DETERMINANTS OF ARMS PRODUCTION IN THE THIRD WORLD: A TIME-SERIES CROSS-SECTION ANALYSIS

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Abstract

Major determinants of third world military industrialization operate at the domestic, regional, and global levels. I examine the relative importance of these by analyzing time-series cross-section data for the twelve leading third world arms producers from 1968 to 1990. Arms production depends the state's industrial capacity and is enhanced by the state's capacity to produce weapons for export. It is affected by the closedness of political and governmental institutions, and thus the military's potential influence in the allocation of resources, and by the actual allocation of resources in the form of military spending. States are motivated to pursue military industrialization programs by their involvement in regional conflict and the level of regional militarization. These too have a measurable impact on domestic arms production. The transfer of military technology in the form of arms imports affects domestic arms production overall; disaggregating, it is clear that technology transfer necessary for indigenous weapons production is accomplished in large part by licensing arrangements. Both arms imports and licensing might also be a vehicle for the diffusion of global military culture, but a crude indicator of state interaction fails to provide any independent confirmation. The global diffusion of military iconology as a driving force behind military industrialization is an important notion in my view, and represents a major challenge for systematic empirical research.

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For the past decade or more, companies from Israel, India, South Africa, and South Korea have been among the world's leading weapons manufacturers. In 1995, Israeli Aircraft Industries had arms sales of more than $1 billion, a level attained by fewer than forty other firms globally. Israel's Koor Industries, Rafael, TAAS, and Elbit have also consistently ranked among the largest 100 arms producers, according to the Stockholm International Peace Research Institute. Other top manufacturers include Hindustan Aeronautics and the Ordnance Factories in India, Daewoo, Hyundai, and Samsung in South Korea, and Denel in South Africa. These companies produce a full range of military equipment: aircraft, armored vehicles, missiles, and military electronics, not to mention artillery, small arms, and ordnance. They are the leading third world members of a fairly elite club — there were only fourteen countries represented in the SIPRI "top 100" in 1995 — but there are several other developing countries with significant arms production capacity as well.[1] For some countries in the third world, military industrialization appears to be proceeding apace.

This paper is about the forces driving that process. My focus is on what motivates state leaders in their efforts, and also on what constrains them. The determinants of arms production in the third world can be located at various levels: domestic politics and economics, regional security dynamics, and global technological and cultural diffusion. Although I will discuss each of these, the paper's main contribution is a quantitative empirical analysis of their relative importance in explaining third world military industrialization. There are very few such analyses in an otherwise diverse empirical literature on third world arms production.[2]

I examine indigenous and licensed arms production by the twelve most active third world producers for which reasonably complete data are available: Argentina, Brazil, Chile, Egypt, India, Indonesia, Israel, Pakistan, Singapore, South Africa, and Taiwan. My results are derived form an analysis of a time-series cross-section covering the period from 1968 to 1990, and they support much of what the literature identifies as correlates of third world arms production. As my analysis will show, domestic economic and political-economic factors both drive and limit military industrialization, as do regional security dynamics. Access to weapons technology also matters, but the technological diffusion afforded by an increasingly competitive international arms market may be less important than the technology flows accompanying patron-client relations. Lastly, I make an attempt to distinguish between the diffusion of technology and the diffusion of global military culture. My analysis does not yield much empirical support for the latter, but because I have had to rely on a rather crude empirical measure of cultural diffusion, I am reluctant to dismiss that explanation before a more nuanced empirical test can be constructed.

The next section identifies the major factors associated with third world arms production, oraganizes them into a coherent analytical framework, and lays out a series of hypotheses to be tested. This is followed by an explication of my research design and then a presentation of the empirical results.

EXPLAINING MILITARY INDUSTRIALIZATION

I start with a discussion of regional security dynamics since these provide a relatively straightforward explanation for a state's decision to pursue an indigenous arms production capacity. I will then turn to domestic forces, both economic and political-economic. Finally, I take up global processes involving the diffusion of weapons technology and culture.

Regional Security Dynamics

Third world states arms because they perceive threats to their national security. Here their behavior is no different from state behavior in general, and we need look no farther than to realist theory for the particular forces driving third world arms production. Ensuring national survival in an anarchic international system means confronting the security dilemma. States arm to protect themselves, but in so doing provoke similar behavior on the part of their neighbors. The resulting arms spiral is fed by weapons acquisition in all its forms. Domestic arms production is one form, and we might even expect to observe states responding in kind to regional competitors' military industrialization efforts. Action-reaction processes have been observed at the level of arms importation (Mintz 1986; Kinsella 1994, 1995). Still, this sort of symmetry is not necessarily predicted by realist theory, which has states responding to the military *capability* of their neighbors, whatever its source. That is, domestic arms production complements arms importation, and likewise is driven both by competitors' arms production and by their imports.

Recent or current involvement in military conflict provides the most obvious incentive to acquire weaponry. To the extent that warfare is sporadic, there may not be much motivation for military industrialization if immediate demands for armaments can be met by existing stocks or transfers. But for states engaged in enduring rivalries — generally hostile relations punctuated by overt militarized disputes — the impetus to develop an indigenous arms production capacity is much greater. The persistent need for weaponry that accompanies involvement in enduring rivalry accentuates the potential costs of being dependent on arms imports. Domestic arms production "is likely to increase the autonomy of decisionmaking in regard to war and peace" (Ayoob 1995, 147). There is consensus in the literature on this point. Indeed, for Katz (1984, 4-5), "[t]he most important factor driving LDCs to produce arms can be summarized quite easily: autonomy" (see also Brzoska 1989; Ross 1988).[3] So although regional conflict drives arms acquisition, it is regional conflict combined with the uncertainty of arms imports that drives military industrialization. Krause (1992, 162) in fact identifies a "near-perfect relationship between state's having been involved in a conflict and/or subjected to embargoes and its initiation of weapons production."

Domestic Forces

There are two sets of forces operating in domestic society, which I classify loosely as economic and political-economic.

Economic Factors. Like the regional security dynamics driving military industrialization, identifying the basic economic factors involved is relatively easy. In contrast to security concerns, which provide incentive for arms production, these operate as constraints on state leaders' ability to realize their desired levels of military industrialization. In short, weapons production rests on some minimally required capital and resource base, and "no Third World country can hope to support arms production if it does not already possess a reasonably strong, diversified industrial sector" (Ball 1988, 358). As a general observation, again there is consensus in the literature on this score. Some researchers have gone further, though, in an attempt to identify precisely the industrial production capacities required for military industrialization. For example, Wulf's (1983, 1985) "relevant industries" consist of manufacturing capacity in the following sectors: iron and steel, non-ferrous metals, metal products, non-electrical machinery, electrical machinery, and transportation equipment. These and similar criteria have been used to generate lists of countries with the highest potential for military industrialization (see also Kennedy 1974, chapter 15; Brzoska 1989; Brauer 1991).

