory Governmental Action

While the future is necessarily uncertain, it is not entirely unknown: Contingent on certain eventualities (states of the world), specific consequences can be anticipated. A significant fraction of governmental action is concerned precisely with mitigation of the more adverse prospective consequences of uncertain but conceivable events. Superficially, such anticipatory governmental action appears to be quite defensible. When particular exigencies can be anticipated, a failure of government to pursue anticipatory policies is commonly perceived to be irresponsible.

If responsibility is attributed to governments for the consequences of events the occurrence (and frequently even the magnitude of the adverse impacts) of which cannot be influenced by governments (e.g.,

floods, earthquakes, other "acts of God"),[1] this attribution of governmental responsibility is especially common with reference to those events the occurrence of which is the result, directly or indirectly, of governmental action. Thus, for example, foreign policies which are at least perceived to contribute to the likelihood of embargoes or other foreclosures of access to imported materials lead almost inevitably (if, occasionally, belatedly) to governmental actions to mitigate the consequences of supply contractions. In this context, it is perhaps not surprising that governmental responsibility is effectively assumed with reference to the potential consequences of military or defense-related contingencies, a domain in which, within any society, government is recognized to have a nominal monopoly of rights of action.

Whatever the factors, governmental or nongovernmental, which are believed to influence events, the fundamental issue from a *social* perspective concerns the optimality of anticipatory action. In general, responsibility for anticipatory action is uncritically attributed to government in response to what is uncritically asserted to be *prima facie* evidence of the inadequacy and nonoptimality of anticipatory *non*governmental action. However, even in many (perhaps most) cases in which the nonoptimality of nongovernmental action can be demonstrated, that nonoptimality is itself the consequence of governmental actions, often in quite unrelated domains. Moreover, the failure to consider the underlying sources of the nonoptimality of nongovernmental action is frequently

[1]Evidence of this perceived "responsibility" of governments is provided by the refusal of many regimes either to admit the occurrence of adverse events or to publically recognize the magnitude of the adverse consequences. It is apparently believed that to do so would be construed by the public as an admission of the failure of the regime or, even, of the social-political system itself.

conjoined with a failure to consider the nongovernmental consequences of anticipatory governmental action. Thus, the unwarranted predisposition toward governmental responsibility is generally reinforced by policy assessments which are vitiated by several particularly critical but generally unstated assumptions, specifically, that anticipatory governmental action

(1) has no impact *per se* on the probability that the anticipated event will occur;[2]

(2) does not alter unexpectedly the anticipatory actions undertaken by nongovernmental parties (and/or that nongovernmental parties do not engage in anticipatory action); and

(3) does not influence "eventuality-conditional" behavior in such a way as to negate the achievement of the objectives of anticipatory policy.

Unfortunately, in a number of highly diverse domains of anticipatory governmental action, ranging from flood control and catastrophe insurance to transportation policy and strategic stockpiles, at least one and frequently all three of these assumptions are violated. As a result, suboptimal public policies are virtually assured.

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[2]It might be objected that an important, perhaps primary purpose of a strategic stockpile is precisely to reduce the probability of prospective hostilities, simply by demonstrating to a potential adversary one's own preparedness. However, this objective can be achieved, arguably more efficiently, *via* current investments in military preparedness *per se* or, if more appropriate, through explicit commitments to future investments in military capabilities, relying on private markets to achieve optimal inventories of necessary inputs (conditional on correct forecasts of the spectrum of possible future governmental demands). Similar arguments can be made, even more easily, with reference to other motivations for anticipatory governmental action.

The purpose of this study is to demonstrate the probable nonoptimality of anticipatory public policy in the specific case of strategic stockpile policies developed in response to the economic dislocations expected to be observed in the event of military hostilities. If such an argument can be plausibly made in the military domain, in which the the consequences of error would conventionally be viewed as most serious and with reference to which the primacy of government as a locus of decision is commonly accepted as unarguable, then a general stance in favor of private *vis-a-vis* governmental responsibility for anticipatory action can be argued to be virtually irrebuttable.

2. Contemporary U.S. Strategic Stockpile Policy: A Descriptive Overview

Notwithstanding significant "advance mobilization" after 1938, directed toward meeting the military demands of Britain, in particular, and of her allies, U.S. entry into World War II in late 1941 was accompanied by the appearance of substantial perceived "shortages" of primary and fabricated materials required for the war effort. Largely because of this experience, since the war the federal government has continuously maintained stockpiles of critical ("strategic") materials anticipated to be in short supply in the event of military mobilization.

As the agency charged with direct responsibility for the conduct of strategic stockpile activities, the Federal Emergency Management Administration (formerly the Federal Preparedness Agency) over the past decade has progressively elaborated the procedures utilized to determine strategic stockpile "objectives" or "goals," i.e., to establish the target level and composition of stockpile holdings. Building upon the

historical (and unchanged) definition of the stockpile objective as the "gap" between anticipated wartime requirements for and availabilities of a given strategic material, the projections of requirements have been significantly refined, taking into account such factors as

(1) the precise characteristics of the military hostilities in which it is anticipated that the nation may be involved;[3]

(2) changes in the composition of final demand, reflecting both enlarged military demands and also civilian austerity (reflected especially in reductions in personal consumption expenditure for durables and in residential construction);

(3) prioritization of final demands (distinguishing between defense, essential civilian and general civilian expenditures, in that hierarchical order), conjoined with an associated concept of "tiered risk" (with a lesser loss or cost attached to shortfalls of requirements from availabilities in the case of lower-priority expenditure categories);

(4) reliability ranking of potential sources of supply (foreign and domestic), considering political orientations, vulnerability to disruption of production facilities and transportation systems, etc., with differential degrees of reliability of supply required for the various priority categories of final demand; and

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[3]In practice, this is achieved by arbitrarily assuming a war of a specified duration (three years), with a specified number of fronts (two). In principle, however, each hostility configuration should be considered, in conjunction with its associated probability of occurrence. On this basis, an "expected" gap between requirements and availabilities, constituting the strategic stockpile objective, could be determined. As will be discussed, this discrepancy between practice and principle is simply one instance of a general class of inadequacies associated with current policy.

(5) specification of differential degrees of anticipated feasible substitution of nonshortage for shortage materials (again related to the priority ranking of the expenditure category).

Superficially, these relatively elaborate and apparently sophisticated procedures for determining stockpile objectives represent a substantial improvement over the simple fixed-coefficients estimates of shortfalls of aggregate "availabilities" from aggregate "requirements" previously employed, permitting a much more sensitive adjustment of stockpile holdings to evolving economic, technological and security conditions and considerations than could heretofore be achieved. Whether this is in fact the case, however, will depend on a number of factors, especially including

(1) the statistical reliability of the highly disaggregated quantitative data required for empirical implementation of this more sophisticated approach;

(2) the correspondence between the behavioral assumptions implicit in the approach and the economic behavior which would actually be observed in the event of military mobilization; and

(3) the absence of premobilization reactions to strategic stockpile accumulations which offset or negate the objectives of stockpile policy.

Each of these is a critical prerequisite for the effectiveness of current procedures, and with reference to each serious questions can be raised.

Data requirements for the more disaggregated approach will rise rapidly, roughly by at least the square of the degree of attempted disaggregation. In light of the costs of acquiring detailed economic and

technological data and of the likelihood of decreasing statistical reliability at more disaggregated levels, the benefits of greater disaggregation and refinement may be more apparent than real, falling significantly short of the costs involved. Various techniques by which to reduce data requirements may, of course, be employed, such as deriving coefficients for a disaggregated sector from a more basic set of coefficients at an aggregated sectoral level. If bases for making such adjustments are reasonably firm, the results may significantly improve on the conclusions that would be reached at the more aggregated level. However, in practice this approach may result in conclusions which differ only trivially (and not significantly) from those that would be reached on the basis of a less apparently refined analysis. In this event, the benefits of more refined procedures will be ephemeral. On the other hand, if the conclusions are found to differ substantially, it is important both to determine the source of the differences and to verify their validity and reliability.

