

Rivalry, Reaction, and Weapons Proliferation: A Time-Series Analysis of Global Arms Transfers

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This article analyzes the competitive dynamics in global arms transfers from 1951 to 1995. I discuss the enduring forces behind the proliferation of military capability during the Cold War and other historical periods, and then consider the competitive dynamics characteristic of the superpower rivalry itself. The process of military-technological advance, along with the dynamics of enduring interstate rivalry, lead us to expect certain patterns in quantitative data representing arms-transfer levels over time. Concepts in time-series analysis—cointegration and error correction—are helpful for understanding competitive arms-transfer policies during the Cold War, and I apply the relevant analytical tools to test for the hypothesized patterns in the empirical data. American and Russian, as well as NATO and Warsaw Pact, arms transfers are examined at three levels of regional aggregation: the Third World as a whole, the Middle East security complex, and the Persian Gulf subcomplex. The evidence shows that arms transfers by the Cold War rivals moved together in patterns consistent with competitive policy making in an environment of military-technological change, and that one or both sides adjusted their supply policies to correct for deviations from a moving equilibrium. This describes an action-reaction process, but a loosely coupled one deriving from military-technological uncertainties, the complexities of regional security dynamics, and the multidimensional character of the Cold War competition.

The end of the Cold War rivalry witnessed a substantial drop-off in the transfer of weapons worldwide. Much of the decline was due to the collapse of the Soviet Union, but in recent years Russia has been more actively courting potential foreign purchasers of its military hardware, signaling an interest in resuming its former role as one of the world's two preeminent arms exporters. Although the superpowers once evenly split about three-fourths of the global arms trade, the United States by itself accounts for just under half of all exports since 1996, while Russia's share is but 15% (Hagelin et al., 2001). Will we see, as a consequence of the former superpower's desire to get back into the game, a resumption of the global competition in American and Russian arms transfers? If so, and assuming

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that this is not accompanied by a second Cold War, the dynamics of this arms-transfer competition are likely to be quite a bit different from what they once were (Trenin and Pierre, 1997). However much we would like to speculate about that, the fact is we know relatively little about the systematic components of the superpowers' arms-transfer competition in the Third World. Were there indeed consistently competitive dynamics in the arms-supply policies of the two superpowers and their respective Cold War alliances? How intense were these competitive dynamics and how widespread?

The competitive dynamics in Cold War arms transfers have been little analyzed, but roundly condemned. Like other more direct forms of arms competition, they were condemned for being the outgrowth of reactive, even mechanistic, policies adopted by global rivals who "did not stop to think" (Richardson, 1960:18). When the superpowers did stop to think, their arms-transfer policies were guided first and foremost by a desire to gain advantage in their global chess game, and not by the true interests of their clients, particularly those in the Third World, where the supplied weaponry was most often put to use and where the consequences were most fully felt (Ayoob, 1995:ch. 3). Even though I don't dispute such indictments of the Cold War arms trade, at least many of them, here I will focus specifically on the characteristics of the superpowers' arms-transfer competition itself, and not on the implications for regional security (or insecurity) in the Third World.¹

The first half of the paper discusses the enduring forces behind the global diffusion of military capability during the Cold War as well as other historical periods, and then considers the competitive dynamics characteristic of the superpower rivalry itself. Drawing on some key insights found in the literature on the evolution of the global arms production and transfer system, I argue that the process of military-technological advance, along with the dynamics of enduring interstate rivalry, lead us to expect certain patterns in quantitative data representing arms-transfer levels over time. I want to suggest that concepts in time-series analysis—cointegration and error correction—are helpful for understanding Cold War arms transfers, and very possibly the contemporary arms trade as well.

In the second half of the paper, I apply the relevant analytical tools in an effort to discern the hypothesized patterns in the empirical data. American and Russian, as well as NATO and Warsaw Pact, arms transfers are examined at three levels of regional aggregation: the Third World as a whole, the Middle East security complex, and the Persian Gulf subcomplex. The evidence does show that arms transfers by the Cold War rivals moved together in patterns consistent with competitive policy making in an environment of military-technological change, and that one or both sides adjusted their supply policies to correct for deviations from a moving equilibrium. This describes an action-reaction process, but a loosely coupled one deriving from military-technological uncertainties, the complexities of regional security dynamics, and the multidimensional character of the Cold War competition.

Interstate Rivalry and the Diffusion of Military Capability

The primary means by which military capability diffuses throughout the international system is the arms trade. Although the transfer of weapons, as well as the transfer of the technology and know-how necessary to produce them, has been a continuous process, some analysts have argued that historical ebbs and

¹ On the impact of arms transfers on interstate conflict in the Third World, see, for example, Brzoska and Pearson (1994) and Neuman (1986). For the impact on internal ethnopolitical conflict, see Sislín and Pearson (2001). Formal statistical examinations include, at the global level, Craft (1999) and, at the regional level, Sanjian (1998, 1999), Kinsella (1994, 1995), and Kinsella and Tillema (1995).

flows in the diffusion of military capability conform to identifiable patterns. Krause (1992), for example, sketches three waves in the arms transfer and production system. The first wave began with the so-called Military Revolution of the 15th century and lasted until the 17th century. This was followed by a two-century period of relative stasis in military-technological development. Arms were produced and traded, of course, but the pace of technological change was slow in comparison to the preceding period, and especially subsequent periods. The second wave began in the middle of the 19th century and was associated with the rapid advance of the Industrial Revolution. There was no period of technological stability between the second wave and the current third wave; rather, the end of one and the beginning of the next were condensed by the transformative event of World War II.²

Within each of these three historical periods, Krause identifies a similar evolutionary dynamic consisting of five phases. In phase one, significant military-technological innovation is realized by a select group of states that then become the leading centers of global arms production. In phase two, rising demand for advanced weaponry produced by this first tier drives a rapid expansion of the arms trade and, in phase three, rising demand for arms-production technology accompanies the demand for finished systems. This gives rise to a second tier of arms-producing states able to manufacture a wide range of military equipment, including the most advanced systems, but generally limited in their capacity to innovate at the military-technological frontier. Next, in the fourth phase, the international arms market becomes characterized by fiercer competition among a larger number of suppliers. The transfer of arms accelerates, as does the diffusion of arms production capacity, and there now emerges a third tier of weapons-manufacturing states. Capacity varies in the third tier, but a common characteristic is the need to import designs, machinery, and often the key components necessary for domestic production of the most technologically advanced systems, if such systems can be produced at all. In the fifth and final phase, military-technological diffusion slows and the arms-production hierarchy solidifies (Krause, 1992:26–32).

Although this evolutionary pattern has been repeated in three waves during the history of the contemporary state system, it is also the case that the second iteration was more compressed than the first, and the third—which some would argue is now yielding to a fourth—has been shorter still. Analysts debate the nature, timing, and historical import of particular military-technological innovations, including whether they count as having triggered revolutions in military affairs (see, for example, Hundley, 1999; Krepinevich, 1994). Without weighing in on the merits of one side or another in these disputes, Buzan and Herring (1998:12) have made a compelling argument that the mid-19th century—the height of the Industrial Revolution and the outset of Krause's second wave of military production and trade—demarcates the beginning of the period of *frequent* military-technological change:

The historical norm has reflected a pace of technological innovation so slow that the continuity of weapons systems has been more conspicuous than their transformation. . . . By the middle of the 19th century, a fundamental transformation in military technology was under way. The industrial revolution, with its ever expanding use of energy and machinery in the process of production, had by this time developed such momentum that major changes in technology began to occur frequently. From around the middle of the 19th century, a new norm of frequent change asserted itself. That norm still prevails. It shows little sign of weakening, though it is beginning to assume a new form.