The degree of indigenization that characterizes a state's domestic arms production varies, of course, and the importance of industrial capacity generally increases as states seek to expand the indigenous content of their weapons systems. Phases in the evolution of domestic arms production capacity are fairly well established. Wulf (1985, 330; also Ross 1988, 167) identifies five:

(1) repair, maintenance, and overhaul of imported weapon systems
(2) assembly of imported arms
(3) production of simple weapons components under license
(4) production of a major portion of weapons systems under license
(5) indigenous design and production of weapons systems

As Wulf and others have pointed out, there is a significant hurdle to be cleared in moving from licensed to indigenous production. For technologically advanced weapons systems, indigenous design and production requires not only industrial capacity, but also diverse and sophisticated research and development facilities. Much of what is labeled "indigenous" in fact consists of technologies and components imported from more advanced arms producers. So despite the considerable progress made by the leading third world arms producers, many predict a continuing — typically, three-tiered — global hierarchy in the design and production of the most advanced weaponry (Neuman 1984; Anthony 1992; Krause 1990, 1992).

For those countries with the industrial and technological capacity to establish domestic arms production programs, sustaining them requires continued demand for these industries' military products. Production runs must be sufficiently long to bring unit costs down to profitable levels if military industries are to survive without major subsidies from the state. This is a universal imperative, of course, and it is why so many of the world's leading arms producers have turned to the export market to supplement domestic demand. That the arms export market is populated by first- and second-tier arms producers presents third-tier aspirants with significant barriers to entry, but some have identified market niches for less sophisticated and inexpensive systems (e.g., Brazil) or sophisticated components (e.g., Israel). Even third world producers, like India, that placed less emphasis on arms exports have come to

appreciate the importance of developing an arms export capacity as a means of sustaining their indigenous programs.

Political-Economic Factors. One constraint facing an arms-producing state is the its industrial capacity evaluated in strictly economic and technological terms. But the literature has also drawn our attention to the capacity of the state itself to mobilize resources in defense of national security, and this includes resources necessary for military industrialization. Barnett (1990, 539-540), in examining the case of Israel, has commented that "even the presence of the necessary industrial and technological infrastructure does not provide the state with access to its required war matériel from domestic sources since the means of production are controlled by private actors." The extent of private control does vary somewhat across third world arms producers, but the more general point is valid even in cases where the state is more actively involved in the production process: the state's ability to mobilize resources, including its extractive capacity, figures in the success of military industrialization, whether resources are to be allocated to private or to state-run enterprises.

The role of the military in the development of an indigenous arms production capacity is open to debate. Most would agree with Brzoska (1989, 522) that the armed forces "have generally supported domestic arms production," although there are noteworthy exceptions. The reason has less to do with enhancing their war-fighting ability — better equipment can usually be acquired from foreign sources — than with the tendency of reform-minded military governments to use domestic arms production to promote industrial development, an essential element of state building (Ayoob 1991, 1995). A great deal of empirical research has examined whether or not "[f]rom an economic point of view [arms production] has a number of attractive features because it tackles some of the structural obstacles to development" (Kennedy 1974, 301). But even the most ardent critics of this view acknowledge that the possibility of military-led industrialization provides a powerful impetus for domestic arms production, and that the states most likely to head down this path are those where the military occupies a prominent role in society (e.g., Ball 1988).

The question remains as to the military's effectiveness in promoting domestic arms production. States most susceptible to military influence, including military rule, might be expected to allocate resources in pursuit of military industrialization. Although these same states might also have formidable extractive capacities vis-à-vis society, this is not a foregone conclusion. As Barnett (1990, 545; 1992) points out, "[a] state with a high degree of legitimacy is better able to mobilize societal resources." Legitimacy is often lacking in the case of military governments and civilian governments perceived to be under excessive military influence. So the same states that allocate resources toward military production may in fact have fewer resources to allocate.

Global Diffusion of Military Technology and Culture

Through their interaction with other states in international society, third world states acquire both preferences and capabilities. Military capabilities in particular are acquired through the diffusion of technology. Krause (1992, 18-25) describes three dimensions of military technological diffusion:

material transfer (technology I) involves the diffusion of finished systems and the ability to *operate* weapons technology; design transfer (technology II) is the diffusion of basic engineering know-how used to *reproduce* weapons technology; and capacity transfer (technology III) is the diffusion of scientific knowledge and technical expertise used to *adapt* weapons technology.[4] The bulk of third world arms production derives from design transfer. The obvious conduit for all three types of technology transfer is the arms trade. Material transfer pretty much dictates that recipients have or will soon acquire the ability to operate the weapons technology. Design transfer can accompany arms imports by way of reverse engineering, but less covert means of design transfer are embodied in licensed and co-production agreements.

Those who predict that existing stratification among arms producers will become less rigid, and third world states more autonomous, point to enhanced competition among suppliers in the international arms market and the leverage this affords recipients (e.g., Ross 1984, 1988; Steinberg 1989; Rosh 1990). Material transfers have become increasingly sophisticated, while the technological gap between what is procured by the world's best equipped armed forces as what is exported to third world states continues to narrow. More important for military industrialization is the willingness of arms suppliers to participate in design transfer in an effort to sweeten the deals they can offer potential customers in the third world, a development Klare (1983) referred to as the "unnoticed arms trade." Again, there is not much dispute in the literature about this empirical trend (see Bitzinger 1993, 1994), or about the global diffusion of military technology which has accompanied changes in arms-transfer practices. However, many analysts do doubt whether "military import substitution" will significantly alter well established patterns of third world military dependence (e.g., Lock and Wulf 1979; Neuman 1984; Krause 1992).

In contrast to the diffusion of military technology, which amplifies the opportunities for third world military industrialization, the global diffusion of military culture affects states' very preferences in this regard. Here it is helpful to distinguish (analytically) the *symbolic* value of advanced weaponry, and the capacity to manufacture it, from *material* utility in the context of war or (perhaps) industrial development. Kaldor (1981, 144) has remarked that the possession of advanced weaponry "allows for an ordering of international military relations, conferring political influence, merely through perceptions about military power," and that participation in this weapons *system* provides "a form of international legitimacy for Third World governments." According to Sagan (1996/97, 74), "military organizations and their weapons can therefore be envisioned as serving functions similar to those of flags, airlines, and Olympic teams: they are part of what modern states believe they have to possess to be legitimate, modern states." In short, high-tech military equipment, whatever its performance characteristics in the field, has "symbolic throw weight" (Suchman and Eyre 1992, 154). There is no great leap involved in suggesting that the capacity to manufacture this weaponry is also imbued with symbolic capital.[5]

The arms trade provides a mechanism for technological diffusion, but it also a mechanism for the diffusion of "technologism," that element of global military culture which leads to the "symbolic valuation of advanced over alternative technology" (Wendt and Barnett 1993, 339; see especially Wulf 1979 and Kaldor 1981).[6] At a more general level, some have sought to link the movement toward isomorphism in military procurement patterns to states' immersion in a world culture dominated by Western notions of rationality. Thus, Eyre and Suchman (1996) observe a correlation between the

possession of symbolically significant weaponry like supersonic aircraft and the state's membership in international organizations. Whether by participating in the arms market or in the deliberations of more formal institutions, the point is that military-cultural diffusion occurs when third world states interact with other states, especially militarily advanced ones, in international society.