In general, the procedures by which stockpile objectives are determined do not rest upon explicitly stated and justified behavioral-economic and public-policy stipulations and assumptions. Thus, changes in economic behavior, e.g., the "austerity reduction" in durable consumption expenditure and in residential construction, are stipulated, but the mechanisms by which these changes are induced are not identified. Unless economic behavior in the event of military mobilization corresponds to that assumed in the formulation of stockpile objectives, the level and composition of the stockpile may have little relationship to the patterns and magnitudes of the material shortages which in fact emerge as a consequence of the final demands which are actually

observed.

Premobilization reactions to the level and rate of investment in the strategic stockpile are entirely ignored in the current approach to the formulation of stockpile objectives. However, if nongovernmental inventory investment behavior is significantly influenced by governmental stockpile actions, then the net augmentation of economic capabilities associated with the strategic stockpile may fall short of that augmentation superficially implied by the gross level of stockpile holdings. In fact, as will be demonstrated, there are substantial reasons to believe that nongovernmental inventory holdings of strategic materials will respond to governmental holdings. First, if governmental stockpile acquisitions lead to current-period increases in prices of these materials (absolutely or relative to expected future prices), then this will imply reductions in desired private holdings of the same materials. Second, the anticipation of future flows from the strategic stockpile, by increasing expected future availabilities and reducing expected future prices, will also serve to reduce desired private inventory holdings.

A detailed critique of contemporary U.S. strategic stockpile policy, however, requires that the economic context of strategic stockpile activity be articulated, capturing (a) those aspects of private economic behavior which would be influenced by governmental stockpile accumulations and dispositions and (b) the internal dynamics of governmental policy.

3. Determinants of Anticipatory Nongovernmental Action

In broadest terms, strategic stockpiles represent inventories of materials deemed to be critical to military mobilization. Thus, the issue of the optimal strategic stockpile *policy* can be viewed as a special case of the more general issue of optimal inventory policy: By what criteria and on what basis should inventories of various materials be determined? This question is conventionally approached at the outset from the specific vantage point of governmental policy, with particular attention to two possibly distinguishing features of the strategic stockpile: (1) its purposes and (2) its governmental ownership. Critical insight, however, may be facilitated by a less restrictive consideration of the strategic stockpile within the context of inventory theory, examining the economic role and determinants of strategic materials inventories, whether publically or privately held.

Two functions of inventories can be identified. First, inventories may be required in order to achieve production efficiency, broadly conceived. If a marginal increment to inventories reduces production costs (through economies of scale in purchasing or shipping, etc.) by an amount greater than the implicit interest, storage and related costs of the enlarged inventory, then the increment in inventory holdings is economically justified.

Second, inventories may be held because of uncertainties concerning future conditions of supply, demand and, hence, prices. Directly or indirectly, inventory holdings (or stockpiles) motivated by uncertainty concerning future market conditions constitute *speculative* inventories.

Speculation in this sense can occur only in the face of uncertainties concerning future states of the world, uncertainties which can involve future conditions of demand or of supply.

The strategic stockpile thus represents a class of speculative inventory, defined by the types of contingencies which motivate its acquisition: changes in demand or of supply which are contingent upon the occurrence of military mobilization or war. In most general terms these contingencies lie along a multidimensional continuum, involving such factors as the nature, duration, extent and geographic locus of actual or potential hostilities. For purposes of the immediate discussion, however, this continuum can be reduced to two states of the world, characterized as "peace" and "war."

If war were a purely probabilistic event, then a private speculator would approach the issue of strategic stockpile or inventory investments as follows: Supply and demand for each future period would be predicted, conditional on the two alternative possible states of the world, peace and war. If supply were expected to be reduced and/or demand were expected to be increased in the event of war, then prices would be expected to be higher in the event of war than of peace. If inventories were accumulated in periods of peace, then they could be sold in periods of war at prices above peace-time purchase prices. Speculative profits would then equal sales revenues less purchase costs and carrying charges (interest, storage fees, physical deterioration, obsolescence, etc.). For any given probability of war, there would then be an inventory (strategic stockpile), the *expected* economic profit on the marginal (and, assuming perfect competition, average) unit of which would equal zero.

With freedom of entry into all markets (on the part of actual or potential speculators), this would represent the competitive, profit-maximizing level of stockpile inventories.

Although, in principle, the problem is amenable to solution, the analytics of competitive, profit-maximizing private stockpile investment become quite complex in the multiperiod or infinite-time-horizon case. However, the essential characteristics of the solution can be meaningfully indicated by a simplified two-period model. Period 0, assumed to be one of peace, is characterized by the current-period supply and demand curves for commodity X (exclusive of net speculative inventory demands) depicted in Figure 1 by D_p and S. Period 1 supply is also assumed, for simplicity, to be represented by the curve S, regardless of the state of the world (peace *versus* war). Period 1 demand, however, is represented as contingent on the state of the world, D_p in the event of peace and D_w in the event of war. Any strategic inventory accumulated in period 0 is assumed to be sold in period 1 regardless of the state of the world which actually eventuates. Increasing speculative inventory demands will raise the period 0 price and lower the period 1 price, whether war occurs in period 1 or not. Assuming zero inventory carrying costs other than interest at the rate r, private stockpiles will be accumulated until the condition is fulfilled that

$$P_0(X_s) = \left[ZP_{1,w}(X_s) + (1-Z)P_{1,p}(X_s)\right](1+r)^{-1} \qquad (1)$$