² Historical treatments of the evolution of arms production and trade can be found in Collier (1980), Parker (1988), O'Connell (1989), and Van Creveld (1989), among other works.

Whatever the timing and nature of specific advances in weapons performance (firepower, mobility, communications, etc.), in the modern period, military planners have come to expect that significant military-technological innovation will not be occasional in the sense usually associated with revolutionary change, but will be recurrent (see also Thee, 1990).

These expectations of frequent change are important because they condition arms-transfer decision making. In an important sense, arms transfers have a leveling effect. The bulk of high-technology-weapons manufacturing takes place in the first and second tiers of the global arms production system. Fortunately, from the perspective of states outside this core group that perceive a need for advanced weaponry, these can be acquired in the international arms market. For a host of reasons ultimately related to the security dilemma—e.g., the proliferation of independent states in the wake of decolonization and persistence of regional rivalries—the demand for this weaponry has remained rather high throughout the post-World War II period. Many states would like to develop their own arms production capacities, but the industrial and technological hurdles are often too high to clear while at the same time attending to the immediate requirements of national security, as the experiences of many third tier producers show (Anthony, 1993; Brzoska, 1999; Parker, 1999). Competition among arms suppliers, characteristic of the mature phases of the evolutionary dynamic just described, means that this demand for advanced weaponry will generally not go unmet.

If this were all there was to it, we might expect that the pace of technological change would return to “normal” levels after a military innovation, even a revolutionary one, has worked its way through the arms production system. But the leveling effect of the arms trade provides a stimulus for further technological advance among the group of leading states, for this becomes their primary means of maintaining military advantage in an international system where access to modern weaponry is increasingly widespread. Thus, the process comes full circle: states perceive threats to their security within an environment of military-technological advance, which generates demand for new weaponry, and the proliferation of this weaponry via the international arms market further erodes state security, generating incentive for continued military-technological innovation.³

Buzan and Herring (1998:50–51) suggest that a technological imperative is a key force behind this process of global military-technological diffusion, but they do not conceive of this as a deterministic process. Technological advances are not exogenous events that trigger automatic efforts to capture and “weaponize” new technologies. They instead grow out of interactions between and within states that, intentionally or unintentionally, help to shape the general course of technological progress.⁴ This is a conceptualization that incorporates more than the iconic lure of new technology in military procurement. Of course, that lure is ever-present in the procurement decision-making process, in the governments of both industrialized and industrializing countries (Kaldor, 1981; Wendt and Barnett, 1993; Eyre and Suchman, 1996). The Cold War competition was, in a

³ The nature of technological change is much discussed in economics. One view, which can be traced back to Joseph Schumpeter (1934), emphasizes the importance of sudden and qualitative leaps in technology that have a transformative impact on economic practices and institutions. This view is consistent with the sorts of military-technological developments identified by Krause (1992) as ushering in new eras in the global arms production and transfer system. Another view stresses the gradual and incremental nature of much technological change and has given rise to evolutionary theories in which technological and economic development are in a dynamic relationship. Useful discussions of these and other perspectives include Hagedoorn (1989) and Elster (1983).

⁴ How best to represent the forces driving technological change can be put in terms of a market-pull approach versus a science-push approach. The distinction is an abstract one, though, since in most cases the different types of forces are linked in a feedback relationship. Hall (1994) provides a good introduction to the ways economists conceptualize and model technological change.

sense, institutionalized in the superpowers' military research and development centers and arms production establishments. It is certainly the case that the organizational processes operating within these domestic institutions represented, and still represent, significant internally driven forces behind weapons procurement (e.g., Holloway, 1983; Kaldor, 1990; Farrell, 1997; Zisk, 1997). However, the military industrial downsizing and restructuring that has occurred in both countries since the end of the Cold War is strong evidence against the notion that procurement was an autistic process.

The technological imperative conditions more than the rapid diffusion of advanced military capability in the aftermath of a significant military-technological innovation; it is also reflected in the frequency of both expected and realized innovations. This notion of frequent change in military technology is not necessarily at odds with the evolutionary dynamic described by Krause (1992), which after all does include periods of slower as well as faster technological advance and proliferation. The increased frequency of truly revolutionary military-technological change suggests that the phased evolution of the global arms transfer and production system is simply becoming more compressed. But it also suggests that the types of technological revolutions that once helped define the onset of a new era in arms production and trade become increasingly hard to pinpoint. Therefore, whether we are talking about military revolutions or just major advances in the performance characteristics of standard weaponry, the high rate of technological change ushered in by the Industrial Revolution may ultimately make the process of global proliferation appear more continuous than wavelike.⁵

The forces driving technological advance and the diffusion of military capability have taken different forms at different times. During the Cold War, the superpower rivalry itself provided incentive for the United States and the Soviet Union to innovate at the military-technological frontier.⁶ Each defined its own military capabilities relative to those of the other, and military planners on both sides feared that unmatched qualitative advances would undermine a defense posture based on existing numerical balances. Their competition was extended to the Third World as military aid and arms sales became a preferred means of courting potential allies in the global struggle for influence. Once patron-client relationships had been established, arms transfers gained additional momentum as the superpowers became invested in the security of their respective clients, many of whom were engaged in enduring regional rivalries. Ongoing disputes between North and South Korea, Israel and its Arab neighbors, India and Pakistan, Iran and Iraq, and Ethiopia and Somalia became extra-regional affairs when the United States and the Soviet Union became the primary arms suppliers of the opposing sides (Brzoska and Pearson, 1994; Laurance, 1992:ch. 5; Neuman, 1986).

Thus, the superpowers' Cold War rivalry accelerated both the pace of military-technological change and the global diffusion of advanced military capability. In return for some measure of political allegiance, the superpowers became willing suppliers of states involved in their own local rivalries. Even though in most cases state-of-the-art equipment was not transferred to client states in the Third World, recipients nevertheless were able to acquire very sophisticated weaponry in their efforts to gain military-technological advantages over their rivals or to redress

⁵ Krause (1992:210) cautions against viewing the international arms-transfer system as one that "endlessly replicates itself in timeless monotony," but he does suggest that his wave model captures its basic evolutionary structure: "Successive epochs, while following a similar pattern, differ from each other in important respects and are at the same time influenced by traces of prior history and other broader forces."

⁶ According to Bischak (1999:48), in the case of the United States, the legacy of this rivalry "goes beyond the vast stores of the means of mass destruction to the central assumptions that still guide both military planning and federal science and technology policy."

disadvantages. Because arms transfers were driven by superpowers' political struggle for global influence, and because they often went to opposing sides in regional rivalries that at times seemed to be reflections of the superpowers' own rivalry, the arms-transfer competition became an extension of the superpowers' direct arms competition.

