NATO Burden Sharing 1999–2010: An Altered Alliance

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Motivated by US Secretary of Defense Robert Gates' farewell address to NATO, this article investigates whether NATO burden-sharing behavior has changed during the last ten years. Based on a Spearman rank correlation test, we find almost no evidence that the rich NATO allies shouldered the defense-spending burden of the poor allies during 1999–2009. In 2010, there is the first evidence of the exploitation of the rich. When allies' defense burdens are related to defense benefit proxies, a Wilcoxon test finds that there is no concordance between burdens and benefits after 2002. This is indicative of a less cohesive alliance, in which allies are not underwriting their derived benefits. We also find that allies' benefits, which are tied to their exposed border protection and terrorism risk, motivate defense spending. Allies' benefits, based on economic base and population, are less of a driver of defense spending for most NATO allies. We devise a broad-based security expenditure burden that accounts for defense spending, UN peacekeeping, and overseas foreign assistance. In terms of this security burden, there is evidence of the exploitation of the rich by the poor beginning in 2004. Our findings indicate a two-tiered alliance that faces significant policy challenges.

> In the past, I've worried only about NATO turning into a two-tiered alliance: Between members who specialize in "soft" humanitarian, development, peacekeeping, and talking tasks, and those conducting the "hard" combat mission. Between those willing and able to pay the price and bear the burdens of alliance commitments, and those who enjoy the benefits of NATO membership – be they security guarantees or headquarters billets – but don't want to share the risks and costs. This is no longer a hypothetical worry. We are here today. And it is unacceptable. US Secretary of Defense Robert Gates (2011)

When first formed in 1949, the North Atlantic Treaty Organization (NATO) consisted of just 12 allies—Belgium, Canada, Denmark, France, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom, and the United States. This military alliance was intended to halt the westward expansion of the Soviet Union. In the 1950s, Greece, Turkey, and West Germany joined NATO. Spain entered in 1982. The membership of NATO remained stable until the fall of the Berlin Wall and the subsequent collapse of the Soviet Union. Unified Germany replaced West Germany as a NATO ally in 1990. Between 1999

and 2009, the alliance expanded from 16 to 28 allies, a net expansion of 75%. Hungary, the Czech Republic, and Poland became NATO allies in 1999; Bulgaria, Estonia, Latvia, Lithuania, Romania, Slovakia, and Slovenia joined NATO in 2004; and Albania and Croatia entered NATO in 2009. These new entrants bring enhanced heterogeneity to NATO in terms of defense capabilities, preferences, location, industrial base, and defense risks (for example, exposed borders to protect). This heterogeneity not only poses problems for NATO's missions since decisions must be unanimous, but it also presents issues about burden sharing owing to differing priorities.[1]

Following the end of the Cold War with the collapse of the Soviet Union in 1991, NATO required a new mission insofar as the Soviet Union did not present the same threat (Gompert and Larrabee 1997). NATO reinvented itself as a protector of European interests with peacekeeping missions in Bosnia, Kosovo, and elsewhere (Shimizu and Sandler 2002). NATO expanded its operations to out-of-area military operations and assisted in humanitarian operations. NATO also conducted a military operation in Afghanistan (that is, International Security Assistance Force [ISAF]). In 2011, NATO assisted Libyan rebels to topple the regime of Muammar Qaddafi.

In addition to its membership expansion, there are other noteworthy changes to NATO that can potentially affect burden sharing among its allies. First, there is a growing gap in weapon-embodied technology among the allies (Hartley and Sandler 1999), which is reflected by the research and development (R & D) expenditures of member states—the United States spent $468.7 billion on R & D during 2001–2010, or 13% of its defense spending (Stockholm International Peace Research Institute[SIPRI] 2010; 198), while most NATO allies spent a negligible amount on R & D (European Defence Agency 2011). Second, there is a much greater reliance on out-of-area missions that involve combat and nation-building operations in distant venues. The Afghanistan War, starting in October 2001 and continuing to the present day, is the first real war fought by NATO and lays bare the allies' disparate capabilities. Third, there is a declining concern about Russia as a threat. Fourth, the great recession has stressed many NATO economies and made them reassess their defense and nondefense public expenditures. Fifth, the post-9/11 era and the war on terror have differentially impacted NATO members, thereby influencing how they perceived the gains from fighting the Taliban and al-Qaida-affiliated terrorist groups. Sandler and Hartley (2001) showed that strategic doctrine changes, technological advances, membership alterations, and mission changes affect the mix of country-specific and alliancewide benefits, derived from allies' defense spending. In so doing, this changed composition of public and private defense benefits influences burden sharing.