where Z is the probability that a state of war will exist in period 1,

$(1-Z)$ is the probability of peace in period 1,

X_s is aggregate inventory investment,

$P_0(X_s)$ is price in period 0, a function of X_s,

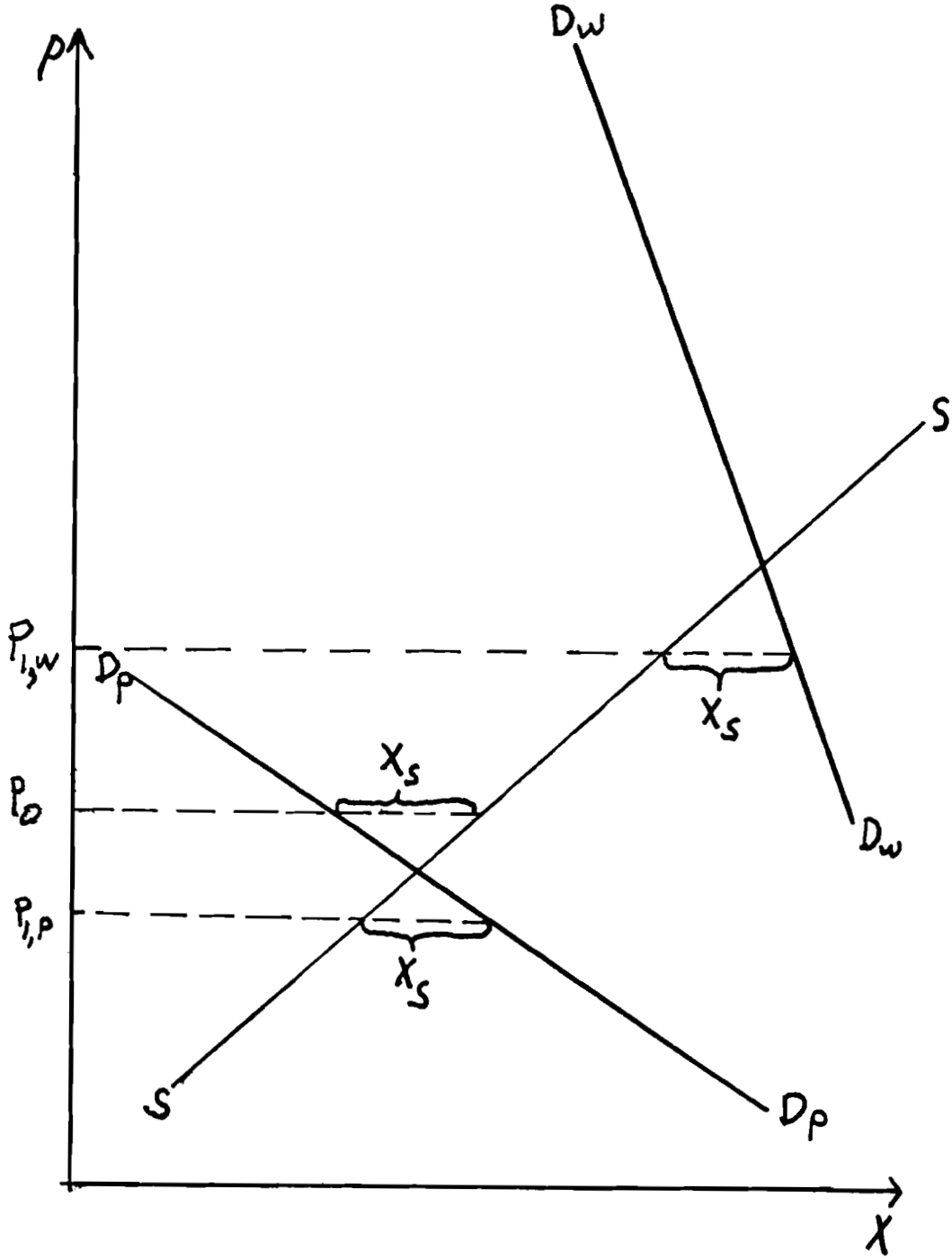

Figure 1. Determinants of Competitive Private Stockpile Investment

$P_{1,w}(X_s)$ is the war-conditional price in period 1,

$P_{1,p}(X_s)$ is the peace-conditional price in period 1, and

r is the interest rate.

The prices P_0, $P_{1,w}$ and $P_{1,p}$ will be functions of period 0 stockpile inventory investment (period 1 stockpile inventory disinvestment), X_s, with the precise functions determined by the parameters of the current period demand and supply functions, D_p, D_w and S. Thus, equation 1 can be solved for the competitive profit-maximizing level of stockpile investment, X_s, at which expected economic profits would equal zero.

Ignoring transactions at disequilibrium prices (or, assuming that a process of Walrasian *tantonnement* Edgeworthian recontracting continues until all markets clear, with no transactions at disequilibrium prices),[4] then at the final solution a period 0 contract for for future delivery (and payment) in period 1 will involve a predetermined price which will just equal (a) the current (spot) period 0 price plus interest and (b) the expected period 1 price. Thus, competitive private speculative investments will insure effective equality between current spot prices and futures prices. Although exchange at disequilibrium prices may qualify this conclusion, the general tendency will be toward interest-rate-adjusted equality between all prices.[5]

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[4]The assumption of a process of *tantonnement* or "recontracting," thus precluding the occurrence of disequilibrium transactions, insures that the *ex ante* and *ex post* equilibria will be identical. Otherwise, disequilibrium transactions, through their influence on the distribution of wealth, could have the effect of altering the equilibrium. The alternative solution to this problem is Marshall's assumption of the constancy of the marginal utility of money (as reflected in his development of the pure theory of exchange, with reference to the "corn market"). See: Léon Walras, *Eléments d'économie politique pure (Théorie de la richesse sociale)* [1874-7], 5th edition (Paris and Lausanne, 1926); Francis Ysidro Edgeworth, *Mathematical Psychics* (1881); and Alfred Marshall, *Principles of Economics* [1890], 4th edition (London, 1898).

[5]This conclusion is, in fact, a specific instance of the general requirement (the "Hotelling"

It must be stressed that this solution assumes that stockpiles (inventories) are accumulated by competitive private speculators and that both producers and consumers of commodity X are perfectly competitive. If, in contrast, stockpiles are accumulated only by a monopolistic private speculator (or by a cartel), then the monopolist's (cartel's) investment in inventories, $X_{s,m}$, would be determined so as to maximize the present value of expected profits, $E(\pi)$, where

$$E(\pi) = \left\{\left[ZP_{1,w}(X_{s,m}) + (1-Z)P_{1,p}(X_{s,m})\right](1+r)^{-1} - P_0(X_{s,m})\right\}X_{s,m} \qquad (2)$$

and it will always be true that $X_{s,m} < X_s$.[6] Thus, monopoly in speculative markets will inevitably lead to underinvestment in stockpiles from a social perspective, because, as will be indicated below, the level of competitive private stockpile investment will represent a lower bound on the socially optimal stockpile.[7]

Although this discussion of private stockpile behavior has been cast in partial equilibrium terms, clearly the actual process of competitive private stockpile investment must be conceived in a general equilibrium

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or "emmetropic" rule) that, in intertemporal equilibrium, prices of resources (nonproduced materials) and of speculatively-inventoried materials generally must rise at the real rate of interest. See H. Hotelling, "The Economics of Exhaustible Resources," *Journal of Political Economy* (1931), and S. P. Dresch, "Myopia, Emmetropia or Hypermetropia? Competitive Markets and Intertemporal Efficiency in the Utilization of Exhaustible Resources," *IIASA Working Paper WP-84-48* (June 1984).

[6]Equation 1 can be viewed as a special case of equation 2, with the maximization of equation 2 (the monopoly equation) replaced by the imposition of the zero-profit condition of equation 1.

[7]The conclusion that the monopolist's stockpile investment will always be less than the competitive inventory investment, and hence less than the socially-optimal inventory, assumes that the probabilities associated with the future states of the world (peace *versus* war) are given and not subject to influence by the monopolist. If, in fact, the monopolist can, at a cost, influence the probability of war, then it is conceivable that the level of investment which maximizes monopoly profits will exceed the competitive level of inventory investment. Also, this monopoly investment and also the monopolistically-influenced probability of war will both exceed the social optima. A parallel case will be discovered with reference to public stockpile investments.

framework, recognizing the full range of direct and derived demands and their interrelationships, including substitution possibilities in production and in end use. However, because the important aspects of the problem can be more easily identified in partial equilibrium terms, the discussion here can be conducted within this frame of reference.

4. Governmental Influences on and Social Optimality of Anticipatory Nongovernmental Action

The essential issue to be addressed here concerns the conditions under which the process of competitive private stockpile investment will lead to socially optimal inventories of strategic materials. In the absence of externalities,[8] this question can be reduced to one of (a) divergences of private inventory investment behavior from that stipulated in the unconstrained competitive model and (b) possible discrepancies between the market (private) and governmental (social) perceptions of the critical factors influencing private inventory investment.

4.1. Actual *versus* Idealized Private Inventory Determination Behavior

In general, apart from monopoly influences (and possibly even including these),[9] actual private inventory behavior will diverge from that implied by the idealized competitive model primarily as a result of governmental

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[8]Externalities here refer to effects which cannot be internalized in governmental final demands for goods and services. Because those externalities which can be internalized through governmental final demands will be reflected in market demands for strategic materials, these do not introduce discrepancies between the competitive private and socially optimal stockpile inventories.

[9]Monopoly influences need not be excluded if the sustained presence of monopoly elements is itself due to public policy, as could be argued to be generally the case. In essence, I would argue that the ***persistence*** of any monopoly (or of a collusive oligopoly or cartel) requires at least the ***de facto*** support of government.

intrusions into the market. In the context of strategic stockpile policy three important classes of intrusions can be identified. First, governmental intrusion into market functioning, in the event of military or other contingencies, may undermine the motivations of private speculators to accumulate inventories which would otherwise be privately (and, as will be discussed, potentially socially) optimal. Second, general governmental policies, e.g., tax policies, may have seriously distorting effects. Finally, governmental stockpile policies, possibly motivated by the deficiencies of private investment resulting from the foregoing governmental influences, may well further vitiate private stockpile investment activity.

Perhaps the most serious source of private market failure with reference to inventories of strategic materials is the prospect of governmental intrusion into market functioning in the event of military (and possibly other) contingencies. The most obvious and likely of these intrusions involves expropriation of private inventories (with compensation at premobilization prices) and/or imposition of price controls (with attendant rationing) in response to the "shortages" which materialize as a result of military mobilization.[10] The expectation of either expropriation or price controls and rationing will undermine the incentives of private speculators to accumulate strategic inventories.