Although basing rights and other concessions from their client states helped each superpower achieve its desired global military reach, rarely was the security of either of them directly affected in any serious way by developments in the Third World regions they supplied with weapons. The point is made by Ayoob (1995:94): "despite the mutual interpenetration of superpower competition and regional conflicts in the Third World, a fundamental asymmetry, with very few exceptions, continued to exist in the interaction between these two phenomena" (see also Kinsella, 1995). Furthermore, the security dilemma did not fuel the Cold War arms trade from above in quite the same way as it did from below. The technological imperative operated during the Cold War as it has during other periods, and the superpowers' military rivalry accelerated the pace of military-technological innovation while their competition for global influence increased the rate at which advanced military capability spread throughout the international system. But the action-reaction dynamic behind the American and Soviet arms-supply competition—a dynamic that helped to shape this particular manifestation of the technological imperative—was less intense than either their own direct arms competition or the regional arms competitions fed, at least in part, by their arms transfers.

Interrelated Processes

To review, there are two dynamics to consider when studying the diffusion of military capability by way of the global arms trade. First, a technological imperative operates that helps drive military innovation ever forward. The forces of supply and demand in the international arms market interact within this environment of military-technological advance, but they also help shape it. Second, competitive interstate dynamics operate, at the global level between great powers and at the local level between regional rivals. During the Cold War, several regional rivalries in the Third World were, in effect, "nested" within the superpowers' global rivalry, and the arms-transfer relationships that linked them gave further stimulus to the diffusion of military capability.⁷

The interrelationship between these two processes is fluid and complex, to be sure, but the conceptualization that provides the basis for the empirical analysis in the second half of this paper can be summarized rather simply with reference to Figure 1. The diagram highlights interstate rivalry—between the United States and Russia and between an unspecified pair of Third World states—as the main forces behind supply and demand in the international arms market. At the same time, these dynamics of interstate rivalry and arms transfer must be recognized as operating within a changing military-technological environment. At any particular point in time, military procurement decisions within each state were driven in the first instance by national security considerations, but they were simultaneously conditioned by the military-technological environment. Of course, domestic military industry was either nonexistent or very underdeveloped in

⁷ On the dynamics of enduring rivalries, including the superpower rivalry and the various linkages between this competition and regional rivalries in the Third World, see Diehl and Goertz (2000:ch. 12). McGinnis (1990) presents a formal model of these dynamics, one that highlights the role of military assistance to client states. A model focusing specifically on arms-transfer decision making by the superpowers can be found in Sanjian (1988). Levine and Smith have also developed a series of formal models of the international arms market, and in these, it is the demand for weaponry that comes from pairs of potentially hostile neighbors (see Levine and Smith, 1997; Levine, Sen, and Smith, 1994; Levine, Mouzakis, and Smith, 2000).

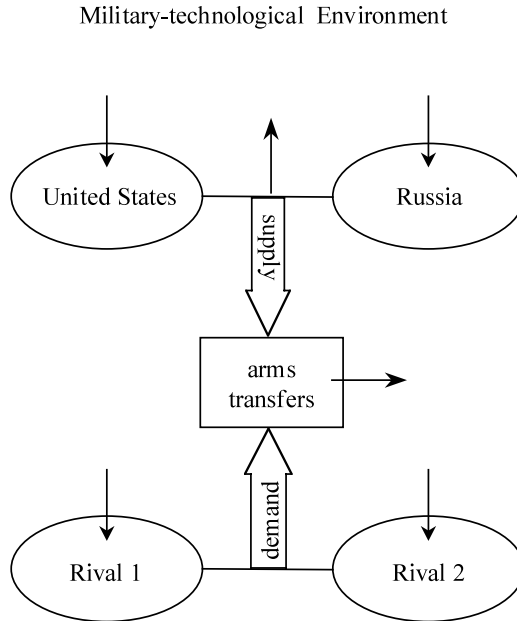


FIG. 1. Interstate Rivalry, Arms Transfers, and the Military-Technological Environment

most Third World countries during much of the post-World War II period, so regional enmity gave rise to the demand for arms imports. The Cold War competition between the United States and Russia, in addition to driving their own procurement efforts, became manifest in many cases as a willingness to supply Third World states with the weaponry they needed.

This is all very straightforward. It is somewhat more difficult, however, to represent the technological imperative in this schema. Alongside the commonly expressed view that states, or certain complexes within them, are anxious to integrate technological advances into their military capacities [the four downward-pointing arrows], we need to keep in mind that the Cold War rivalry was itself a prime impetus for technological innovation, thereby shaping the military-technological setting for both superpower and Third World rivalry [upward-pointing arrow]. Without highly developed indigenous arms-production facilities, regional rivalries did not have a direct impact on the state of military technology, but the proliferation of advanced weaponry through the Cold War arms trade did chisel away at the superpowers' military advantages, thus providing them with further impetus to secure new advantages through innovation [the rightward-pointing arrow]. Arms transfers also helped to finance the new initiatives at the military-technological frontier, initiatives that grew out of the superpowers' direct military confrontation, although this was typically a secondary consideration in their decisions to arm client states, if it was a consideration at all.⁸

My main goal in the empirical analysis to follow is to illuminate the competitive dynamics driving American and Russian arms transfers throughout the post-World War II period. However, as implied in the previous discussion, and as I will make more explicit in the next section, understanding the competitive

⁸ It is second tier arms suppliers like Britain and France for whom arms exports were (and are) most crucial to the maintenance of the defense industrial base. Nevertheless, arms exports served this purpose even for the superpowers—and, of course, have become more important in this regard since the end of the Cold War.

political dynamics in the arms trade requires that we take into account the environment of frequent military-technological change and diffusion. One approach would be to identify an operational indicator of these technological dimensions of the arms trade, and then try to model them alongside the political dimensions in an effort to obtain a more accurate picture of the latter.⁹ Another approach is to proceed under the premise that these technological dynamics will be manifest as certain properties in the data, which can be identified but do not prevent a judicious examination of the competitive political processes of primary interest. I take the second approach.

Analysis

Students of the Cold War have long been preoccupied with the question of whether the competition in superpower arms procurement can be properly called an arms *race*. A race was what it was most often called in the public discourse—in the United States, the Soviet Union, and elsewhere. But a tightly coupled dynamic of action and reaction was not present in the superpower “arms race,” as it was in, say, the Anglo-German naval race prior to World War I. Military planners in both countries did react to developments in the other, but this reaction was not always manifest in the form of reciprocated military efforts. Short-term reciprocity was most evident in nuclear deployments (numbers of both launchers and warheads), but in other areas the action-reaction dynamic was less clear-cut. American and Soviet military expenditures, for example, after moving together rather closely during the 1960s, sometimes followed divergent paths during the 1970s and 1980s. The loosely coupled nature of the superpower arms competition is suggestive of the importance of military-technological innovation. When behavior is governed by an intense action-reaction dynamic in the strictest sense, it becomes rather predictable. But flexibility in reacting to threatening military developments was seen as a more effective form of competition, and this required a sustained devotion of resources to military-technological innovation. And if one side was pushing against the military-technological frontier, the other could hardly afford not to do the same (Koubi, 1999; Thee, 1990).