Hypotheses

I have tried to identify the major determinants of third world arms production. By way of summary, I adopt Starr's (1978) distinction between opportunity and willingness. Opportunity refers to the "total set of environmental constraints and possibilities," while willingness is shorthand for the "willingness to choose (even if the choice is no action), and to employ available capabilities to further some policy option over others" (Most and Starr 1989, 23). Any reasonably comprehensive explanation must consider what motivates third world states (makes them willing) to pursue a domestic arms production capacity, and what environmental conditions expand or limit their opportunities to do so. Based on the previous discussion, Figure 1 lists the domestic, regional, and global forces involved in third world military industrialization as to whether they fall into one or the other category of explanation.

[Figure 1 about here]

At the domestic level, I expect that higher levels of military influence in governance will serve to increase the level of domestic arms production, due either to the military's desire to protect its own institutional interests or to its desire to promote military-led industrialization. also expect that greater industrial capacity, arms export capacity, and mobilization of military-targeted resources each provide greater opportunities for expanding weapons production. At the regional level, states are hypothesized to desire increased weapons production in response to both armed interstate conflict and militarization. I have not identified constraints on domestic arms production operating at the regional level. Finally, at the global level, I expect that third world states increasingly value military industrialization — emblematic of modern statehood — as a consequence of greater interaction with other, militarily advanced states in international society, especially in the arms market. I hypothesize that their opportunities to pursue military industrialization are enhanced also through participation in the arms market, and more so when competition among suppliers overcomes the aversion to transfer arms-production technology in addition to the arms themselves.

DATA ANALYSIS

I now turn to operationalizing and testing these hypotheses. My approach will be quantitative, and temporal. That is, in constructing a time-series cross-section (TSCS) for analysis, I have selected as my cases the leading third world arms producers: Argentina, Brazil, Chile, Egypt, India, Indonesia, Israel, Pakistan, Singapore, South Africa, and Taiwan. My goal cannot be to determine whether the factors I have identified predict which countries will produce arms and which will not. Rather, I want to examine whether these factors explain, for military-industrializing states, changes in the level of arms

production over time. Generalizing my results to other states, including non-arms producing states, is not intention of this analysis. More appropriate would be conjecture about future arms-production dynamics among these twelve.

Dependent Variable

Data on domestic arms production in the third world is collected by SIPRI. SIPRI keeps track of both licensed and indigenous production programs in the form of "registers." The first and only comprehensive list of both types of domestic production appeared in Brzoska and Ohlson (1986), although data for select countries are sometimes reported in the *SIPRI Yearbook*. Registers of licensed production have appeared regularly as a part of SIPRI's arms trade registers. The data used here are from Anthony (1992, table 17.1). They represent annual dollar-valued production output from 1965 to 1990, and they are generated by applying a price to items appearing in the registers. As Anthony (1992, 369) explains, "the estimates are not a proxy... for actual production costs," but instead are "based on technical comparisons of weight, speed, range, year of development and year of production between these systems and those for which production costs are available (usually systems produced in the United States)." This presents no particular problem for the present analysis.[7]

Separate statistical analyses are conducted for all domestic production and indigenous production only. Indigenous arms production is really the ultimate goal of states pursuing military industrialization and it is a capacity that is considerably harder to achieve. For that reason we might expect that indigenous weapons production is somewhat less responsive to factors that increase either the willingness or opportunity to push military industrialization. Table 1, from Anthony (1992), reports for each state the initial full-production year for major categories of indigenous weaponry. It seems to confirm what analysts generally suggest, namely, that artillery production is a fairly modest accomplishment, while indigenous manufacture of large integrated systems like warships, jet aircraft, and main battle tanks is considerably more difficult.

[Table 1 about here]

Independent Variables

Domestic Economic. Industrial capacity is measured as the value added by industry (manufacturing, mining and quarrying, construction, utilities) and comes from the World Bank's *World*Data* database. Data for Taiwan are not released by the World Bank; this time series was computed from data published by the U.S. Department of Labor and the Taiwanese government.[8] Although information on manufacturing, or more specifically manufacturing in Wulf's (1985) "relevant industries," might be a truer indicator of arms production potential, it seems much less essential for the sort of temporal analysis conducted here. Arms export capacity is measured simply as the value of actual arms exports, and comes from editions of the U.S. Arms Control and Disarmament Agency's *World Military Expenditures and Arms Transfers*.

Domestic Political-Economic. Systematic data on military influence are not readily available, to my knowledge, so as a surrogate I use the autocracy score from the *Polity III* database, which is a scaled (0-10) measure of political closedness (Jaggers and Gurr 1996).[9] My assumption is that higher levels of autocracy correlate with military influence in governmental affairs, including resource allocation. Military spending, as reported by ACDA, is used as a measure of the commitment of resources to military production. It too is imperfect, since a large chunk of any state's military budget goes to the maintenance of personnel and infrastructure, and some to procurement from foreign sources, but as a temporal indicator it will suffice.

Regional Security. My measure of regional conflict is the average number of militarized interstate disputes that the state was involved in during the previous three-year period. Since wars, or even lesser military conflicts, do not vanish so quickly from memory, a three-year moving average allows for the possibility of a lingering impact on domestic arms production. Data come from the *Militarized Interstate Dispute* (MID) dataset maintained by the Correlates of War Project. I employ two measures of regional militarization. The first is the total value of arms imported by major regional actors, as reported by ACDA; the second is the total value of arms produced by any of the other eleven states inhabiting the region. For each state, the regional actors assumed to be relevant in its security calculations are listed in Table 2. I have not attempted to distinguish between friend and foe, although refinement along these lines is certainly possible.[10] The measure of regional arms production may seem somewhat problematic since there are some major arms producers that are not among the twelve states for which I have production data: China, Australia, and Japan are the most obvious omissions. However, my intention is to capture the effects of any separate competition between states of comparable military-industrial development.

[Table 2 about here]

Culture and Technology Diffusion. Three variables used as indicators of military technology and cultural diffusion are based on the state's participation in the international arms market. Military technology in embodied in the transfer of complete weapons systems, so as one indicator I use the total value of arms imports reported by ACDA. Another measure of technology diffusion — or, rather, the state's ability to lever technology transfers from its arms suppliers — is the degree to which its arms-import portfolio is diversified. I start with Catrina's (1988, 199) measure of arms import dependence (see also Kinsella 1998):

$$\left(\frac{t_1}{T}\right)^2 + \left(\frac{t_2}{T}\right)^2 + \ldots + \left(\frac{t_n}{T}\right)^2$$

where t is the amount of arms imported from each supplier $i = (1, 2, ..., n)$, and T is the amount imported from all n suppliers. I subtract this from one and multiply by 100, so that the resulting index ranges between 0 and 100, with higher values indicating diversified arms-import portfolios and lower values dependent ones. A third measure of technology diffusion is licensed production. Since licensed

production is part of domestic arms production, I consider its impact only on indigenous production when examined separately.