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[10]While expropriation appears to differ from imposition of price controls and rationing, this difference is only apparent. In essence, these represent identical public policy actions. In the case of expropriation, the government commandeers the available stock, providing such compensation of prior owners as it deems fit, and then directly allocates that stock to alternative uses (and users). The same result can be achieved by fixing prices (at the desired compensatory levels) and then achieving the desired allocations via rationing. Thus, although the mechanisms are slightly different, the end result is effectively the same. In both cases there is an excess demand at prevailing (governmentally determined) prices, with the actual allocation of the scarce supply determined not by the market but rather by governmental decree.

Superficially, expropriation or price controls and rationing appear to be necessary in order to assure adequate governmental command over scarce strategic material in the event of military hostilities. However, because the government presumably could outbid other prospective purchasers of strategic materials in the event of war, even if it were forced to acquire these materials on free and open markets,[11] the optimal governmental policy, if fear of expropriation or price controls and rationing is a source of private market failure, is to certify noninterference with normal market functioning, even in the event of war.

Such a certification of governmental noninterference in the functioning of free private markets, even under conditions of military crisis and mobilization, will have the desired effect only if it is credible to actual and potential inventory investors, i.e., only if it is believed. Clearly, this requires substantially more than a simple statement of "policy" (e.g., an Executive Order of the President) on the part of the government. Such a statement will lack credibility because investors can anticipate circumstances under which the government may change (leading to a concomitant change in price policy), while even in the absence of a political change a governmental policy may be altered in

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[11]The one possibly significant exception to this statement involves demands of the military opponent which might be satisfied, directly or indirectly, on domestic markets. This possibility exists because, if optimal strategic inventories are to be accumulated, private speculators should be free to engage in transactions on world markets, both prior to and in the event of military conflict. However, even this exception may be argued to be more apparent than real, in that the foreign and defense policies of the various countries should take into account the resources which a potential adversary would choose to devote to a military confrontation. More generally, even in the case of military opponents there exist "gains from trade," as reflected, e.g., in differential demands for strategic materials, exploitation of which should benefit both parties. In other words, if the opponent values a given flow of material at a higher rate than does the own country, then the own country can profit from exchange. Of course, the relative valuations should include consideration of the consequences of the trade for probabilities of military victory and defeat.

response to changed circumstances. While it is probably not possible to consider any constraint on any governmental entity to be strictly inviolable, specific devices in certain institutional contexts may offer substantial real *and perceived* protection to investors.

With reference to U.S. governmental institutions and history, it can be argued that a prohibition against market interference which takes the form of a *Constitutional* guarantee of nonintervention will impose substantially greater constraints on governmental action than would, e.g., an executive order or a statutory provision. Clearly, as the history of the Civil War (and subsequent wars) will indicate, even Constitutional constraints have been significantly loosened in periods of national crisis. However, even in these cases the existence of Constitutional prohibitions has served to limit the degree of *extra*Constitutional action on the part of government, and in most cases even these more limited *extra*Constitutional actions were eventually censured, with provision for at least limited compensation of victims (although in many cases, e.g., the internment of citizens of Japanese ancestry during World War II, the compensation was seriously delayed and was significantly less in present value than the costs incurred).

Even if an effective guarantee of nonintervention could be devised, it might be argued that expropriation or price controls are necessitated not by the need to insure governmental command over scarce resources but in order to prevent the income and wealth redistributions to which private speculation would give rise in event of war. Thus, for example, if the probability of war were very low, then the level of competitive inventories of strategic materials would, *ceteris paribus*, be correspondingly

low; the very low probability of a large speculative gain in the event of war, due to the small size of the strategic inventories, would be just offset by the high probability of a succession of small losses on these small inventories should war not occur (as is likely). However, if war did indeed occur, then the large gain, regardless of how unlikely, would actually be realized, implying possibly major redistributions of income and wealth.

In fact, on average and over very long periods of time such infrequent large gains would be fully offset by frequent small losses. Of course, over the short and intermediate runs, these war-conditional redistributions might be quite substantial. And while arguably not unacceptable in their own right, their political implications in a period of national emergency might be seriously deleterious, simply due to the misperception of the source of these gains (and of corresponding, peace-conditional losses) on the part of the populace. However, as will be discussed subsequently, to attempt to mitigate or offset these redistributions through, e.g., the imposition of high rates of taxation on speculative profits, by reducing the rate of return to inventory investment, would itself vitiate the motive for private stockpile accumulations.[12] Thus, political considerations may virtually force what are effectively confiscatory rates of taxation, despite the fact that these undermine the

[12]This would be the case unless (a) taxes on strategic inventory profits (and losses) are levied at a flat rate, (b) private inventory investments are entirely debt financed (in which case all inventory costs are fully deductible for tax purposes), (c) private inventory investments generate, in the long term, zero economic profits (expected net losses in periods of peace just equal, in present value, expected net profits in periods of war), and (d) private inventory losses in periods of peace lead to immediately rebateable negative tax liabilities. If these conditions are fulfilled, the inventory-profits tax will simply amount to governmental sharing in both the profits and losses of private stockpile investors, with the governmental share of losses just offsetting the governmental share of gains.

efficiency of private inventory investment.[13]

As noted, more general public policies may have similarly deleterious consequences for the performance of private speculative markets. While the effects of taxes specifically targeted on "windfall gains" of private speculators in periods of military mobilization would be especially adverse, even general income taxes, by driving a wedge between interest rates and rates of return to stockpile investment, would have the consequence of reducing levels of strategic inventories below their socially optimal levels. Thus, taxes, and especially income taxes, represent the most seriously intrusive element of public policy influencing private inventory investment.

In this regard, however, it is important to note that the effects of tax policy for strategic inventory investment are qualitatively no different than the effects for other categories of investment. Thus, strategic inventories cannot be assumed to be more suboptimal than, e.g., investment in other inventories or in physical plant and equipment. Moreover, to the degree to which these nonoptimally depressive effects of tax policy are compensated by other policy instruments (e.g., investment tax credits), there may be no net adverse consequences for rates of investment, including strategic inventory investments (assuming that these are also eligible for favorable compensatory treatment).

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[13]While the imposition of nonneutral taxes on speculative inventory profits may undermine the efficiency of *domestic* speculative markets, this need not imply that world speculative markets will be inefficient. Thus, if the domestic component of these markets is sufficiently small, exclusion of domestic speculators may have little consequence for the social optimality of global speculative activity. The key issue is the optimality of inventory supplies to which the nation has access in the event of hostilities, not the national identities of the legal owners of these, as long as access itself can be assured.

Apart from tax policy, other general governmental policies also influence inventory (including strategic stockpile) investments. In particular, tariffs, import quotas and other intrusions into international trade may significantly reduce inventories of primary materials for which foreign sources enjoy a comparative advantage. Conversely, subsidies to producers will inflate domestic supplies, thus lowering net-of-subsidy prices, currently and (through induced expansions of capacity) in the future. Whether this will induce increases in inventory levels will depend upon the relative reduction in present by comparison to expected future prices. Regardless of the consequences of subsidies to domestic producers for strategic inventories, however, these subsidies can be argued to be inefficient in their own right.

A plethora of other policies altering business costs (e.g., intrusions into financial markets which serve to influence interest rates) or constraining market functioning (e.g., insurance and securities regulation) will exert lesser, but possibly nontrivial, impacts on strategic materials inventory investments. Directly and indirectly serious consequences may flow from governmental policies which permit or even foster collusion among actual and potential inventory investors, since monopolistic elements in speculative markets will (a) reduce inventory investments, *ceteris paribus*, below what will be argued to be their socially optimal levels and (b) stimulate possibly effective attempts to raise the probability that a military contingency will in fact occur, thus raising expected monopoly profits. With reference especially to monopolistic cartellization but also to other constraints on market functioning, the persistence of these over time (i.e., into the "intermediate" term) almost inevitably

requires governmental acquiescence if not active governmental assistance, even if the origins are nongovernmental.