Secretary of Defense Gates' quote at the outset of the paper is significant for a number of reasons. In the polite world of diplomacy, such unabashed bluntness is rarely heard. His remarks are tied to burden sharing, because spending on combat dwarfs the spending on peacekeeping and humanitarian operations, thereby resulting in a two-tiered alliance of contributors. His statement also implies that there is now a mismatch between defense burdens and benefits received. Until recently, the NATO burden-sharing literature showed that there has generally been a concordance between allies' defense burdens and their derived benefits since 1967 (see, for example, Sandler and Forbes 1980; Sandler and Hartley 1999, 2001; see, however, Solomon 2004 for a dissenting viewpoint). If Secretary of Defense Gates' remarks are correct, then the NATO alliance has changed in a fundamental way in recent years.

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[1] On NATO's missions and its institutional structure, see Sandler and Hartley (1999).

The purpose of this paper is to systematically explore Gates' concerns. In particular, we investigate the changes in NATO burden sharing over the last decade using three alternative burden-sharing measures: within-ally defense burdens, between-ally defense burdens, and a broad-based security burdens. We show that our findings are dramatically different than the extant literature that considered NATO burden sharing up through 1999. Moreover, we explain why these burden-sharing differences have arisen in the post-9/11 era. A secondary purpose is to introduce a couple of novel burden-sharing measures, appropriate to the war-on-terror era. A tertiary purpose is to consider the state of NATO in light of Gates' remarks and our burden-sharing findings. By so doing, we raise some policy concerns and predict the prospects for NATO's future.

When defense burdens are compared to NATO allies' national income, there is little evidence after 1967 of the exploitation of the rich by the poor allies, predicted in the seminal article of Olson and Zeckhauser (1966). After 2002, there is, however, clear evidence that various average benefit shares of the allies no longer match their defense burdens. This means that the cohesiveness of NATO falls following the war on terror, NATO expansion, and the growing importance of out-of-area missions. For a broad-based security burden measure, there is evidence of exploitation of the rich by the poor starting in 2004 when additional defense controls are held constant.

The findings of this paper indicate real policy challenges for NATO. During these difficult economic times, NATO must address how to foster greater cohesiveness of capabilities among its members. This is difficult when some allies (for example, Lithuania and Estonia) recently announced procurement moratoriums and other allies (for example, Italy, Greece, Poland, Slovenia, and Slovakia) announced deep defense cuts (International Institute for Strategic Studies [IISS] 2011:80). A two-tiered alliance with unbalanced burden sharing limits the ever-increasing emphasis in NATO on out-of-area missions, as embodied by the Lisbon summit document on *Active Engagement, Modern Defence* in November 2010 (IISS 2011:73–74). This paper points to an apparent mismatch between emerging NATO doctrine and allies' capabilities that require future foreign decision making.

Past Studies of NATO Burden Sharing: A Brief Review

In a seminal study, Olson and Zeckhauser (1966) viewed NATO allies as sharing a purely public defense good in the form of deterrence (see also, Olson 1965), arising from the doctrine of mutual assured destruction. The latter threatened to respond to Warsaw Pact aggression in Europe with an annihilating volley of nuclear missiles. The threat embodied in the US arsenal of strategic nuclear weapons provided nonrival and nonexcludable benefits for the NATO allies as long as the United States' commitment to fire these missiles was credible and automatic. This depiction of NATO was an accurate one for the 1950s and much of the 1960s. Olson and Zeckhauser (1966) predicted a suboptimal spending on defense as allies did not account for the benefits that their defense spending conferred on other allies. Moreover, Olson and Zeckhauser hypothesized that the small, poor allies would rely on the large, rich allies, three of which (the United States, the United Kingdom, and France) had strategic nuclear weapons. A fourth rich ally—West Germany—was motivated to guard its eastern border against possible Soviet aggression, thereby defending most allies to the west. This scenario led Olson and Zeckhauser (1966) to predict an exploitation of the rich (large) by the poor (small) allies. This was tested by them with a Spearman rank correlation test, where each ally's ME/GNP rank was computed along with its GNP rank, where GNP denotes gross national product. Olson and Zeckhauser (1966) found a positive and significant rank correlation between defense