The state's arms-import relationships have also been identified as fostering the transfer of military culture, and arms imports and licensed arms production would seem to serve a dual purpose as empirical indicators of both technological and cultural diffusion.[11] One obvious difficulty that this presents is untangling the two (theoretically) distinct effects captured by a single parameter estimate. An alternative indicator of cultural dimension, following Eyre and Suchman (1996), is the state's membership in IGOs, but there is not much temporal variance in this and may not give a fair hearing to the culture hypothesis. Instead, I opt for the state's total number of arms suppliers. This is meant as a straightforward indicator of the state's interaction with other states in the international arms market, a measure not otherwise weighted by the value of arms actually provided. Clearly, the number of suppliers it is related to total arms imports and import diversification, though they are not highly correlated (r = .09 and .56, respectively), but my intention is that after controlling for the latter, any effect captured by this variable will be more thoroughly cultural.

Statistical Estimation

Each of the independent variables in my analysis is lagged one year to approximate a temporal order consistent with the assumed causal relationship between the independent and dependent variables. The period of analysis is 1968-1990, so the TSCS consists of 276 observations. The TSCS design overcomes the degrees-of-freedom problem I would otherwise confront in examining twelve separate time series, but it does assume that the effects of the independent variables are consistent across the twelve countries. At this point, there is no reason to question that assumption, but spatial consistency — along with temporal consistency assumed by time-series models generally — could be a subject for further investigation.

TSCS data are also notorious for yielding "misbehaved" residuals when models are estimated using Ordinary Least Squares. Therefore, I began with a two-factor analysis of variance in the OLS residuals from my model. One factor is country: I want to know whether OLS residuals have a tendency to be higher for some countries than for others. Here I can reject the null hypothesis of equal residual means in the case of both domestic arms production ($F = 12.42$, $p = .00$) and indigenous arms production ($F = 7.27$, $p = .00$).[12] That is, aside from the various factors affecting the willingness and opportunity to produce weaponry, there is an "individual effect" associated with each, or at least some, of the twelve countries covered by my analysis. Contained in these individual effects are the country-specific idiosyncracies that pooling the data threaten to blur. Another factor is time: whether there is a tendency for residuals to be higher in some years (or periods) than in others. Here I can also reject the null of hypothesis of equal residual means for both domestic production ($F = 1.47$, $p = .09$) and indigenous production ($F = 1.75$, $p = .02$). The "time effects" suggest that particular years or periods are associated with higher levels of weapons production for the entire cross-section of countries or for subsets of them.

The presence of country-specific idiosyncracies can be handled quite easily, by re-expressing all time series as deviations from the series means for that country. This is a "fixed effects" model and is essentially the same as including a different intercept for each of the twelve countries.[13] The presence of contemporaneously correlated errors due to time effects requires correction if statistical inferences are to be unbiased. Another problem, "panel heteroscedasticity," is also evident in the OLS residuals. Because the twelve countries in my analysis vary along such dimensions as the size of the economy, government, and armed forces, it would not be surprising to find that residual variances differ across countries due to differing scales of arms production. In fact, I can reject the null hypothesis of equal residual variances for domestic arms production ($P^2 = 213.3$, $p = .00$) and for indigenous production ($P^2 = 216.6$, $p = .00$).[14]

Beck and Katz (1995) propose a solution for the problem of contemporaneously correlated errors and panel heteroscedasticity, which I adopt here. In short, they suggest taking advantage of the fact that TSCS residuals contain repeated information on the contemporaneous correlation of the errors in order to make the proper adjustments to the covariance matrix (see Beck and Katz 1995, 638). From this procedure we can obtain panel-corrected standard errors (PCSEs) and thereby avoid biased inferences. Beck and Katz have demonstrated the superiority of their modified OLS approach relative to others that employ modified Generalized Least Squares procedures, at least under the most common research conditions confronted by political scientists.

Statistical Results

Table 3 shows the results of the TSCS analysis. The first set of estimates are for the effects on all domestic production, licensed and indigenous. Column A consists of parameter estimates with panel-corrected standard errors. At the domestic level, all of the hypothesized determinants of third world arms production do seem to have been at work in the leading military industrializers during the period studied. Increases in both industrial capacity and export capacity provide expanding opportunities for increases in domestic arms production. All raw dollar-valued data are in millions (1990 = 100), so a $1 billion increase in industrial output is associated with a $5 million increase in arms production, while the same increase in last year's arms exports is associated with a $177 million increase in arms production. The relative closedness of political and governmental institutions — and, by assumption, the potential influence of the military — is also associated with higher levels of domestic arms production. An incremental increase in a state's autocracy score is associated with a $10 million increase in arms production. Relatedly, and not at all surprisingly, military spending also shows a positive impact. The more resources devoted to military procurement (among other things), the more arms the country produced: for every $1 billion more that went to military activities, $25 million worth of arms were produced.

At the regional level, the state's past involvement in military conflict as well as arms flows into the region affected its domestic arms production. The incidence of one additional militarized dispute on average during the previous three years is associated with a $44 million increase in arms production. For a $1 billion increase in regional arms inflows, there was a $4 million increase in arm production. As

to the impact of regional arms production, the finding is genuinely puzzling. The parameter estimate is negative, which neither supports the hypothesized action-reaction dynamic nor lends itself to a very convincing post hoc interpretation. In the arms race literature, the best explanation for negative reaction parameters is, in my view, Oren's (1996): because bellicose behavior is riskier for weaker states, it is also more credible and therefore threatening; so for any given level of bellicosity, the *stronger* the opposing state is, the less credible its threat and the *less* impetus there is for arming in response (see also Fearon 1992). The explanation is not a very plausible one in this context, however. The negative parameter estimate attaches to arms production by other states in the region, some competitors and some not (recall Table 2). The sort of strategic calculus that Oren (1996) posits would seem to apply best to states locked in rivalry. So, I remain puzzled by this finding.

At the global level, empirical support for the hypothesized relationships is mixed. Contrary to expectations, arms-import diversification has not expanded opportunities for domestic arms production. To the contrary, arms production has been fostered by arms-import *dependence*. An decrease of, say, 10 units on the import diversification scale is associated with a $16 million increase in arms production. One implication is that states have more leverage over military-technology transfers in the context of more dedicated arms-transfer relationships — in the extreme, patron-client relationships — than they do when trying to play suppliers off against one another. Although the empirical finding was not anticipated, this dynamic is fully plausible. The amount of weaponry the state imports has a positive on the amount of weaponry it produces, as expected. A $1 billion increase in imports is associated with a $152 million increase in production. The effect on arms production could be due to military technology transfer or to the transfer of military iconology, or to both. My attempt to isolate the effects of cultural transfer by focusing on states' interaction with others in the arms market has been unsuccessful, either because the effects do not operate or because the indicator is too crude. The parameter estimate for the number of arms suppliers is statistically insignificant.