Finally, active governmental involvement in strategic stockpile accumulation will have severe consequences for the social efficiency of private inventory investment behavior. One of the most important implications of the simplified competitive inventory investment model developed in the preceding section is that, if private stockpile investments motivated by the anticipation of war are determined as indicated, then any attempt by the state (government) to augment private inventories by the accumulation of public stockpiles will be frustrated as a result of concomitant reductions in private inventories. This will result because previously marginal private investments will become unprofitable; the public stockpile reduces expected future prices relative to current prices, but only if the ratios of future to present prices are restored to their prior (pre-public-stockpile) levels will inventories be profitable (zero economic profit) for private investors. Thus, an announced intention of the state to release any given flow of material from the public stockpile in the event of war will correspondingly reduce the intended flows from private inventories.

In short, *if* the sole motivation for private inventories of strategic materials is the expectation of prospective military contingencies, then the accumulation of a public strategic stockpile will induce what can be anticipated to be precisely offsetting reductions in private inventories. This process will continue until the public stockpile has become so large as to reduce private inventory investments to zero. Only beyond that point will an increment in public stockpile holdings constitute a

corresponding increment in total national inventories.

The foregoing must be qualified somewhat when private speculative inventory holdings are motivated by the anticipation of contingencies other than war (or military contingencies more generally). Thus, to the degree to which private speculators, at the margin, determine inventory holdings in response to such nonmilitary contingencies as, e.g., adverse weather conditions, strikes or political events, private speculative investments will be relatively unaffected by the existence of a public stockpile *as long as* speculators do not anticipate losses in the event of military contingencies (resulting, e.g., from expropriation) and do anticipate that recourse will be made to the public stockpile only in the event of military contingencies. Conversely, were the public stockpile viewed as a general market-stabilizing device, from which the government would sell under any circumstances in which prices were believed to be above long-run equilibrium levels, then the public and private stockpiles would again become close substitutes, while the anticipation of expropriation in the event of hostilities would lead military contingencies to enter negatively into the determination of speculative inventories motivated (positively) by nonmilitary contingencies.

In fact, if private stockpiling is motivated entirely by contingencies unrelated to war or military hostilities, and if private speculators anticipate the release of public stockpiles only in the event of war, then the existence of public stockpiles may actually induce *increases* in private inventory investments. This paradoxical result could occur if private speculators viewed the existence of the public stockpile as significantly reducing the likelihood of governmental interference with the market

allocation of resources in the event of war. Anticipation of, e.g., expropriation or price controls and rationing in the event of a military contingency could, as noted, reduce inventories desired in anticipation of nonmilitary contingencies, while the existence of the public stockpile could possibly insulate these non-war-related inventories from uncertainties associated with the possibility of war. This positive effect of a public stockpile would be greater the higher the perceived probability of a military contingency. Apart from this "special case," however, public and private speculative inventory investments, to a greater or lesser extent, appear as substitutes.

4.2. Systematic Discrepancies between Private and Social Perceptions of the Determinants of Strategic Inventory Investment

If, apart from the foregoing class of divergences of actual from hypothesized private stockpile investment determination, the speculative private market functions as outlined, this leaves only one class of potential discrepancies between socially optimal and privately elected levels of strategic inventory investment. This relates to systematic differences between "true" and privately-perceived values of the variables determining rates of inventory investment. On the basis of the foregoing analysis five key determinants of competitive private inventory investments can be identified. Specifically, the competitive private stockpile will vary, *ceteris paribus*,

(a) directly with

(i) the probability of war, Z, and

(ii) the degree of war-induced demand and/or supply shift, and

(b) inversely with

(iii) the base- and future-period elasticities of demand and of supply (war- and peace-conditional),

(iv) the interest rate, and

(v) other inventory costs (storage charges, physical deterioration, etc.).

If perceptions of these factors by governmental authorities and by private speculators are identical, then the optimal stockpile from the vantage point of the state is identical to that which would be determined by a freely-functioning private, competitive market, insulated from governmental interference.

Of the foregoing determinants of competitive private stockpile investment, the last, noninterest inventory costs, would not be expected to lead to significant discrepancies between optimal public and private stockpile inventories, i.e., there is little or no reason to believe that social and private costs, or perceptions of these, would differ systematically. With reference to the other four, however, private speculative perceptions and "true" social values might well differ significantly, implying seriously nonoptimal (in general, suboptimal) levels of strategic inventories. This is especially likely with reference both to the supply-demand related variables and also to the probability of a military contingency, because strategic considerations may lead to significant efforts on the part of governments to mislead systematically potential

opponents and also, by default, potential speculators, thus magnifying any independent sources of private speculative error. Finally, as a result of capital (and possibly insurance) market imperfections, significant discrepancies may be observed between private and social discount (interest) rates.

Of these determinants of competitive private stockpile investments, the war-conditional demand and supply shifts are likely to be most critical; any divergence of private expectations from true values will have probably severe consequences, manifested in serious discrepancies between the privately-elected and socially-optimal level of strategic materials inventories. Moreover, misperceptions of war-conditional demand and supply shifts are likely to be closely related to (and generally indistinguishable from)[14] misperceptions of elasticities of demand and supply, i.e., a high elasticity of demand, *ceteris paribus*, is likely to imply the existence of close substitutes, with the consequence that war-induced shifts in functional requirements will be distributed over demands for a number of highly substitutable commodities, implying a relatively modest demand shift, while a low elasticity of demand will suggest the absence of close substitutes and thus the likelihood of significant war-conditional demand shifts (unless, in either case, the material in question is not required, directly or indirectly, as a significant input into military capabilities).

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[14]Demand (supply) shifts and elasticity differentials will be operationally equivalent in the sense that any given war- *versus* peace-conditional price differential observed under a regime of competitive private stockpile investment could be generated by a virtually infinite number of combinations of (a) demand (supply) function shifts and (b) elasticities of demand (supply), with reductions in elasticities compensating for reductions in the magnitude of functional shift. Thus, in their effects these factors are equivalent.

Discrepancies between "true" war-conditional developments and perceptions of these on the part of private speculators concerning war-conditional supply and (especially) demand shifts are particularly likely, simply because differences between war-time and peace-time demands for and supplies of strategic materials are likely to be due primarily to directly conflict-related military demands and supply disruptions. If full information concerning war-conditional military demand and supply prospects were available to private speculators, then (assuming public and private coincidence with reference to all other relevant factors) optimal public and private stockpiles (inventories) would coincide. However, strategic considerations may lead to restrictions on the dissemination of information concerning war-contingent supplies and military demands for specific materials. To the degree to which such information is classified, withheld from private speculators, governmental predictions of war-conditional market conditions, e.g., military demands, may be very different from, and in general significantly "tighter" (as exemplified by higher demands, lower supplies, and hence higher prices) than, private speculative predictions. In short, private speculators would be especially likely to fail to anticipate particular, secret uses of specific materials and probable unavailability of particular sources of supply.

In this situation the government is confronted by a difficult dilemma. Specifically, it can either (a) reveal to private speculators classified information the secrecy of which is deemed to confer strategic military advantages or (b) attempt to compensate for nonoptimally small private inventories by accumulating a public stockpile. In the first case, it will inevitably reveal strategic information not only to private

speculators but also to potential adversaries. But, if the government elects to accumulate a publically-owned stockpile, it will risk (a) indirectly revealing, through its stockpile purchases, information which it had wanted to remain secret, or, if secrecy concerning prospective military demands is maintained, (b) inducing offsetting reductions in private inventories. In order both to maintain secrecy and to avoid eroding private inventories, the government might attempt to conduct its stockpile acquisition activities (purchases) themselves in secrecy. However, in the event of significant stockpile demands on materials markets, secrecy may well be impossible to maintain. Hence the dilemma of governmental intervention to accommodate systematic discrepancies between true and speculatively anticipated war-conditional demands for strategic materials.