As with their own military buildups, American and Soviet arms transfers to other regions were competitive, but usually only loosely coupled. This can be understood in reference to both the push and the pull factors operating in the Cold War arms trade. On the pull side, although many recipients of major arms transfers were (and are) involved in enduring rivalries, the normal states of affairs usually have not been arms races, if we reserve that term for the most intense form of mutually reactive military buildup (for carefully drawn distinctions, see Goertz and Diehl, 1993). What was true for the U.S.-Soviet rivalry holds more generally, according to Buzan and Herring (1998:80): “relations between virtually all potential adversary states fall into the grey area between maintenance [of the military status quo] and racing.” On the push side, even if local rivals were inclined to engage in more intense forms of arms competition, they still had to turn to willing suppliers, since most possessed no capacity to produce their own advanced weaponry and those that did possess it were able to manufacture only a very limited number of systems, a small fraction of their perceived security needs. Contrary to some of the more radical portraits of the Cold War in the Third World, the superpowers and their allies generally tried to avoid provoking or feeding regional arms races, especially in high-tension areas like

⁹ Economists, for example, have operationalized technological developments by looking at the number of registered patents in certain areas of production, as well as at the production processes stemming from them. See Oxley and Greasley (1998) and Sullivan (1989).

the Middle East and South Asia (Miller, 1995; Wriggins, 1992; Kanet and Kolodziej, 1991; Doran, 1991).

Trends in Arms Transfers

The trend in the possession or stock of military capability (say, the capability of the “typical” state) is generally upward over time. Military technology moves forward, and the performance characteristics of today’s weapons are almost always superior to yesterday’s. However, when it comes to the diffusion of military capability—that is, the interstate transfer or spread of weapons and arms-production technology—the expected patterns are less obvious.

Competitive arms dynamics help to shape global patterns in military production and arms transfers. But as the arms-race literature demonstrates, these processes are often not well represented by simple structural models in which one side consistently reacts to the other side’s military procurement, and vice versa—even in what would seem to be a paradigmatic case: the U.S.-Soviet “arms race” (McGinnis and Williams, 2001; Kinsella and Chung, 1998). The shortcomings of earlier externally oriented models of action and reaction led analysts to refocus their attention on the processes internal to the state that account for the large measure of inertia discernible in many states’ military budgets (for literature reviews, see Etcheson, 1989; Gleditsch, 1990). The operation of organizational dynamics, for example, typically means that in any given period, the best predictor of a policy output, including a military budget, is the previous period’s policy output. In effect, the domestic forces highlighted by these analysts—organizational routines, but also the influences exerted by governmental and societal actors who have stakes in military production and trade—derive from a domestic institutionalization of the technological imperative (e.g., Flank, 1993/94; Farrell, 1997; Zisk, 1997). The presence of countervailing domestic forces, even though their influence is often less strongly felt, adds another layer of complexity.

More recently, political scientists and economists interested in the empirical aspects of the demand for military capability have suggested that the apparently autistic patterns in some countries’ defense expenditures are in fact consistent with externally oriented arms-racing behavior. This “rational expectations” argument treats forward-looking decision makers as using available information to form unbiased expectations of future behavior by their opponents (see McGinnis and Williams, 2001:ch. 3; Smith, Dunne, and Nikolaidou, 2000).¹⁰ In the case of military acquisitions, x_{1t} , at time t , if we assume that any new information received by policy makers is immediately used to adjust procurement decisions, then x_{1t} should be well represented as a random walk:

$$x_{1t} = a_1 x_{1t-1} + \varepsilon_{1t} \quad (1)$$

where $a_1 = 1$. If decision makers have updated their policy preferences based on available information about their opponent’s behavior, then the best predictor of this year’s procurement will be last year’s procurement. New information is unanticipated and is therefore represented as a stochastic shock, ε_{1t} , but as in

¹⁰ The limits of the rational expectations argument, especially the strong version in which the subjective probability distributions of decision makers are equated with the probability distributions of actual behavior or events, has been a subject of some controversy in economics. Nevertheless, the rational expectations argument still seems to be the standard framework in economic analysis. One of the best discussions of the rational expectations perspective, one that is both thorough and critical, is still Pesaran (1987). Alternatives to the rational expectations model include the adaptive expectations model, where current expectations are revised based on the deviation of past events from past expectations, and learning models, where expectations are updated as new information becomes available.

previous periods, that information becomes an input to actual procurement decisions at t .

Although they do not lay out the microfoundations of their argument in this way, Buzan and Herring (1998:121) seem to suggest much the same thing when they distinguish a technological imperative from technological determinism: "The technological imperative represents an unavoidable requirement to consider how to respond to the frequent technological advances of the contemporary world. It does not determine what that response will be or even whether there will be a response of any vigor; that will be influenced to varying degrees by political, domestic structure, and action-reaction factors." Military-technological innovations are among the essentially stochastic shocks to the procurement process. The impact of particular innovations has varied in magnitude and, following Buzan and Herring (1998), those advances are probably best understood as becoming increasingly frequent. Whatever their magnitude and frequency, their impact remains, forever changing (whether fundamentally or incrementally) the military-technological environment. Since it is not always clear how, when, and with what intensity military planners will respond to technological advances, beyond being compelled to take seriously their implications for national security, actual procurement will be hard to predict very far into the future. But to the extent that planners are responsive to their changing environment, this should be discernible in the data nonetheless. A time-series indicator of the procurement process, such as military expenditures or arms transfers, will be nonstationary, or *integrated*—that is, it will have a stochastic trend reflective of the fact that shocks to the process have a lasting effect. There is no long-run mean level to which the series reverts in the aftermath of military-technological innovations; the impact of these innovations is permanent, or at least "long remembered."¹¹

My conjecture is that trends in Cold War arms transfers are due to these same dynamics. The demand for military capability by Third World states engaged in regional rivalries was affected by technological change, since military innovation by first tier arms producers provided part of the military-technological context for regional conflict and competition. The impact of such changes did not die out, but became a permanent feature of these states' overall security environments. Although some embarked on programs to develop indigenous arms-production capacities, they did not pay substantial dividends in terms of import substitution during the Cold War period (or since). We can reasonably expect, therefore, to observe stochastic trends in arms transfers on the assumption that arms supplies were sufficient to meet Third World demand. On the supply side, American and Russian decisions to provide weaponry was an outgrowth of their global competition and spurred the global diffusion of advanced military capability, even if arms agreements often fell short of what was requested. In short, arms transfers were reflective of the changing military-technological environment, one in which technological innovation had a lasting impact on security-related expectations and behavior of both suppliers and recipients.