It is not obvious from the parameter estimates which factors are relatively more important than others for predicting third world arms production. Standardized estimates — adjusted by standard deviation of the independent variable relative to that of the dependent variable — can give some sense of this, if we take a standard deviation change to be a "typical" change. Based on these computations, industrial capacity and arms imports are the most important factors affecting arms production, with a standard deviation change in each associated with a one-quarter to one-third standard deviation change in arms production (β = .32 and .28, respectively). Next most important are military spending, regional conflict, and arms-import diversification, but their effects are equal to less than a one-fifth standard deviation change in arms production (β = .18, .14, and .13). It is interesting that the most important predictors of military industrialization in the third world are factors that constitute constraints on arms production: industrial capacity and technology diffusion via the arms trade. Two of the three second most important factors also affect opportunity as opposed to willingness. The most important motivating forces behind domestic arms production appear to be the state's involvement in regional conflict and, possibly, the diffusion of military culture (to the extent that this captured empirically by arms imports).

Taken together, the domestic, regional, and global sources of motivation and opportunity explain 80 percent of the variance in domestic arms production for the twelve countries examined.[15]

The potential problem with the model, and the integrity of my inferences, is serial correlation in the residuals, as indicated by a Lagrange Multiplier test. I have approached this in two ways, neither of which is completely satisfactory in my view. First, I estimate the model using OLS, then correct the covariance matrix for serially correlated errors, but not for contemporaneously correlated errors or panel heteroscedasticity.[16] These estimates are reported in column B. Second, I follow Beck and Katz (1996) by including a lagged dependent variable in the specification. They have argued for explicitly modeling the dynamics in such cases rather than treating serial correlation as a "nuisance" to be purged by transforming the data in a GLS procedure. These estimates appear in column C.

The model that corrects for serial correlated errors only generates parameters estimates similar in magnitude and statistical significance to those just discussed. The exceptions are the effects of political closedness and regional arms imports, which are now statistically insignificant. The Beck-Katz solution, on the other hand, generates results in which only the effects of industrial capacity, arms imports, and arms-import diversification are left in tact, along with the effects of last year's domestic arms production. The obvious problem with the estimates in column B is that the standard errors are not panel corrected. But the problem with those in column C is that the lagged dependent variable, while taking care of the serial correlation problem, does not leave much unexplained variance for the other regressors. If the lagged dependent variable was truly explanatory, this would be flimsy ground to stand on. But to say that last year's arms production explains this year's arms production isn't to say much. Neither solution to the serial correlation problem is satisfactory, in my view, but I report all three sets of results so that the reader may judge.

The last three columns of Table 3 repeat the entire procedure for indigenous arms production, including the corrections for serially correlated errors. The one difference is that licensed production can now be included in the specification as an indicator of technological (and possibly cultural) transfer. The effect of licensed production on indigenous production is positive, as expected. Specifically, from column A, a $1 billion increase in licensed production is associated with a $470 million increase in indigenous production. It is not surprising to see that, compared to the effects for all domestic production, the effect of arms imports is statistically insignificant in this model: licensed production is a more direct measure of technology transfer than arms imports. The model's other parameter estimates are generally somewhat lower in magnitude than those for domestic production. Again, this is not surprising. The capacity for indigenous weapons production is harder to develop than the capacity for licensed production, which still relies on foreign sources for many of its inputs. When restricting attention to the former, production output should be somewhat more sluggish in response to increases in both the motivations and opportunities for military industrialization.

Standardizing these parameter estimates also results in weights that are in the same ballpark as for domestics arms production as a whole. Of course, licensed production substitutes for arms imports as a leading predictor of indigenous production, along with industrial capacity and military spending ($ = .24, .24, and .23, respectively). Like before, these represent constraints on arms production as opposed to motivations.

CONCLUSION

In this paper, I have tried to highlight the major determinants of third world military industrialization operating at the domestic, regional, and global levels. The literature on third world militarization is a rich source of insights into the dynamics involved, but there few (if any) comprehensive empirical investigations that consist of rigorous — shall we say "scientific" — analyses of the impact of the various factors affecting the state's willingness to pursue an arms production capacity and the opportunities to do so. I have undertaken such an investigation and have found much support for the relationships identified in the literature (methodological complications notwithstanding). Third world arms production depends the state's industrial capacity and is enhanced by the state's capacity to produce weapons for export. It is affected by the closedness of political and governmental institutions, and thus the military's potential influence in the allocation of resources, and by the actual allocation of resources in the form of military spending. States are motivated to pursue military industrialization programs by their involvement in regional conflict and the level of regional militarization. These too have a measurable impact on domestic arms production. The transfer of military technology in the form of arms imports affects domestic arms production overall; disaggregating, it is clear that technology transfer necessary for indigenous weapons production is accomplished in large part by licensing arrangements. Both arms imports and licensing might also be a vehicle for the diffusion of global military culture, but a crude indicator of state interaction failed to provide any independent confirmation. The global diffusion of military iconology as a driving force behind military industrialization is an important notion in my view, and represents a major challenge for systematic empirical research.

Whether or not the diffusion of arms production capacity to the third world constitutes "bad globalization" — as opposed to the "good globalization" emerging within the industrialized west (Bitzinger 1994) — depends on one's standpoint. But for those who do see this as the next proliferation challenge, an appreciation of the variety of forces driving it will facilitate the creation of effective arms control regimes. Noteworthy are my findings regarding the importance of constraints on arms production, compared to motivations, as predictors of actual levels of third world military industrialization. Resolution of the tensions that drive regional militarization and the eruption of military conflict should have some positive effect in restraining the proliferation of arms production capacity. But there also seems to be a certain inevitability to the process, which is limited only by states' industrial capacities and access to weapons-production technology. Of course, curtailing the former is not an option for the international community. Curbing the latter is an option, but maybe not a realistic one given the economic and political imperatives operating on advanced arms-producing states in a position to do so.

APPENDIX: ESTIMATING MISSING OBSERVATIONS

For the period analyzed in this paper, 1968 to 1990, there are 12 states × 23 years = 276 observations. Since licensed production also appears as a lagged independent variable in the analysis, another 12 observations are required for 1967. For these periods, the time series reported by Anthony (1992, table 17.1) contain 36 missing observations for indigenous production (13 percent) and 87 for licensed production (31 percent). Many of these values, roughly half, are safely assumed to be zero, based on adjacent values, but that still leaves many gaps in the two series. To fill these, I use simple linear interpolation. See Table A1.

[Table A1 about here]

This, it seems to me, is an appropriate procedure for two reasons. First, eliminating these missing observations from the dataset would require restricting my analysis to the 1980-1990 period or thereabouts. Alternatively, I could examine fewer countries over a longer period — say, seven of them from 1970 to 1990. Either approach results in roughly halving the total number of observations, giving me less information with which to estimate parameters. Counting the zeros as real values, along with the 60 or so missing observations, I would be excluding somewhat more nonmissing observations. Second, linear interpolation essentially involves filling the gaps in the time series without increasing the variance. The effect of this is probably to give an edge to the null hypotheses and to decrease the chances of making Type I errors. The null would only be disadvantaged if the actual patterns for the missing years were opposite those patterns for nonmissing years, a possibility I consider unlikely. In short, and in this particular case, linear interpolation of missing values would seem to offer benefits for parameter estimation that outweigh the risks.