While there may be no easy resolution of this dilemma, it is likely that it is more apparent than real. Especially in light of contemporary intelligence capabilities, it is probable that attempts at secrecy will be more successful *vis-a-vis* actual and potential speculators than *vis-a-vis* actual and potential military adversaries. Thus, a policy of full disclosure of information concerning prospective war-conditional materials demands would be unlikely in fact to confer strategic advantages on prospective adversaries, while it would permit private speculators, *ceteris paribus*, to accumulate socially-optimal inventories of strategic materials.

The possibility of systematic private speculative error in the estimation of the probability that a military contingency will occur raises issues virtually identical to those confronted with reference to private

misconceptions of war-conditional military demands for strategic materials. If assessments of speculators are significantly above or below the true probability of war, then private strategic inventories will be excessively large or small, respectively. If all information relevant to the assessment of the probability of war were in the public domain, then there would be no reason *a priori* to believe that a discrepancy between governmental and private perceptions of this probability would be attributable to "private error," but full information may well not be available, simply because diplomatic and strategic considerations may lead to restrictions on the full disclosure to private speculators (and to adversaries) of information relevant to the assessment of the probability of war. In this event market-determined private inventories of strategic materials may well diverge significantly from the social optimum. Again, however, it is likely that restrictions on the availability of information are more effective *vis-a-vis* prospective market participants than prospective opponents. Thus, a policy of full disclosure can be argued to be the appropriate response to private speculative error.

Especially with reference to the probability that a military contingency will occur, given full disclosure by the government of all information relevant to the assessment it is not clear *a priori* that any discrepancy between governmental and private estimates of the probability will reflect a private error. That is, the true probability of war may be miscalculated by the government as well as by private speculators. In the absence of compelling evidence to the contrary, there would appear to be no reason to embrace such a discrepancy as indicative of market failure.

The issue of "moral hazard" inevitably arises in connection with the anticipated probability of war or other military contingency. Specifically, given any level of stockpile inventories, an increase in the probability of war will increase the value of stockpile holdings, as reflected in capital gains to inventory owners. As long as stockpile speculation is competitive, there is no incentive for the individual speculator to act, alone or in concert with other speculators, to bring about an increase in the probability of war. However, a monopolistic speculator (or speculative cartel) will increase his expected profits if he can act to raise the probability of war. Thus, in any case in which speculative markets are noncompetitive, the probability of war itself may be manipulated to enhance expected speculative profits.

In general, however, there is no reason to anticipate the presence of significant noncompetitive elements in strategic material inventory markets. In the absence of governmental restrictions, barriers to entry would be expected to be slight or nonexistent. Economies of scale, which are generally identified as sources of concentration, would be especially unlikely, since physical storage represents the only real current economic activity. Finally, commodity markets are sufficiently highly developed to encourage recurrent entry into and exit from these markets. Thus, the reasonable presumption is that these markets will exhibit relatively high degrees of competition.

The problem of moral hazard enters in a particularly complex manner when government itself acts as the stockpile inventory investor, especially in cases in which either private speculative stockpile inventories are fully displaced through substitution of public for private

holdings or in which the operation of the private speculative market is vitiated by the threat of governmental expropriation or price controls and rationing. With government as the sole strategic stockpile investment agent, the very existence of the stockpile may act to increase the probability of war, especially if the size of the stockpile is excessive *vis-a-vis* the social optimum (determined by the true *ex ante* probability of war, i.e., that probability which would be observed were responsibility for strategic inventory investment vested in an efficiently functioning private speculative market). Because the excessive size of stockpile inventories reduces the dislocations which would be encountered in the event of war, the willingness of government to pursue policies which raise the likelihood of war may be increased.

Conversely, from a game-theoretic point of view the excessive size of the governmentally-owned stockpile may reduce the willingness of potential adversaries to initiate or enter into hostilities, since the probability of victory/defeat will depend upon the resources (including strategic inventories) available to the contending parties. Whether this effect will fully (or more than fully) offset the proconflict influences of a more confrontational foreign policy is, of course, uncertain. Thus, it is difficult to determine, *ex ante*, even the direction of the effects of the size of the strategic stockpile on the probability of war. However, it can be noted that, whatever the beneficial effects of excessive stockpiles on the behavior of potential adversaries, these effects could be more efficiently achieved by a policy of announced governmental commitment to the maintenance of military capabilities, in times of both peace and war.

With reference to the potential implications of the size of the strategic stockpile for the probability of victory or defeat in the event of hostilities, the question of whether these implications should not be explicitly considered in the determination of the socially optimal strategic stockpile arises. However, given the economic resources available to the nation in current and future periods, the desire to avoid defeat or to achieve victory will be reflected in the peace- and war-conditional military demands for resources and hence are already taken into account, implicitly, in the determination of the optimal competitive private (and social) strategic stockpile inventory. One possible exception, related to externalities associated with *private nonmilitary* demands and resource utilization in the event of war, is discussed below.

Returning to the prospect of moral hazard and of prospectively excessive strategic inventories when inventory accumulation is the province of a governmental monopoly, the situation is probably worse than that which would be anticipated in the event of private monopoly because of the bureaucratic incentives confronting the various involved governmental authorities and of the interactions between these authorities. If each group, e.g., stockpile authorities, military authorities and foreign policy authorities, attempts to maximize its budget and influence, subject to constraints, then actions of each become mutually reinforcing. An excessive stockpile loosens the constraints (anticipated dislocations) associated with prospective conflict, permitting foreign policies exhibiting higher risks of military confrontation, while these risks necessitate greater military preparedness, etc.

This situation would not be cause for serious concern *if* each of the relevant parties were acting independently and *if* the action of each were socially optimal, conditional on the actions of the others. However, it is clearly the case that stockpile authorities will have every incentive (enhancement of bureau size, budget, etc.) to accumulate stockpiles which exceed the social optimum, that similar incentives will confront defense and foreign policy officials, and that collusion between defense, foreign policy and stockpile bureaucracies will permit joint maximization at what may be especially pronounced social suboptima (as exemplified, in this case, by excessively high strategic inventories, inflated military capabilities, and confrontational foreign policies).

In short, a necessary (but not sufficient) condition for socially optimal stockpile, foreign policy and military decisions is that decisions in each domain be made by effectively independent parties, with each party's decisions conditional only on knowledge of the decisions made in the other domains and of the relationship of these "other-party" decisions to "own" decisions. This is clearly more likely, in the case of strategic stockpile decisions, if decisionmaking responsibility is decentralized and privatized, especially since the allocation of responsibility to private markets can be argued to result in an at least approximately socially optimal strategic inventory configuration.

Returning to the key determinants of strategic material inventories, the final dimension in which there may be a significant discrepancy between private and social (true) values of a relevant variable involves the discount or interest rate. To the degree to which the effective interest rates confronted by private speculators, inclusive of market-

determined risk premia, exceed the social discount rate, profit-maximizing private stockpile inventories will fall short of the social optimum. As in the case of general income taxes, however, this will be true of the relationship between actual and optimal investments of all types, strategic inventory and other; similarly, to the degree to which these discrepancies between private and social discount rates are compensated by appropriate public policies, e.g., investment tax credits, then conditions for optimality of private inventory accumulation will have been restored. In short, this discrepancy implies either a general problem related to the optimality of all investment or will have been appropriately compensated by other means.

It might be thought that the risks associated with private strategic inventory investments, e.g., the risks of unanticipated price changes and especially the "risk" that war (and consequent price increases) will *not* occur, would be reflected in substantial risk premia incorporated in interest rates confronting private strategic inventory speculators. However, in principle, and to a significant degree in fact, this risk can be both shifted to those most willing to bear it (to the most risk neutral, or, less plausibly, risk seeking) and also pooled across contingencies (reducing the magnitude of the variance of expected returns, the principle measure of risk), and hence would not be expected to be reflected significantly in the interest rate confronting private speculators. Of course, unless this risk (variance in expected returns) can be reduced to zero or the residual risk can be shifted to risk neutral market participants, the residual risk will have at least some depressive effect on private strategic inventory investments. However, if the residual risk is small, then

the replacement of profit maximization by utility maximization on the part of private investors, due to the presence of risk aversion, should have only minor consequences for levels of strategic inventories. Moreover, the depressive effects of risk aversion on strategic inventory investments should be no greater than the depressive effects of risk aversion on other classes of investment.