Shared Trends in Cold War Arms Transfers

Buzan and Herring (1998) and others have argued that the competitive dynamic in arms acquisitions by rival states may not conform to a tightly coupled action-

¹¹ On the distinction, see Beck (1992). Econometricians frequently point to technological change as the mechanism behind integrated and cointegrated (see below) time series (e.g., King et al., 1991; Campbell, 1994). On terminology, an integrated time series is said to contain a "unit root," which comes from the analysis of difference equations with stochastic components. Solving difference equations involves finding their characteristic roots, and only when all roots are less than one (lie within the unit circle), does the time path of the solution converge to zero. When a root is greater than one, the function explodes; when the root is exactly one, it neither converges to zero nor explodes, but meanders (see Enders, 1995:ch. 1).

reaction process commonly associated with arms racing. This is consistent with the notion of policy substitution, which suggests that “decision makers who are confronted with some problem or subjected to some stimulus could, under at least certain conditions, substitute one [policy] for another” (Most and Starr, 1984:387; see also McGinnis, 1991). The Cold War rivalry was multifaceted. It was conducted with different degrees of intensity at different times and using multiple policy instruments, including military procurement and arms transfers to existing and potential allies. The superpowers’ global competition often involved asymmetric responses by one side to behavior perceived as challenging to its global interests. Sometimes such asymmetric responses took the form of policy substitution. Sometimes the same policy instrument, say, arms supplies, was used but was focused on a different region of the Third World, where it was deemed more likely to enhance the supplier’s own position or to undermine the position of the other superpower.

Recognizing that enduring rivalries are often multidimensional dilutes considerably any expectations we might have of uncovering evidence of short-term reciprocal reaction in a model of interstate competition, whether it is operationalized using military expenditures, arms transfers, or some other indicator of state behavior. The concept of *cointegration* seems much better suited to an analysis of international rivalry than the structural approach typically employed in the Richardsonian modeling tradition. Start with a long-run relationship between American arms transfers, x_{1t} , and Soviet transfers, x_{2t} , such that $\beta_1 x_{1t} + \beta_2 x_{2t} = 0$. Superpower arms transfers are cointegrated if both x_{1t} and x_{2t} are integrated and if deviations from this relationship, e_t , is a stationary process.¹² Because the cointegrating vector (β_1, β_2) gives the parameters of a linear combination of the two integrated series that produces a stationary e_t , it is the case that the series’ stochastic trends are shared and “cancel out” when they are combined. That the stochastic trend in the two series is shared is indicative of forces—such as those associated with interstate rivalry—keeping the superpowers’ arms-transfer policies in an equilibrium relationship. This is a “moving equilibrium,” manifest as a tendency for the two series to move together over time without prolonged or systematic divergence. Deviations from the long-run relationship, e_t , are induced by shocks to existing policies, whether these shocks take the form of military-technological change or behavioral changes associated with the conduct of interstate rivalry.

Returning to equation (1), notice that this representation of the demand for military capability assumes that new information immediately affects adjustments to the policy decisions, which is obviously implausible. In fact, “implementation costs” are well documented in the literature on the organizational dimensions of arms racing, and are to be expected given the lag times involved in weapons development and procurement. Arms transfers almost always involve equipment currently under production, so the policy adjustment process is not as lengthy. In this context, the shocks discussed above as military-technological innovations are better seen as the willingness of a superpower (or its allies) to introduce a level of weaponry into a region that was heretofore unavailable. However, even though in some cases the reaction to these new regional realities may have been swift, in the form of compensatory arms requests and even supplies, instantaneous policy adjustment is unrealistic as a general assumption.

When there are costs of adjustment, a conception of interstate rivalry involving rational expectations can be represented as an error correction model (Alog-

¹² This assumes that the series are integrated of order one, or $I(1)$, meaning that differencing the series once will produce stationary series. More generally, if each series is $I(d)$, then they are cointegrated of order d, b —written $CI(d, b)$ —when there exists a cointegrating vector yielding an e_t that is $I(d - b)$. However, few series are integrated of order higher than one. I use “integrated” to mean $I(1)$ and “cointegrated” to mean $CI(1, 1)$.

oskoufis and Smith, 1991). The simplest ECM for American and Soviet arms transfers would take the form:

$$\begin{aligned}\Delta x_{1t} &= \alpha_1(x_{1t-1} - \beta x_{2t-1}) + \varepsilon_{1t} \\ \Delta x_{2t} &= -\alpha_2(x_{1t-1} - \beta x_{2t-1}) + \varepsilon_{2t}\end{aligned}\quad (2)$$

where the cointegrating vector $(1, -\beta)$ has been normalized with respect to x_{1t} such that $\beta = \beta_2/\beta_1$. The coefficients α_1 and α_2 on the error-correction terms give the speed of adjustment to deviations from the equilibrium relationship. If the arms-transfer series are cointegrated, then arms supplies will change in response to deviations from equilibrium such that either or both of α_1 and α_2 will be different from zero; the greater the magnitude, the faster that state's policy adjusts to shocks. A more general model would take this form:

$$\begin{aligned}\Delta x_{1t} &= \alpha_1(x_{1t-1} - \beta x_{2t-1}) + a_{10} + \sum_{i=1}^r a_{11i} \Delta x_{1t-i} + \sum_{i=1}^s a_{12i} \Delta x_{2t-i} + \varepsilon_{1t} \\ \Delta x_{2t} &= -\alpha_2(x_{1t-1} - \beta x_{2t-1}) + a_{20} + \sum_{i=1}^u a_{21i} \Delta x_{1t-i} + \sum_{i=1}^v a_{22i} \Delta x_{2t-i} + \varepsilon_{2t}\end{aligned}\quad (3)$$

where a_{10} and a_{20} are constants allowing for drift, while the a_{11i} , a_{12i} , a_{21i} , and a_{22i} are parameters for short-term reactions by one side to past changes in its own and its opponent's arms transfers. A key point here is that even in the absence of short-term reaction, cointegration nevertheless implies a responsiveness by one or both sides in the form of policy adjustments that maintain a long-run equilibrium relationship. Models of interstate rivalry that omit an error-correction term cannot illuminate this dimension of the competition when it exists (e.g., Mintz, 1986a, 1986b).

The relevance of these time-series concepts for the argument in the first half of the article can be summarized as follows. Military-technological change is a stochastic process that is composed of technological advances that have become increasingly frequent over time. These advances, or shocks, have had a lasting impact on the demand for military capability, whether in the form of domestic production or weapons imports. The dynamics of global and regional interstate rivalry, which were so often linked during the Cold War, played out in an environment of military-technological change. Therefore, to the extent that arms import and export decisions were made by rational, forward-looking policy makers whose states were in competition with other states, we would expect that Cold War arms flows exhibited stochastic trends, and that time-series indicators of the process will be integrated. Furthermore, when examining arms flows involving pairs of rivals—competitive suppliers in the case of the superpowers (and their allies), or competitive recipients—we would expect that these stochastic trends were shared; their time series will be cointegrated. This constitutes evidence of a moving equilibrium in their competitive relationship, and an error-correction model should capture the dynamics by which one or both rivals adjusted their policies to out-of-equilibrium conditions. Again, while they do not invoke these same analytical concepts, Buzan and Herring (1998:51) hit upon the same notions:

A substantial amount of the behavior that is commonly identified as arms racing (but which . . . may turn out to be something less than that) stems from the underlying process of technological advance. When countries compete with each other in armaments (whether as potential opponents in war or as competitors in the arms trade), they must also compete with a standard of technological quality that is moving forward.