burdens (ME/GNP) and GNP for 1964, indicative of the anticipated exploitation as richer allies carried the greatest defense burdens, normalized by GNP. ME/GNP reflected a within-ally defense burden, because richer countries could support a greater ME.

In a series of subsequent papers, a joint product model of alliances was put forward, where allies' defense spending gave rise to country-specific private benefits (for example, national disaster relief), purely public benefits from deterrence, and impurely public protective benefits (see, for example, Sandler 1977; Sandler and Forbes 1980; Murdoch and Sandler 1982). Impurely public protective benefits may arise from troop deployment on a national border that gives more protection to the provider than to distant allies (see, for example, McGuire and Groth 1985; Sandler and Murdoch 1990). The doctrine of flexible response, first expressed in the directive MC 14/3, allowed NATO to respond in a measured way to Warsaw Pact challenges. In light of the doctrine, NATO's arsenal of strategic, tactical, and conventional forces became complementary, because they had to be used in conjunction with one another (Murdoch and Sandler 1984). By relying on all three kinds of weapons, this doctrine meant that NATO's defense activities gave rise to joint products with varying degrees of publicness. The greater the share of excludable (that is, private and impurely public defense benefits) to total defense benefits, the smaller the extent of free riding as NATO allies must reveal a preference if they are to benefit from the defense activity of the alliance. Moreover, the anticipated complementarity among weapon types would limit free riding and bolster optimality. As a consequence, the doctrine of flexible response ushered in an era during 1967–1990, where defense burdens were expected to match defense benefit.

During the immediate post-Cold War era (1991–2000), the threat to NATO was no longer in the east. NATO assumed crisis management missions in nearby Bosnia and Kosovo to safeguard European interests and to contain the spread of conflict. Such missions possessed more purely public benefits with greater free-rider opportunities for allies that would limit their participation in NATO's new strategic doctrine. The Oslo Declaration during June 1992 included peacekeeping as part of NATO's new strategic doctrine (Asmus 1997). NATO officially recognized that it possessed vital interests beyond its allies' territory. These interests spread initially as far as the Persian Gulf owing to the importance of oil. During the Brussels summit in January 1994, NATO adopted the principle to expand to the east, which paved the way for NATO enlargement beginning in 1999.

Past Empirical Record

Previous articles tested the exploitation hypothesis for NATO before and after 1967, the official start of the doctrine of flexible response. Russett (1970) found a significant rank correlation between ME/GNP and GNP for 1950–1967; however, this correlation declined after 1961. Sandler and Forbes (1980) only uncovered a significant rank correlation between ME/GDP and GDP for 1960–1966; thereafter, they found an insignificant rank correlation, except for 1973. Khanna and Sandler (1996) examined the same rank correlation for 1960–1992 and found no significant correlation after 1966. With an alternative methodology, Oneal and Elrod (1989) investigated the percentage of ME/GDP variance, explained by GDP during 1953–1984. They showed that an insignificant percentage of defense burdens were explained by GDP after 1968, consistent with the rank correlation studies. Finally, Sandler and Murdoch (2000) showed that there were no significant rank correlations for any year during 1988–1999. Thus, the evidence overwhelmingly indicates no exploitation of the rich by the poor allies after the institution of the doctrine of flexible response.

In light of these results, the literature sought empirical support for the joint product model of alliance. Two approaches were taken. One regressed an ally's military expenditures on its income, the lagged military expenditure of other allies (denoted by alliance spillovers), and a spillover shift variable for the doctrine of flexible response (Murdoch and Sandler 1984). It was found that an ally's reaction to spillovers became more positive after the doctrine of flexible response took hold. This finding is indicative of defense joint products of allies being complementary, since free-riding behavior is consistent with a negative coefficient on the spillover term as an ally cuts its defense when the other allies spend more. A negative reaction to spillovers implies that the defense spending of allies substitute for one another.