In short, the risks associated with strategic inventory investments are of an inherently insurable variety, implying that these can be both reduced by pooling and shifted to the most risk neutral of potential market participants, As a result, approximately optimal private stockpile investments will equate the preset values of expected prices (net of noninterest inventory costs) in all future periods, with the interest rate entering into the discounting of expected future prices incorporating only a minor component related to risk (variance in returns) while the probability of war (and other factors influencing the mean and variance of expected prices) will enter primarily through their influence on mean prices expected in any future period.

The judgement implicit in the foregoing, that, subject to various qualifications, competitively determined private stockpile investments will be socially optimal, assumes that no externalities are associated with the private pattern of final demand as determined, whether in peace or war, subject to the market interactions of demand (as augmented by competitively-determined private stockpile investment) and supply (as augmented by competitively-determined private stockpile disinvestment). This may not, however, be the case.

Private consumption of certain commodities the demands for which are highly elastic with respect to either price or total consumption may decline significantly in response to the civilian austerity imposed in time of war and to price increases associated with shortages even when these are conjoined with optimal private stockpile accumulations. While these declines would represent utility-maximizing private responses to war-induced changes in relative prices and rates of consumption, because of potential negative externalities associated with reduced consumption certain specific changes in consumption might have seriously nonoptimal social consequences, as, e.g., if tire purchases fell, due to high prices, to a point that tire failures led to a significant rise in auto-related mortality and injury. Even here, however, other governmental policies would more efficiently respond to these externalities. Thus, for example, in the case of nonoptimally low private demands for tires, efficient liability rules would serve either to stimulate war-contingent demands for tires, hence increasing the level of the competitive private stockpile, or to reduce driving in a period of war. Thus, it is difficult to imagine specific cases in which adjustments of private demand to war-time austerities would be necessarily undesirable, assuming optimality of other, related public-*cum*-private policies. However, at least the possibility of negative externalities should be entertained, providing a potential source of divergence of the competitive private stockpile from the

socially-optimal level of strategic inventory investments.

4.3. Private Strategic Inventory Investment and Social Optimality: A Reprise

In summary, competitive private investments in strategic material inventories would be determined with reference to (a) the probability of war in each future period, (b) anticipated peace- and war-conditional configurations of demand and supply for all materials, taking into account both anticipated war-conditional shifts from civilian to military final demand, as induced by tax and expenditure policies anticipated in the event of war, and also substitution possibilities in production and end use, (c) the interest costs of inventory investment, and (d) other costs associated with strategic inventory holdings (storage, deterioration, etc.). The socially optimal stockpile investment will differ from competitive private investments in strategic inventories only if private perceptions-*cum*-expectations of these differ systematically from true social values and/or if significant externalities are associated with private war-conditional rates of utilization of strategic materials.

Even if competitive private stockpile investments and stocks would be, in the absence of constraint, socially optimal, the functioning of the competitive private inventory market may be seriously impaired if private speculators anticipate the expropriation of scarce supplies (or other interferences with private market allocations, e.g., imposition of price controls and concomitant rationing) in the event of a military contingency. Considerations of short- or intermediate-term changes in the distribution of income or wealth may encourage direct (expropriation,

price controls and rationing) or indirect (income, profits, windfall profits tax) governmental intrusion into private strategic inventory markets, notwithstanding the fact that, on average and over the very long run, private strategic material speculation will not generate excessive profits; as a result, the government may not find it politically feasible or desirable to provide the guarantees of market nonintervention which would be required if private strategic stockpile investment were to be encouraged, even if the level of private investment which would result were judged to be socially optimal.

5. Contemporary U.S. Strategic Stockpile Policy: A Critique

The general conclusion of the foregoing analysis is that, in general, the level and configuration of strategic inventories which would be elected by an efficiently functioning private speculative market would also be socially optimal (subject to certain exceptions and qualifications, exceptions and qualifications which could be accommodated by policies other than governmental intrusion into strategic inventory accumulation). Thus, the objective of governmental stockpile policy, for whatever reasons it is undertaken, should be to simulate as closely as possible what would otherwise be the private competitive outcome. However, it will not, in general, be possible for government simply to enter into the strategic materials market solely to augment what are perceived to be nonoptimally small private inventory holdings, simply because the governmental attempt to augment strategic inventories will induce offsetting changes in private inventory holdings.

The most serious failure of contemporary procedures for the formulation of U.S. strategic stockpile policy is that these procedures totally ignore pre- and post-mobilization reactions of private inventory behavior to governmental intervention. Premobilization reactions will be especially important, in that governmental intrusion will (a) immediately alter current materials prices and (b) will alter expected future prices as a result of flows from governmental inventories.

Of these premobilization reactions, the first effect (i.e., the response to rises in current-period prices) will be observed in any period in which net additions are made to the strategic stockpile, *if* the short-run elasticities of supply are less than infinite.[15] In contrast, the second effect (i.e., the response to anticipations of future price reductions resulting from future flows from the stockpile) will be observed even in periods in which no net additions to the strategic stockpile are undertaken.

The potential negative private effects of net additions to the strategic stockpile raise questions concerning optimal strategies of stockpile acquisition, involving such issues as the relative degree of reliance to be placed on spot markets, futures markets and long-term supply contracts, etc. For example, if supply is highly price-inelastic in the short run and if expectations of future prices are highly correlated with current prices, then governmental entry into spot markets when demand is low, by maintaining levels of current (and hence of expected future) prices, may

[15]While the primary response to price increases resulting from stockpile acquisitions will be exerted in the period of the acquisition, lesser effects will also be exerted in other periods, due to the intertemporal shift of private purchases in response to the price increases resulting from stockpile investments.

result in relatively little depression in private inventory demands. Similarly, if long-run supply is highly elastic while short-run supply is inelastic, a strategy of stockpile accumulation that relies heavily on long-term supply contracts or futures markets will minimize the effect of strategic stockpile accumulations on private markets. Although the serious analysis of these issues is beyond the scope of the present paper, it is important to note that they are subsidiary to and virtually independent of the more basic issues raised by the second class of premobilization reactions, induced by expectations concerning net withdrawals from (rather than additions to) the strategic stockpile.

The magnitude of the response to the anticipation of lower future prices associated with prospective stockpile outflows will depend upon (a) private motives for inventory accumulation and (b) private expectations concerning the circumstances under which net outflows from the strategic stockpile will be made by the Federal government. If, *at the margin*, private inventory holdings are determined entirely by considerations unrelated to expectations concerning future military mobilization and its economic consequences, and if net withdrawals from the strategic stockpile are anticipated *only* in the event of military mobilization, then the existence of the strategic stockpile will have little or no influence on the level and composition of private holdings of strategic materials. If, however, either of these conditions is not met, then the very existence of the strategic stockpile will induce offsetting reductions in private holdings, reductions potentially equal in magnitude to the strategic stockpile holdings.

This possibility, of partially or fully offsetting reductions in private inventory holdings as public holdings are increased calls into question the very rationale for the establishment of a publically-owned strategic stockpile. The critical issues here involve private expectations and motivations, neither of which is even considered in the current formulation of strategic stockpile objectives. Current policy seems implicitly to assume that military considerations and the anticipation of military mobilization are of no importance in the determination of private inventories of strategic materials and that private parties anticipate flows from the strategic stockpile only in the event of military hostilities and mobilization.

With reference to many materials widely used in the civilian economy, the first of these implicit assumptions, that private holdings are not motivated by military considerations, may be justified. However, with reference to materials predominantly used in military production, this assumption is probably quite unrealistic. In this case, as has been discussed, if the governmental objective is to bring about inventories of strategic materials greater than would be held voluntarily by private investors, then it will be necessary for the government to totally displace the private sector, acting effectively as the sole holder of strategic inventories. This suggests a distinction not currently made in the formulation of strategic stockpile objectives, between those materials the private holdings of which are determined primarily without regard to anticipated military demands and those for which military demands represent the predominant motivation for both public and private inventory holdings. Very different approaches to the formulation of strategic

stockpile policy and objectives will be appropriate in these alternative cases.