NOTES

1. Actually, South Korean companies did not make it into SIPRI's 1995 list, but would have had the data been available. Counting China, also not represented for lack of data, the leading firms actually come from sixteen countries — still, an elite group. See Sköns and Cooper (1997, table 8.1) and Sköns and Gill (1996, table 10.14).

2. Peleg's (1980) superb study is one of the few exceptions, and provides something of a model for the present examination. Most other empirical work consists of single or comparative case studies. They are typically qualitative analyses, but informed by a wealth of quantitative data. Some researchers eschew statistical analysis because they are wary of the caliber of the quantitative data. This concern is misplaced, since the very purpose of statistical analysis is to distinguish "signal" from "noise" in quantitative data. Another reservation involves the generalizability of findings, even those processes revealed in rather accurate quantitative data. This concern has more merit in my view.

3. To say that third world states *seek* autonomy through military industrialization is not to say that they achieve it. Many argue that arms import substitution merely replaces dependence on weapons systems with dependence on weapons technology. See, for example, Lock and Wulf (1979), Moodie (1979), and Neuman (1984).

4. A fourth category (technology IV) involves the capacity to innovate at the technological frontier, and therefore is not acquired through diffusion.

5. Not surprisingly, the literature on nuclear weapons has generally been more attentive to such issues. Examples include Jervis (1989, chapter 6), Sagan (1996/97), and, from the domestic standpoint, Flank (1993/94). The literature on the symbolic motivations for conventional weapons acquisition is rather more sparse. And on military industrialization, it is virtually nonexistent; but see Kinsella and Chima (1997) on conventional arms production in India.

6. There are other mechanisms as well, including the training of third world military elites. See Mullins (1987, especially chapter 2) and Luckham (1984).

7. There is a different problem, however: the spotty coverage for some states, especially in the early years and especially in the case of licensed production. See the appendix.

8. Specifically, the series was computed from the manufacturing index released by the U.S. Department of Labor (http://stats.bls.gov/news.release/prod4.t16.htm, accessed 11 February 1998) and industry value added from Taiwan's Council for Economic Planning and Development (http://cepd.spring.org.tw/English/Economic/con9.html, accessed 11 February 1998). The industrial production index was not available for the entire period, but is highly correlated with the manufacturing index for period available ($r = .99$ for 1986-1996). Data for 1967-1969 are estimates based on extrapolated growth rates (based on 1970-1980 data).

9. The autocracy score, like the democracy score, is based on evaluations of the following: competitiveness and regulation of political participation, competitiveness and openness of executive recruitment, and constraints on the chief executive. See Jaggers and Gurr (1995, 471-472).

10. A systematic approach would be identify more or less threatening states based on aggregated levels of cooperation and conflict generated from an events dataset like the *World Event/ Interaction Survey* (see Tomlinson 1993).

11. There are two reasons to prefer ACDA's data on arms imports to SIPRI's in this particular context. First, although ACDA includes licensing fees as part of its definition of arms transfers, it does not include the value of the equipment produced under license, as does SIPRI. I want to keep imports separate from licensed production in the present analysis. Second, ACDA includes as transfers "military services such as training, supply operations, equipment repair, technical assistance, and construction" when data are available. Since all these activities are potentially involved in the diffusion of military culture — are part of Kaldor's (1981) weapons *system* — ACDA's measure is somewhat better for my purposes than SIPRI's, which is restricted to the transfer of major weapons. Note that beginning with the 1995 issue of *World Military Expenditures and Arms Transfers*, covering the period 1984-1994, ACDA includes military services in its tallies of U.S. transfers. This component was excluded from the U.S. data reported in prior issues, which was not altogether inappropriate (see ACDA 1996, 183-184).

12. The F ratios test the joint significance of the additional variance explained by separate dummy variables for each country.

13. This is a "fixed effects" model because the individual effect is treated as a fixed but unknown constant which varies only across individuals. An alternative, a "random effects" model, treats the individual effect as a random but unknown variable. Estimation involves decomposing the error term into its individual-effect and noise components and re-estimating the model with data transformed using that structure. In a random effects model, parameter estimates will remain biased and inconsistent if those individual effects are correlated with one or more of the regressors. These issues are discussed by Hausman (1978, 1261-1264) and Hausman and Taylor (1981). In the absence of knowledge about the individual effects, I have elected to estimate the safer (if cruder) fixed effects model.

14. The P^2 is the likelihood ratio statistic and tests the joint significance of pairwise differences in residual variances for the twelve countries.

15. In estimating the model using transformed data, the individual effects have been purged and are not reflected in the R^2 measure of explained variance. To get a more accurate indication of explained variance, I report the R^2 from a model using country-specific intercepts instead of transformed data.

16. The correction allows for serial correlation up to a moving average order of 1. Frankly, I do not know enough about either this correction or that used to compute PCSEs to try to combine them at this

point.

REFERENCES

Anthony, Ian. 1992. The "Third Tier" Countries: Production of major Weapons. In *Arms Industry Limited*, ed. Herbert Wulf. Oxford: Oxford University Press.

Ayoob, Mohammed. 1991. The Security Problematic of the Third World. *World Politics* 43: 257-283.

Ayoob, Mohammed. 1995. *The Third World Security Predicament: State Making, Regional Conflict, and the International System*. Boulder, CO: Lynne Rienner.

Ball, Nicole. 1988. *Security and Economy in the Third World*. Princeton: Princeton University Press.

Barnett, Michael. 1990. High Politics is Low Politics: The Domestic and Systemic Sources of Israeli Security Policy, 1967-1977. *World Politics* 42: 529-562.

Barnett, Michael. 1992. *Confronting the Costs of War: Military Power, State, and Society in Egypt and Israel*. Princeton: Princeton University Press.

Beck, Nathaniel and Jonathan N. Katz. 1995. What to Do (and Not to Do) with Time-Series Cross-Section Data. *American Political Science Review* 634-647.

Beck, Nathaniel and Jonathan N. Katz. 1996. Nuisance vs. Substance: Specifying and Estimating Time-Series Cross-Section Models. *Political Analysis* 6:1-34.

Bitzinger, Richard A. 1993. *The Globalization of Arms Production: Defense Markets in Transition*. Washington, DC: Defense Budget Project.

Bitzinger, Richard A. 1994. The Globalization of the Arms Industry: The Next proliferation Challenge. *International Security* 19: 170-198.

Brauer, Jurgen. 1991. Arms Production in Developing Nations: The Relation to Industrial Structure, Industrial Diversification, and Human Capital Formation. *Defence Economics* 2: 165-175.

Brzoska, Michael. 1989. The Impact of Arms Production in the Third World. *Armed Forces and Society* 15: 507-530).

Brzoska, Michael and Thomas Ohlson, eds. 1986. *Arms Production in the Third World*. London: Taylor and Francis.

Catrina, Christian. 1988. *Arms Transfers and Dependence*. New York: Taylor and Francis.