Before turning to the empirical findings, I want to underscore the two broad categories of shocks that are relevant for an understanding of the relationship between global arms transfers and interstate rivalry. The first type, on which most of my discussion has focused, consists of military-technological advances. These have a lasting impact on military security environment of states, and I have argued that their importance would lead us to expect nonstationarity in time-series indicators of military production and transfer. Although the next section will report test results regarding the nonstationarity of some arms-transfer time series, without a direct measure of technological change, the *linkage* between the stochastic trends and military-technological advance must remain a conjecture; it is not a hypothesis I can test.

The second type of shock, more often the focus of research on international conflict processes, consists of sudden changes in policy or competitive behavior, especially military operations and deployments. My view is that these are not likely to be the source of nonstationary movement in arms-transfer series, because, in general, conflict processes seem best described as mean-reverting, with the baseline being peace (though not necessarily harmony). This is not to deny the existence of long-lasting conflicts. Rather, I am suggesting that the policy and behavioral shocks we usually associate with interstate rivalry do not have the same sort of permanent impact as military-technological change. They are often quite important, and they may be long remembered, but their impact fades with time, unlike the impact of technological innovation, which is part of a more cumulative (and integrated) process of technological advance. That said, shocks of this second type are very likely to be among the forces behind the out-of-equilibrium conditions discussed above. State leaders react to them and adjust their policies in response.

Estimation and Results

My argument is that Cold War arms-supply policies were in an equilibrium relationship—in different regions and at multiple levels of aggregation—due to the dynamics of sustained interstate rivalry. In separate analyses, I examine American and Soviet arms transfers to (1) the Persian Gulf; (2) the entire Middle East, inclusive of the Persian Gulf; and (3) the Third World as a whole. I repeat the analyses for NATO and Warsaw Pact arms supplies.

At the core of the Persian Gulf security complex is the Iran-Iraq rivalry, and that rivalry combined with the superpower competition for influence in this strategic region gave rise to predominant-supplier relationships that paired the United States with Iran and the Soviet Union with Iraq. After the 1979 Islamic Revolution in Iran, the United States refocused its attention on Saudi Arabia in an effort to cultivate a new counterweight to Iraq. The Persian Gulf is therefore one of several regions where we might expect to observe in the data the sort of competitive dynamics described in the previous section.¹³ But the global nature of the Cold War competition suggests that a multiregional equilibrium relationship in arms transfers may have been maintained; the whole chessboard was in play, not just one corner of it. Thus, I analyze arms transfers to the Middle East, which encompassed interstate rivalries in the Maghreb and Horn regions of

¹³ Regional “security complexes,” defined by Buzan (1991:190) as formations of states identifiable by their “patterns of amity and enmity that are substantially confined within some particular geographical area,” have proven to be useful units of analysis in the study of world politics, especially Third World security issues (Buzan, Wæver, and de Wilde, 1998; Lake and Morgan, 1997). Other conceptual frameworks for analyzing regional security in the developing world—distinct from Buzan’s notion of security complexes, but with much in common—include Lemke’s (1996) “regional hierarchies” and Marshall’s (1999) “protracted conflict regions.”

Northern Africa, the Levant, as well as the Persian Gulf.¹⁴ For the same reason, I also examine transfers to all Third World countries.

Although my investigation is conducted at various levels of aggregation, the building block for all of the time series assembled for this analysis is the dollar value of all major weapons transferred between a supplier and a recipient during a given year. Dollar values represent not what was actually paid by the recipient to the supplier, but the estimated market value of that weaponry based on performance characteristics. The market value of an arms delivery serves as a good summary measure of the transfer of military capability, the best currently available for a large number of countries and a lengthy time span (1948–1996). The data come from the Stockholm International Peace Research Institute, which publishes its data in the *SIPRI Yearbook: Armaments, Disarmament and International Security*. SIPRI's data collection procedures, including its pricing methodology, are discussed in Brzoska and Ohlson (1987).

The first step in the analysis is to test whether Cold War arms transfers contained stochastic trends—i.e., whether the series are integrated. The usual practice is to conduct a Dickey-Fuller test, which involves estimating an equivalent but augmented version of (1) above:

$$\Delta x_{1t} = \gamma x_{1t-1} + \sum_{i=1}^k \beta_i \Delta x_{1t-i} + \varepsilon_{1t} \quad (4)$$

where $\gamma = a_1 - 1$, with the implication that if the estimate of γ is not significantly different from zero, then a_1 is one and x_{1t} is integrated (has a “unit root”). The lagged difference terms are included in order to obtain proper estimates of γ in the presence of moving average and higher-order autoregressive processes. A constant could be added to (4) to capture any drift in the process, as could time to capture a deterministic trend (which needs to be distinguished from a stochastic trend), and then Ordinary Least Squares (OLS) applied to test restrictions and estimate the final model. More recently, Generalized Least Squares (GLS) tests have been proposed that improve the small-sample properties of the test (see Elliott, Rothenberg, and Stock, 1996). The GLS test, which I use here, transforms the series—by de-meaning or de-trending it—before estimating the regression, and also tests for the appropriate number of lagged difference terms.

Results from the unit root tests are shown in Table 1. The Dickey-Fuller statistics in the table are t ratios for estimates of γ in (4), except that significance levels are given by a nonstandard limiting distribution. Whether the data are tested allowing for a drift or a deterministic time trend, the results are the same: all the arms-transfer series are integrated. With one partial and very slight exception, the tests performed on the once-differenced data suggest that the series are $I(1)$.¹⁵ Arms transfers from the United States and Russia, as well as NATO and the Warsaw Pact, did exhibit nonstationary movement over time. The stochastic trends in the series are consistent with arms-transfer decisions made by forward-looking policy makers operating in an environment of military-technological change and Cold War competition.

Since it has been established that there were stochastic trends in Cold War arms transfers to the Persian Gulf, the larger Middle East security complex, and

¹⁴ The states classified by Buzan (1991:199) as members of the Middle East security complex are as follows. Persian Gulf: Bahrain, Iran, Iraq, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, and Yemen. Eastern Mediterranean: Egypt, Israel, Jordan, Kuwait, Lebanon, and Syria. Maghreb: Algeria, Chad, Libya, Mali, Mauritania, Morocco, Niger, and Sudan. Horn: Djibouti, Ethiopia, Somalia, and Tunisia.

¹⁵ Notice that the statistic for de-trended NATO transfers to the Third World fails to meet the 0.10 level of significance necessary to reject the null hypothesis of a unit root. However, the statistic just misses this hurdle (critical value = 2.81) when 3 lags are used, and when computed using either 2 lags or 1 lag, the statistic (−4.05 or −4.92) is significant at the 0.05 level.