The second approach checked the match between defense burdens and derived defense benefits. This method first devised a between-ally burden-sharing measure, which indicates an ally's share of *overall* NATO ME for each ally. If, say, this burden share is 50%, then this ally's benefit share must be near 50% to indicate that burdens and benefits are matched. To test for the match between defense burdens and benefits, Sandler and Forbes (1980) first devised an average benefit share measure to reflect what defense spending protected for each ally through the deployment of conventional and strategic forces. They argued that each ally's economic base, its population, and its exposed borders are protected by NATO forces and their ability to deter aggression. An ally's economic base is directly related to its GDP. To proxy an ally's overall share of defense benefits, Sandler and Forbes (1980) computed each ally's share of NATO GDP (that is, an ally's GDP/NATO GDP), its share of NATO population, and its share of NATO exposed border. [2] Since the utility function of each ally is not known, Sandler and Forbes (1980) summed the three benefit shares together and divided by three, which equally weighted each component. Consistent with the joint product model and a large share of excludable benefits, Sandler and Forbes (1980) discovered a much closer match between NATO defense burdens and derived benefits for 1975 than for 1960. In follow-up studies, Khanna and Sandler (1996, 1997) could not reject a match between NATO defense burdens and derived benefits, based on a nonparametric Wilcoxon test for the following sample years: 1965, 1970, 1975, 1980, and 1990. Only during the height of the Reagan defense buildup in 1985 did NATO defense burdens not statistically match derived benefits. Sandler and Murdoch (2000) tested the concordance between NATO defense burdens and derived benefits for each year in the 1990s and could not reject the null hypothesis that NATO defense burdens and average benefit shares matched one another. This finding supports the notion that NATO defense possessed sufficient country-specific and impurely public benefits to limit free riding up through 1999 as allies assumed defense burdens commensurate with a benefit proxy.

Predictions for the Last Decade

NATO has gone through drastic transformations during the last decade. The horrific terrorist attacks on 9/11 launched a US-led war on terror, which began with military action against Afghanistan on October 7, 2001, to eliminate the Taliban and al-Qaida. Some ten years later, the Afghanistan War against these foes continues with US and NATO forces. The derived benefits from this war are likely to be greatest for those countries that are venue or the target of transnational terrorist attacks, orchestrated by al-Qaida or its global network of affiliates. In each year, the venue for transnational terrorist attacks in NATO allies is highly variable. Less variation characterizes the target of attack, with US interests

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[2] An ally's exposed border includes its coastline (if any) and its borders, not contiguous to another NATO ally.

attracting the largest share of transnational terrorist attacks (Enders and Sandler 2012).[3] Other prime-target NATO countries include the United Kingdom, France, Germany, and Italy (Mickolus et al. 2011). Inclusion of a terrorism-based benefit share may foster the match between NATO defense burdens and derived benefits.

Out-of-area missions should generate more alliancewide purely public benefits as stability brought to trouble spots yields nonrival and nonexcludable benefits for all NATO allies. Actions to rid Libya of a tyrant generate benefits to all NATO allies, especially if Qaddafi's ouster stabilized the flow of oil from Libya. Nation-building and peacekeeping missions in Bosnia and Kosovo bolster peace throughout Europe by limiting the spread of ethnic unrest. In so doing, nonrival and nonexcludable benefits are received by the NATO allies.

NATO expansion implies a number of subtle influences on burden sharing. This expansion has greatly increased the range of capabilities and tastes of the allies. Increased diversity will bifurcate the alliance into one set of allies (typically the richer ones) that can assist with combat missions and another set of allies that cannot assist with such missions (except in a support role). As a consequence, burden sharing will become more unbalanced in terms of the match between defense burdens and derived benefits. Even among allies that can assist in "soft" (cheap) peacekeeping missions, these allies may not view such missions as yielding much benefit for them. Many new allies are more concerned about security at home than underwriting security in distant venues. This may result in more exploitation of the rich by the poor and a poorer match between defense burdens and derived benefits. Thus, the bifurcation, recognized by Secretary Gates, is predictable and a product of NATO expansion.