Correlates of War Project. 1996. *Militarized Interstate Disputes*, version 2.10. [computer file]

Eyre, Dana P. and Mark C. Suchman. 1996. Status, Norms, and the Proliferation of Conventional Weapons: An Institutional Theory Approach. In *The Culture of National Security: Norms and Identity in World Politics*, ed. Peter J. Katzenstein. New York: Columbia University Press.

Fearon, James D. 1992. Threats to use Force: Costly Signals and Bargaining in International Crises. Ph.D. dissertation, University of California, Berkeley.

Flank, Steven. 1993/94. Exploding the Black Box: The Historical Sociology of Nuclear Proliferation. *Security Studies* 3: 259-294.

Hausman, J.A. 1978. Specification Tests in Econometrics. *Econometrica* 46: 1251-1271.

Hausman, Jerry A. and William E. Taylor. 1981. Panel Data and Unobservable Individual Effects. *Econometrica* 49: 1377-1398.

Jaggers, Keith and Ted Robert Gurr. 1995. Tracking Democracy's Third Wave with the Polity III Data. *Journal of Peace Research* 32: 469-482.

Jaggers, Keith and Ted Robert Gurr. 1996. *Polity III: Regime Change and Political Authority, 1800-1994*. [computer file]

Jervis, Robert . 1989. *The Meaning of the Nuclear Revolution: Statecraft and the Prospect of Armageddon*. Ithaca, NY: Cornell University Press.

Katz, James Everett. 1984. Understanding Arms Production in Developing Countries. In *Arms Production in Developing Countries: An Analysis of Decision Making*, ed. James Everett Katz. Lexington, MA: D.C. Heath.

Kennedy, Gavin. 1974. *The Military in the Third World*. New York: Charles Scribner's Sons.

Kinsella, David. 1994. Conflict in Context: Arms Transfers and Third World Rivalry During the Cold War. *American Journal of Political Science* 38: 557-581.

Kinsella, David. 1995. Nested Rivalries: Superpower Competition, Arms Transfers, and Regional Conflict, 1950-1990. *International Interactions* 21: 109-125.

Kinsella, David. 1998. Arms Transfer Dependence and Foreign Policy Conflict. *Journal of Peace Research* 35: 7-23.

Kinsella, David and Jugdep S. Chima. 1997. Symbolic Forces Driving Third World Military Industrialization: The Case of India. Paper presented at the annual meeting of the International Studies Association, Toronto.

Klare, Michael T. 1983. Unnoticed Arms Trade: Exports of Conventional Arms-Making Technology. *International Security* 8: 68-90.

Krause, Keith. 1990. The Political Economy of the International Arms Transfer System: The Diffusion of Military Technique via Arms Transfers. *International Journal* 45: 687-722.

Krause, Keith. 1992. *Arms and the State: Patterns of Military Production and Trade*. Cambridge: Cambridge University Press.

Lock, Peter and Herbert Wulf. 1979. The Economic Consequences of the Transfer of Military-oriented Technology. In *The World Military Order: The Impact of Military Technology on the Third World*, ed. Mary Kaldor and Asbjørn Eide. New York: Praeger.

Luckham, Robin. 1984. Armament Culture. *Alternatives* 10: 1-44.

Mintz, Alex. 1986. Arms Imports as an Action-Reaction Process: An Empirical Test of Six pairs of Developing Nations." *International Interactions* 12: 229-243.

Moodie, Michael. 1979. Defense Industries in the Third World. In *Arms Transfers in the Modern World*, ed. Stephanie G. Neuman and Robert E. Harkavy. New York: Praeger.

Most, Benjamin A. and Harvey Starr. 1989. *Inquiry, Logic and International Politics*. Columbia, SC: University of South Carolina Press.

Mullins, A.F., Jr. 1987. *Born Arming: Development and Military Power in New States*. Stanford, CA: Stanford University Press.

Neuman, Stephanie G. 1984. International Stratification and Third World Military Industries. *International Organization* 38: 167-197.

Oren, Ido. 1996. Capability and Hostile Behavior in Arms Race Models. *International Interactions* 21: 309-334.

Peleg, Ilan. 1980. Military Production in Third World Countries: A Political Study. In *Threat, Weapons, and Foreign Policy*, ed. Pat McGowan and Charles W. Kegley, Jr. Beverly Hills: Sage.

Rosh, Robert M. 1990. Third World Arms Production and the Evolving Interstate System. *Journal of Conflict Resolution* 34: 57-73.

Ross, Andrew L. 1984. World Order and Third World Arms Production. In *The Implications of Third World Military Industrialization: Sowing the Serpents' Teeth*, ed. James Everett Katz. Lexington, MA: D.C. Heath.

Ross, Andrew L. 1988. Arms Acquisition and National Security: The Irony of Military Strength. In *National Security in the Third World*, ed. Edward Azar and Chung-In Moon. Aldershot: Edward Elgar.

Sagan, Scott D. 1996/97. Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb. *International Security* 21: 54-86.

Sköns, Elisabeth and Julian Cooper. 1997. Arms Production. In *SIPRI Yearbook 1997: Armaments, Disarmament and International Security*. Oxford: Oxford University Press.

Sköns, Elisabeth and Bates Gill. 1996. Arms Production. In *SIPRI Yearbook 1996: Armaments, Disarmament and International Security*. Oxford: Oxford University Press.

Starr, Harvey. 1978. "Opportunity" and "Willingness" as Ordering Concepts in the Study of War. *International Interactions* 4: 363-387.

Steinberg, Gerald. 1989. Technological Transfer and the Future of the Center-Periphery System: A Realist Perspective. *Jerusalem Journal of International Relations* 11: 96-117.

Stockholm International Peace Research Institute. annual. *SIPRI Yearbook: World Armaments and Disarmament*. Oxford: Oxford University Press.

Suchman, Mark C. and Dana P. Eyre. 1992. Military Procurement as Rational Myth: Notes on the Social Construction of Weapons Proliferation. *Sociological Forum* 7: 137-161.

Tomlinson, Rodney G. 1993. *World Event/Interaction Survey*, 6th revision. [computer file]

United States Arms Control and Disarmament Agency. 1996. *World Military Expenditures and Arms Transfers*. Washington, DC: U.S. Government Printing Office.

Wendt, Alexander and Michael Barnett. 1993. Dependent State Formation and Third World Militarization. *Review of International Studies* 19: 321-347.

World Bank. 1995. *World*Data 1995*. [computer file]

Wulf, Herbert. 1979. Dependent Militarism in the Periphery and Possible Alternative Concepts. In *Arms Transfers in the Modern World*, ed. Stephanie G. Neuman and Robert E. Harkavy. New York: Praeger.

Wulf, Herbert. 1983. Developing Countries. In *The Structure of the Defense Industry: An International Survey*, ed. Nicole Ball and Milton Leitenberg. New York: St. Martin's.

Wulf, Herbert. 1985. Arms Production in the Third World. In *SIPRI Yearbook 1985: World Armaments and Disarmament*. Oxford: Oxford University Press.