TABLE 1. Integration Tests for Arms Transfers, 1951–1995

	<i>de-meaned</i>				<i>de-trended</i>			
	<i>levels</i>		<i>first differences</i>		<i>levels</i>		<i>first differences</i>	
	<i>lags</i>	<i>DF-GLS</i>	<i>lags</i>	<i>DF-GLS</i>	<i>lags</i>	<i>DF-GLS</i>	<i>lags</i>	<i>DF-GLS</i>
<i>Third World</i>								
American	1	-0.94	1	-5.63**	3	-1.83	1	-5.64**
Russian	3	-1.06	1	-5.54**	3	-1.13	1	-5.64**
NATO	1	-0.59	3	-2.73**	1	-1.88	3	-2.75
Warsaw Pact	3	-0.78	1	-5.06**	3	-1.63	1	-5.24**
<i>Middle East</i>								
American	3	-0.81	1	-6.77**	3	-1.88	1	-6.70**
Russian	3	-0.97	1	-5.00**	3	-0.80	1	-5.17**
NATO	3	-0.58	1	-6.09**	3	-1.37	1	-6.19**
Warsaw Pact	3	-0.93	1	-4.83**	3	-1.06	1	-5.00**
<i>Persian Gulf</i>								
American	2	-1.75	1	-5.97**	1	-2.84	1	-5.96**
Russian	1	-1.46	2	-3.98**	1	-1.65	2	-4.08**
NATO	2	-1.11	2	-4.28**	2	-2.09	2	-4.21**
Warsaw Pact	1	-1.28	2	-2.99**	1	-1.82	2	-3.07*

Note: Statistics are *t* values for estimates of γ from Dickey-Fuller GLS regressions. The number of lagged difference terms (maximum = 3) is determined using a modified Akaike Information Criterion (see Ng and Perron, 2001). The time span of the NATO and Warsaw Pact series is 1951–1991.

*significant at the 0.10 level

**significant at the 0.05 level

the Third World as a whole, testing for cointegration can determine whether these trends were shared and thus whether interstate rivalries served to keep policies in a competitive equilibrium. Following Johansen (1988; Johansen and Juselius, 1990), the two-variable ECM represented in (3) above can be generalized to n variables, such that the vector $x_t = (x_{1t}, x_{2t}, \dots, x_{nt})$:

$$\Delta x_t = \pi x_{t-1} + A_0 + \sum_{i=1}^{k-1} \Gamma_i \Delta x_{t-i} + \psi z_t + \varepsilon_t \tag{5}$$

where π and the Γ_i are $n \times n$ coefficient matrices, A_0 is an $n \times 1$ vector of constants, and ε_t is an $n \times 1$ vector of error terms. The generalized model also allows for a vector of exogenous (including dummy) variables, z_t , with coefficients ψ . Each row of π is a cointegrating vector, so testing for cointegration means determining the rank of π —that is, the number of linearly independent rows. Of course, for a pair of time series, there can be no more than one cointegrating vector, but in the general case of cointegration, $1 \geq \text{rank}(\pi) \geq (n - 1)$. The Johansen test is based on the fact that the rank of π is equivalent to the number of characteristic roots that differ from zero. For n characteristic roots, ordered such that $\lambda_1 > \lambda_2 > \dots > \lambda_n$, the likelihood ratio test for reduced rank is:

$$\lambda_{\text{trace}}(r) = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \tag{6}$$

where r is the rank of π under the null hypothesis and T is the number of observations. Again, in my bivariate analyses, the only possible null is that of no cointegration ($r = 0$).¹⁶

A maximum likelihood procedure is used to both estimate the ECM and test for cointegration.¹⁷ I include in each model an exogenous variable representing the number of militarized interstate disputes that involved any of the states in that regional aggregate during year t , whether newly initiated or ongoing from the previous year (for a description of the dispute data, see Jones, Bremer, and Singer, 1996). This means that at least some of the types of events I discussed at the end of the previous section as belonging in the category of policy and behavioral shocks are actually represented in the model. However, this is a very crude indicator of regional military conflict—not distinguishing disputes according to their severity or duration—and therefore leaves outside the predictive model information relevant to regional arms flows. That is, some of these events are still likely to manifest as stochastic shocks to equilibrium conditions. Finally, I determine the number of lagged-difference terms in each ECM by estimating vector autoregressions using the undifferenced series and then conducting likelihood ratio tests for reduced lag length, which is standard practice.

The first pair of columns in Table 2 give the results of the cointegration tests. The trace statistics indicate that each pair of series is cointegrated; their stochastic trends were shared. Arms supplies from the United States and Russia and from NATO and the Warsaw Pact moved together over time in an equilibrium relationship, a pattern we would expect to observe if a competitive dynamic was a driving force behind arms-transfer decision making. The cointegrating parameter, β , can be obtained from (5) because $\pi = \alpha\beta'$, where, in the present application, α and β are 2×1 vectors. The cointegrating parameters shown in the table are for normalizations with respect to the American or NATO arms-transfer series, so they show the long-run responsiveness of Russian or Warsaw Pact transfers. This implies nothing about causality, though; the responsiveness of American or NATO transfers is simply the inverse of the number reported in the table. Basically, these estimates (and their inverses) represent long-run elasticities, and with magnitudes ranging from roughly 0.5 to 2.0, they are certainly plausible for rival states or rival blocs with comparable resources and global interests.

The middle columns in Table 2 are the error-correction results. The error-correction parameter, α , indicates the rate at which arms transfers from the indicated country or bloc adjusted to shocks to the equilibrium relationship. Recall that if a pair of series is cointegrated, then it must be the case that one or both sides adjust to deviations from the equilibrium path. The estimates shown for the United States and NATO represent their rate of adjustment to positive

¹⁶ In addition to this trace statistic, the λ_{\max} statistic tests the null of $\text{rank}(\pi) = r$ not against the general alternative, but against the specific alternative of $\text{rank}(\pi) = r + 1$, and is defined as:

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_i)$$

This statistic is used for testing reduced rank in systems involving possibly multiple cointegrating relationships, but in the bivariate context, yields the same conclusions as λ_{trace} . Critical values for both statistics are given in Johansen and Juselius (1990).

¹⁷ Maximum likelihood estimation allows for cross-equation restrictions. For example, in my analysis, restrictions are imposed on the vector of constants, A_0 , such that the time series may exhibit linear trends but the cointegrating relation linking them will not, though it may have a nonzero intercept. In econometric practice, the Johansen procedure seems to have superseded the original two-step OLS approach proposed by Engle and Granger (1987). The latter involves first estimating the cointegrating relationship and then using the residual series from that model as a regressor in the ECM in order to estimate the dynamics of adjustment to out-of-equilibrium conditions. The Johansen results reported here are largely, but not perfectly, consistent with the results obtained when applying the Engle-Granger method. (The Engle-Granger results are available on request.)

TABLE 2. Cointegration Tests and Error-Correction Parameters for Arms Transfers, 1951–1995

	<i>cointegration</i>		<i>error correction</i>				<i>LM(1)</i>	<i>lags</i>
	λ_{trace}	β	<i>America/NATO</i>		<i>Russia/Warsaw Pact</i>			
			α	χ^2	α	χ^2		
<i>American and Russian</i>								
Third World	25.92**	0.78	-0.14	2.01	-0.42	15.77**	20.00**	1
Middle East	25.85**	1.31	-0.10	1.17	-0.55	19.71**	7.11	1
Persian Gulf	31.29**	0.88	-0.43	8.18**	-0.35	8.80**	4.02	2
<i>NATO and Warsaw Pact</i>								
Third World	27.06**	1.26	-0.41	11.10**	-0.43	11.18**	6.63	1
Middle East	31.49**	1.51	-0.29	3.80**	-0.55	24.89**	3.01	1
Persian Gulf	27.72**	1.98	-0.27	3.83**	-0.60	23.55**	3.12	2

Note: The estimates of β are based on a normalization with respect to the American/NATO series. The estimate of each α is based on a normalization with respect to that same series. LM(1) is the Lagrange Multiplier test for first-order autocorrelation in the residuals. The time span for the NATO-Warsaw Pact analyses is 1951–1991.