Bifurcation also stems from the technological revolution in warfare over the last decade. There are only a handful of NATO allies that spend any of their military expenditures on R & D. In 2009, the United States spent $79 billion on R & D (SIPRI 2010). By contrast, France spent 3.7 billion euros, the United Kingdom spent 2.8 billion euros, and Germany spent 1.1 billion euros on R & D during 2009 (European Defence Agency 2011). This spending pattern, coupled with procurement choices, will result in many NATO allies not having the capability to fly combat sorties where targets must be acquired in cloudy weather.[4] Moreover, a limited set of allies can fire precision-guided missiles and munitions at distant targets. These vastly different abilities will result in a greater exploitation of the rich by the poor if NATO takes on more out-of-area combat missions, such as Libya. There will also be an anticipated increased mismatch between defense burdens and derived benefits if missions to spread democracy and remove tyrants really improve the security of all allies in relation to their GDP and population—their most valuable assets—as many allies are not really participating in these missions (Gates 2011).

Another expected change in burden sharing is due to the downsizing of military spending as a share of GDP over the last twelve years. Table 1 displays each NATO ally's ME/GDP or within-ally defense burden for 1999–2010, disaggregated by year. Allies' ME shares of GDP are only listed when they are NATO members. For example, the shares for Bulgaria and Estonia are only listed for 2004 on. There are a number of clear patterns. First, many of the longtime NATO members have continued to reduce their share of GDP devoted to defense,

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[3] This variability in terrorist attacks will be a key factor in driving our new burden-sharing measures in Tables 3–5, displayed later in the paper.

[4] At the end of 2010, the following NATO allies had all-weather combat planes—Belgium, Canada, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain, Turkey, the United Kingdom, and the United States (IISS 2011). Many of these allies acquired these planes recently with delivery of the Eurofighter Typhoon. Some allies with such capabilities may be unwilling to participate in out-of-area combat missions.

Table 1. Military Expenditures As a Share of Gross Domestic Product: 1999–2010 (In Percent)

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Albania											2.07	1.73
Belgium	1.42	1.37	1.31	1.25	1.25	1.18	1.12	1.08	1.13	1.17	1.14	1.15
Bulgaria						2.57	2.42	2.26	2.45	2.35	2.27	1.55
Canada	1.24	1.14	1.17	1.16	1.15	1.14	1.15	1.16	1.22	1.29	1.44	1.28
Croatia											1.80	1.77
Czech Rep.	2.00	2.04	1.91	1.99	2.06	1.86	1.96	1.72	1.51	1.31	1.54	1.31
Denmark	1.60	1.49	1.57	1.55	1.50	1.46	1.35	1.42	1.34	1.40	1.40	1.47
Estonia						1.70	1.91	1.90	2.08	2.15	2.29	1.75
France	2.67	2.55	2.49	2.51	2.56	2.58	2.48	2.42	2.35	2.33	2.43	2.37
Germany	1.52	1.48	1.45	1.45	1.44	1.38	1.36	1.31	1.28	1.29	1.37	1.41
Greece	4.31	4.34	4.09	3.89	3.11	3.25	3.50	3.46	3.30	3.64	4.03	3.07
Hungary	1.68	1.67	1.79	1.63	1.66	1.50	1.45	1.25	1.29	1.20	1.31	1.02
Italy	1.97	2.04	1.97	2.00	2.01	1.97	1.89	1.79	1.70	1.69	1.69	1.86
Latvia						1.67	1.70	1.84	1.70	1.88	2.63	1.15
Lithuania						1.82	1.60	1.56	1.54	1.53	1.74	1.19
Luxembourg	0.66	0.63	0.79	0.80	0.79	0.78	0.79	0.78	0.71	0.40	0.40	0.50
Netherlands	1.71	1.55	1.55	1.54	1.55	1.54	1.50	1.51	1.47	1.40	1.53	1.48
Norway	2.08	1.74	1.74	2.12	2.01	1.89	1.62	1.49	1.52	1.32	1.47	1.52
Poland	1.92	1.85	1.91	1.90	1.93	1.92	1.93	1.88	1.93	2.01	2.02	1.78
Portugal	1.91	1.88	1.94	1.97	1.93	2.01	2.11	2.02	1.88	1.91	1.96	2.27
Romania						2.03	2.00	1.84	1.54	1.50	1.42	1.33
Slovak Rep.						1.69	1.72	1.63	1.52	1.49	1.50	1.17
Slovenia						1.46	1.44	1.56	1.46	1.52	1.73	1.69
Spain	1.22	1.21	1.17	1.15	1.10	1.09	1.05	1.17	1.16	1.20	1.25	1.21
Turkey	3.98	3.75	3.68	3.89	3.39	2.78	2.50	2.54	2.17	2.21	2.76	2.10
UK	2.43	2.39	2.40	2.46	2.52	2.45	2.42	2.35	2.35	2.47	2.68	2.55
USA	3.02	3.05	3.06	3.37	3.74	3.93	4.00	3.96	3.98	4.31	4.71	4.60