	Willingness	Opportunity
Domestic	military influence	industrial capacity export capacity resource mobilization
Regional	conflict militarization	
Global	arms market	arms transfers technology transfer

Figure 1. Determinants of Military Industrialization

Table 1. Indigenous Arms Production in the Third World

Producer	Jet Aircraft	Battle Tanks	Armored Vehicles	Guided Missiles	Large Artillery	Major Warships
Argentina	1987	•	1980	1978	1978	1943
Brazil	1986	1985	1974	1987	1969	1983
Chile	•	•	1984	•	•	•
Egypt	•	•	1966	1982	1981	•
India	1963	1995	•	1993	1980	1978
Indonesia	•	•	•	•	•	•
Israel	1971	1977	1975	1970	1968	•
Pakistan	•	•	•	•	1990	•
Singapore	•	•	•	•	1986	•
South Africa	•	1991	1973	1975	1979	•
South Korea	•	1987	•	•	1976	1980
Taiwan	1982	•	•	1979	1976	•

Note: Entries are the first year of full-scale production.

Source: Anthony (1993), table 17.2.

Table 2. Third World Arms Producers and Relevant Regional Actors

Producer	Regional Actors
Argentina	Bolivia, *Brazil*, *Chile*, Columbia, Paraguay, Peru, Uruguay, Venezuela
Brazil	*Argentina*, Bolivia, *Chile*, Columbia, Ecuador, Paraguay, Peru, Uruguay, Venezuela
Chile	*Argentina*, Bolivia, *Brazil*, Columbia, Paraguay, Peru, Uruguay, Venezuela
Egypt	Algeria, Chad, Ethiopia, Iran, Iraq, *Israel*, Jordan, Libya, Saudi Arabia, Sudan, Syria
India	Afghanistan, Bangladesh, China, *Indonesia*, Malaysia, Myanmar, *Pakistan*, *Singapore*, Thailand
Indonesia	Australia, Cambodia, *India*, Malaysia, Papua New Guinea, Philippines, *Singapore*, Thailand, Vietnam, South Vietnam (until 1975)
Israel	*Egypt*, Iran, Iraq, Jordan, Lebanon, Libya, Saudi Arabia, Syria
Pakistan	Afghanistan, Bangladesh, *India*, Iran
Singapore	Cambodia, *India*, *Indonesia*, Malaysia, Philippines, Thailand, Vietnam, South Vietnam (until 1975)
South Africa	Angola, Botswana, Mozambique, Namibia, Zambia, Zimbabwe
South Korea	China, Japan, North Korea, *Tawain*
Taiwan	Cambodia, China, *Indonesia*, Japan, Malaysia, North Korea, Philippines, *Singapore*, *South Korea*, Thailand, Vietnam, South Vietnam (until 1975)

Note: Data for countries listed as regional actors were used to construct the variable for regional arms imports. Data for countries in italics were used to construct the variable for regional arms production.

Table 3. Estimated Effects on Third World Arms Production, 1968-1990

	All Domestic Production			*Indigenous Production*		
	A	B	C	A	B	C
Domestic Economic						
Industrial Capacity	0.005**	0.005**	0.002**	0.003**	0.003**	0.002**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Arms Export Capacity	0.177**	0.186*	0.040	0.111**	0.115**	0.029
	(0.073)	(0.098)	(0.058)	(0.052)	(0.056)	(0.044)
Domestic Political-Economic						
Political Closedness	9.610*	9.020	5.363	9.710**	9.602**	5.328
	(5.053)	(6.723)	(5.353)	(3.314)	(4.071)	(3.450)
Military Spending	0.025**	0.022**	0.010	0.024**	0.022**	0.010**
	(0.010)	(0.011)	(0.008)	(0.006)	(0.008)	(0.005)
Regional Security						
Militarized Disputes	43.561**	51.525*	19.203	27.954*	33.124	13.872
	(17.871)	(27.601)	(16.379)	(14.659)	(24.442)	(13.249)
Regional Arms Imports	0.004*	0.005	0.002	0.006**	0.006**	0.002**
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.001)
Regional Arms Production	-0.083**	-0.079**	-0.027	-0.049**	-0.046*	-0.026**
	(0.023)	(0.035)	(0.018)	(0.015)	(0.024)	(0.012)
Technology & Culture Diffusion						
Arms Import Diversification	-1.629**	-1.640**	-1.275**	-1.590**	-1.532**	-1.138**
	(0.751)	(0.679)	(0.652)	(0.607)	(0.475)	(0.554)
Arms Imports	0.152**	0.142**	0.049*	0.029	0.023	0.016
	(0.035)	(0.060)	(0.028)	(0.023)	(0.027)	(0.021)
Arms Suppliers	10.352	11.235	9.283	-2.601	-2.139	5.333
	(8.625)	(9.539)	(7.722)	(7.086)	(8.256)	(5.971)
Licensed Arms Production				0.470**	0.457**	-0.083
				(0.140)	(0.176)	(0.150)
Lagged Dependent Variable			0.621**			0.619**
			(0.078)			(0.090)
Degrees of Freedom	254	242	241	253	241	240
Lagrange Multiplier	73.71**		0.88	73.87**		0.09
Explained Variance	.39	.36	.60	.38	.35	.57
Explained Variance (dummies)	.80	.80	.87	.79	.79	.86

Note: Models are based on a TSCS consisting of Argentina, Brazil, Chile, Egypt, India, Indonesia, Israel, Pakistan, Singapore, South Africa, South Korea, and Taiwan. All are "fixed effects" models and do not include constants. Columns A and C are OLS estimates with panel corrected standard errors (in parentheses). Estimates in column B are from OLS with autocorrelation corrected standard errors (using a first order moving average), but no panel correction. Columns B and C cover the 1969-1990 period. The Lagrange multiplier tests the null hypothesis of no first order autocorrelation. Explained variance is reported twice: for models using transformed data and for models using untransformed data with panel dummy variables.

** significant at the 0.05 level * significant at the 0.10 level

Table A1. Missing Arms Production Data and Means of Estimation

Producer	*Missing Years* Indigenous	Licensed
Argentina		1971-73, 1988-89 (interpolated)
Brazil		1967-71, 1985 (interpolated)
Chile	1969-70, 1972-1980 (interpolated)	1967 (zero); 1969-70, 1972-79 (interpolated)
Egypt		1970-78 (zero)
India		
Indonesia	1969, 1971-73 (interpolated)	1967-75 (zero)
Israel		1967-75, 1988-90 (zero)
Pakistan	1968-75 (zero)	1967-76 (zero)
Singapore	1970, 1972-73, 1976-77 (interpolated)	1967, 1989-90 (zero); 1970, 1972-73, 1976-77, 1984-85 (interpolated)
South Africa		
South Korea	1968-70, 1973-74 (interpolated)	1967-74 (zero)
Taiwan	1980, 1982, 1989 (interpolated)	1967 (zero); 1980-89 (interpolated)
zero	8 (2.9%)	50 (18.1%)
interpolated	28 (10.1%)	37 (13.4%)