*significant at the 0.10 level

**significant at the 0.05 level

shocks in the long-run relationship and are computed while using those same series for normalization. Likewise for the Russia and Warsaw Pact estimates. The χ^2 statistics measure the statistical significance of the estimates, and in this bivariate application, we could just as easily consult the t ratios. In any event, in the case of the superpower arms-transfer relationship, Russian policy adjusted to out-of-equilibrium conditions at all three levels of regional aggregation, while American policy did so only in the Persian Gulf. In the case of the NATO-Warsaw Pact relationship, policy adjustment is in evidence for both sides at all three levels, although Warsaw Pact transfers showed a tendency to adjust somewhat faster, especially in the Middle East security complex and in the Persian Gulf subcomplex.

Taken together, these results suggest a certain asymmetry in the maintenance of arms-transfer equilibria during the Cold War. As far as I am aware, such asymmetry has not been the subject of much (if any) formal theorizing, but informal empiricism does suggest one possible explanation. Error-correcting behavior is a tendency to adjust to deviations from the equilibrium path, whatever the source of out-of-equilibrium conditions, including sudden changes in one's own policies. In the case of Soviet arms transfers to the Middle East (and the Third World overall), major spikes in activity were associated with supply increases to the Arab states during and after the Six Day War, the War of Attrition, and the Yom Kippur War, as well as to Syria after the break with Egypt. These events were behind the (literally) extraordinary Russian arms-transfer levels during certain years, and neither superpower wanted such "shocks" to permanently shift the equilibrium path so sharply upward. That meant that the United States was unlikely to adjust its transfers to target a new, higher level; instead, the Soviets would bring theirs down.

The same self-correcting dynamic should operate after major changes in American activity, but the fact is that American arms transfers have followed a somewhat smoother time path, rather less affected in the aggregate by relations with particular arms clients.¹⁸ But at lower levels of aggregation, regional events loom large. Crises and wars were usually beyond the control of the superpowers, and

¹⁸ One exception is the sudden drop associated with more restrictive arms-supply policies adopted by the Carter administration, combined with the collapse of the shah's regime in Iran, a major U.S. client.

the uncertainty associated with such volatility—in the Persian Gulf and perhaps elsewhere—suggests that the equilibrium path, when it existed, was in greater flux. In such a context, it may be more reasonable to expect mutual adjustment to restore equilibrium, since both sides were essentially feeling around in the dark.

The asymmetry is not as pronounced in the NATO-Warsaw Pact relationship, where NATO transfers did appear to adjust to shocks regardless of the level of aggregation, though more slowly than the Warsaw Pact. My tentative explanation for the superpower asymmetries could apply also to these different rates of adjustment, given the superpower dominance of the Cold War arms trade. However, the finding more in need of explanation is the contrast, in the case of the Middle East and the Third World as a whole, between NATO adjustment and American nonadjustment. While it is true that the superpowers dominated arms transfers from their respective alliances, this was more true of the Soviet Union than the United States. Britain and France, in particular, were far more significant arms suppliers than any of the Eastern European members of the Warsaw Pact. With other NATO members actively involved in the arms trade, serving as collaborative agents of Western influence in the Cold War competition, the United States shouldered a smaller share of the burden of policy adjustment within NATO than did the Soviet Union within its alliance. American transfers may have seemed less reactive than Soviet transfers, but arms supplies from the U.S.-led alliance did adjust to disequilibrating shocks at all three levels of regional aggregation. What appears as reactive asymmetry when restricting attention to superpower interaction appears somewhat more balanced when Cold War coalitions become the units of analysis.

The last two columns in Table 2 show the number of lagged-difference terms appearing in each model and the Lagrange Multiplier (LM) test for first-order autocorrelation in the residuals. All but one LM test indicate that the residuals are white noise, suggesting that the dynamics in these arms-transfer relationships have been adequately modeled. The one exception may in fact be anomalous in light of results from alternative specifications.¹⁹

Conclusion

The global diffusion of military capability is a process of enormous consequence, for it enables states to wage war and to engage in other forms of repression and violence. That states' leaders perceive a need to acquire and maintain military capability is, sad to say, such a basic tenet of world politics that it hardly requires comment. But because this perceived need is a near constant, other forces must be considered in order to account for shifting patterns in global arms production and transfers. Analysts have highlighted the impact of military-technological advance and the forces of supply and demand that push and pull military capability through the international system via the arms trade. The importance of technological innovation makes temporal movement in the arms trade rather unpredictable in the short run, even though in the long run we may expect to observe the wavelike patterns of expansion and contraction identified and theorized by Krause (1992). On the other hand, one of the few sources of predictability in the arms trade during the second half of the 20th century was its connection to the Cold War competition between the United States and Soviet Union. As Buzan (1991), Ayooob (1995), and others have argued, this rivalry

¹⁹ Residual autocorrelation typically means that too few lagged-difference terms appear in the model. Including 2 lags and 3 lags in the American-Russian/Third World ECM also fails to yield white-noise residuals. Oddly, at least to me, autocorrelation is not a problem in this model when the exogenous military-disputes variable is excluded.

became the global context within which regional rivalries emerged and evolved throughout the Third World.

Interstate arms competition does not always, or even often, take the form of a tightly coupled process of action and reaction. This held for the Soviet-American "arms race," at least judging from their military expenditures, and it should have been even more true of their arms-transfer competition. This was due to the complex and, in many respects, autonomous dynamics operating in regional security complexes, as well as the multidimensional and multiregional character of the superpowers' own rivalry. The patterns we observe in the proliferation of weaponry emerged from a military-technological imperative that has long shaped the global arms trade, but also from the superpowers' struggle for influence during the Cold War. Empirically, this enduring competitive relationship was manifest as co-movement of American and Russian (and NATO and Warsaw Pact) arms-transfer series along an equilibrium path, the general contours of which reflected a process of forward-looking policy making in an environment of military-technological advance. I have argued that the relevant concepts from time-series analysis are cointegration and error-correction, and my analysis has revealed the presence of such data-generating processes at different levels of aggregation.

The scope of my empirical study has been limited. Although I have examined arms-transfer competition at a high level of aggregation (the Third World), beyond that, I have focused on only one security complex (the Middle East) and one regional subset of arms recipients within it (the Persian Gulf). It remains to be seen whether the dynamics in evidence here operated in other regions, and in what form. More relevant for contemporary world politics, however, is the question of continuity. As the previous discussion has emphasized, military-technological advance has been an enduring feature of the global arms production and transfer system, and there are at present few signs that the rate of innovation will slow down significantly in the near to medium term. But the nature of the global competition in arms transfers most certainly has changed. Whether or not Russia is successful in its bid to renew its once-exalted position in the global arms marketplace, competitive dynamics will continue to drive the spread of military capability. The degree to which these differ from those associated with the Cold War rivalry, and their consequences for regional security, deserves the sustained attention of empirical research.

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