Even if private holdings are determined primarily without regard to prospective future military demands, any private expectation that flows from the strategic stockpile will be utilized to augment availabilities under circumstances not related to military mobilization will result in reductions in desired private inventory holdings. Thus, if it is anticipated that the strategic stockpile will be utilized to stabilize markets even in the absence of military mobilization, then the existence of the stockpile will reduce desired private holdings. In this connection, it can be strongly argued that the effectiveness of the strategic stockpile with reference to its primary function, the augmentation of economic capabilities in the event of war, has been significantly eroded over the postwar period, as repeated recourse has been made to strategic stockpiles for purposes of general market stabilization and supply augmentation.

Although the political pressures to utilize the strategic stockpile to alleviate shortages unrelated to military mobilization can be well understood, the adverse consequences of this practice can be clearly demonstrated and should be strongly argued by those authorities responsible for the formulation of strategic stockpile policy. If it is determined that it is desirable for the federal government to intervene to stabilize markets in the event of instabilities not involving military mobilization, then the conduct of this (even more difficult) function should be totally separated from the formulation and execution of strategic stockpile policy. Unfortunately, all of the incentives confronting strategic stockpile

authorities will be in the direction of consolidating military and civilian stockpile activities, notwithstanding the fact that pursuit of the second will inevitably imply a sacrifice of the first.

In short, current strategic stockpile policies rest upon very tenuous foundations, with reference to both premobilization and postmobilization economic behavior and consequences. To a significant extent, however, strategic stockpile policy may become a selffulfilling and selfjustifying prophecy precisely because of these weaknesses. Thus, if the accumulation of a federal strategic stockpile leads to offsetting reductions in private inventories, the deficiencies of private inventories will constitute *prima facie* (but false) evidence of the necessity for a publically-owned inventory of strategic materials. Similarly, in the event of military mobilization, if the level and composition of the strategic stockpile is known, then, on the basis of anticipated flows of material from the stockpile, those materials of which there are large stockpiles will be substituted for others, creating precisely those "shortages" which are then "alleviated" by drawing on the strategic stockpile. Thus, after the fact, it will be difficult or impossible to determine the true efficacy of strategic stockpile policies. In effect, cause and effect are reversed: *Shortages are not anticipated in the formulation of stockpile objectives, but stockpile objectives (through their pre- and postmobilization impacts on private behavior) give rise to shortages which the stockpile then mitigates.*

This selffulfilling-prophecy characterization of strategic stockpile policy is simply an extreme instance of what can be argued to be a general problem: Although current procedures for determining stockpile

objectives assume that, in the event of military mobilization, the configuration of the economy (of materials requirements and availabilities) will be given independently of the strategic stockpile, in fact the existence of the stockpile will influence the configuration of the economy. Clearly, if certain "requirements" cannot be met, then some adaptation will be made, at greater or lesser cost or sacrifice of objectives, and these "requirements" will thus cease to be requirements. Correspondingly, in an environment of general shortage availabilities from the stockpile will either reduce resources devoted to the generation of supply from other sources or will induce increased utilization ("requirements").

These considerations suggest a possibly interesting and useful reversal of the procedures currently employed in the formulation of federal strategic stockpile policy. Rather than stipulating a configuration of the war-mobilization economy, on which basis stockpile objectives are determined, instead the level and configuration of the stockpile could be stipulated, on which basis the resultant configuration of the economy would be identified, taking into account both pre- and postmobilization reactions to the existence of the stockpile. Variations in the composition of the stockpile could then be translated into variations in the ultimate economic configuration. With this approach, the consequences of, e.g., increasing stockpile holdings of a particular material could be predicted, permitting an assessment of the benefits, direct and indirect, relative to the costs entailed.

The point of this proposal for a reversal of current practice is, simply, that the purpose of the strategic stockpile is to increase economic capabilities in the event of military mobilization, while current procedures assume capabilities in deriving stockpile objectives. Although "benefits" (gross if not net) may well be associated with increased stockpile holdings, current procedures provide no basis on which to estimate these benefits or the associated costs. Only if the benefits and costs can be identified and quantified can the optimality of stockpile policy be assessed and desirable changes in policy be undertaken.

The foregoing leads directly to the fundamental issue of stockpile policy. The general objective in the determination of stockpile policy must be to achieve an optimal (or more optimal) configuration of the economy in the event of military mobilization than would be achieved in the absence or alteration of the strategic stockpile. Although current procedures assume α configuration of the economy, for the realization of which required stockpile holdings are determined, there is no evidence that this configuration is socially optimal, or is more optimal than that which would be achieved were no strategic stockpile to be maintained. Until this is demonstrated, the real social benefits deriving from the existence of the stockpile, if any, cannot be determined.

6. Conclusion

Implicitly underlying contemporary strategic stockpile policy is the apparent perception that the inventories of strategic materials which would be held by private speculators in anticipation of war would in fact be nonoptimal from either a social or governmental perspective. Thus,

either the private speculative solution must be deemed to be nonoptimal as a result of one or more of the factors discussed above (e.g., systematically biased information available to private speculators concerning either the probability of war or war-conditional military demands for strategic materials, private interest rates above the social discount rate, or externalities associated with private wartime utilization of scarce materials), governmental action necessary to permit private achievement of socially optimal inventories (e.g., guarantees of nonintervention into market resource allocations even in times of military hostilities) must be considered politically infeasible (e.g., as a result of the short- or intermediate-term redistributions of income and wealth which would occur in the event of war), or, finally, criteria which would not be reflected in optimal speculative private investment must be deemed (by government) to be relevant to the determination of desirable strategic stockpile inventories.

If governmental action is motivated by private speculative market failure resulting from either of the first two factors just indicated, then the appropriate objective of governmental strategic stockpile policy must be to simulate the solution which would be achieved by efficient private speculative markets, taking into account the probable displacement of private by public stockpile inventories. In this event, the evaluation of current procedures for determining governmental strategic stockpile objectives (target inventories of all relevant materials) is conceptually straight-forward. First, are these strategic stockpile objectives appropriately sensitive to the various factors which would enter into the determination of speculative private inventory holdings? And

second, is the probable displacement of private by public inventories adequately recognized in the determination of governmental stockpile objectives?

The foregoing assumes that the private competitive solution, with qualifications, would in fact represent the socially optimal investment in strategic inventories. The conclusion of the preceding analysis is that, in welfare-economic terms, this would indeed be the case. However, *socially* and *governmentally* optimal strategic inventory investments might well diverge. In consequence, even if current procedures for determination of strategic stockpile objectives were found not to conform to those which would be represented in the socially optimal private speculative solution, this would not constitute *prima facie* evidence that actual procedures are inappropriate from a more narrowly governmental perspective. Thus, the evidence that current procedures are seriously inadequate from a social perspective does not negate the possibility that these procedures are desirable when evaluated with reference to divergent governmental objectives. The issue then, of course, concerns the legitimacy of such divergences between social and governmental "optimality," should they actually be found to exist.

Finally, even assuming a correspondence between social and governmental objectives, the finding that the criteria which would be reflected in the strategic inventory investments of an efficient private speculative market are not represented in the determination of governmental stockpile objectives might indicate only that the analytical and computational demands which would actually be associated with an attempt to simulate the private speculative solution are simply so great as to render the

attempt infeasible or, if feasible, so costly that the costs exceed any possible benefits which would result from otherwise more optimal strategic inventory holdings. Even if this conclusion should be reached, however, it is important to consider the possible desirability of representing more adequately the relevant private speculative solution criteria in more feasible "second-, third-, ..., n*th*-best" procedures for determination of public stockpile objectives.

The fundamental conclusion of this analysis, however, is that effectively all of the possible objections to an explicit and overt policy of reliance on private speculative markets for the determination of strategic materials inventories are extremely weak, resting on superficial perceptions rather than serious analysis. Moreover, even those possibly significant objections (e.g., externalities associated with private material use) could be met by means other than the displacement of private by public responsibility for strategic inventory accumulation.