(*Note*. These shares come from World Bank (2011), except for Luxembourg's shares for 2008–2010, which come from NATO [2011]).

whose decline began after the end of the Cold War. These allies include Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, and Turkey. Second, many new entrants started with about 2% of their GDP earmarked for defense, but then their shares gradually dissipated, that is, Czech Republic, Hungary, Romania, and Slovak Republic. Third, other NATO entrants' shares fell greatly in 2010, that is, Bulgaria, Estonia, Latvia, Lithuania, and Poland. Fourth, the share of US GDP devoted to defense increased beginning in 2002 during the war on terror. Given the size of US defense spending, a larger burden of NATO has been placed on the United States (this shift will be shown later).

For 1999–2009, many rich NATO allies—for example, Canada, Belgium, Denmark, Germany, Italy, and the Netherlands—spent a relatively small portion of their GDP on defense. Moreover, many relatively poor NATO entrants devoted a larger share of their GDP to defense in order to integrate themselves into the NATO military structure. Other poor allies—Greece, Portugal, and Turkey—devoted respectable shares of their GDP to defense.[5] Despite the growing defense burden on the United States, there should not be any disproportionate burden placed on the rich by the poor, given the above hybrid pattern. The sole exception might be 2010 when so many poor allies cut their share of GDP devoted to defense. Later, we perform a Spearman rank correlation test on these predictions.

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[5] The rivalry between Greece and Turkey and past disputes over Cyprus have driven these countries' high ME shares of GDP.

Data

NATO allies' ME shares of GDP are obtained from the World Bank (2011), except for 2008–2010 values for Luxembourg, which are drawn from NATO (2011). Besides ME/GDP, the data include each ally's GDP in current US dollars, population (POP), and exposed borders. The latter is the sum of an ally's coastlines and its borders with non-NATO countries including neutral countries. For example, the long border between Canada and the United States is not exposed and hence is not included in these two allies' exposed border calculations. Insofar as we are testing rank correlations for each year separately, there is no need for converting nominal ME and GDP into real or constant dollar terms. GDP and POP are taken from World Bank (2011), while exposed borders are computed using data obtained from the US Central Intelligence Agency (2011). Apart from ME/GDP, the data on ME in 2009 US dollars are drawn from SIPRI (2011), with the exception of 2008–2010 ME values. These are calculated using corresponding ME figures in current US dollars listed in NATO (2011) and appropriate GDP deflators taken from the World Bank (2011).

In a later section, we extend the average benefit share measure for allies to include terrorist incident measures. This is a novel and important extension for an analysis of burden sharing during the war on terror era. To construct these measures, we take the terrorist incident data from *International Terrorism: Attributes of Terrorist Events* (ITERATE), which records transnational terrorist incidents for 1968–2010 (Mickolus et al. 2011). ITERATE indicates transnational terrorist incidents' date, location (by country), victims' nationalities, and other information. Through its perpetrators, victims, institutions, or implications, transnational terrorist incidents concern two or more countries. An incident that commences in one country but concludes in another, such as a skyjacking, is a transnational terrorist incident. In proxying the derived benefits from the war on terror, we focus on transnational terrorist events because they present potential risks to all NATO allies at home and abroad. These threats follow from the attack venue, that is, the country of the attack. An alternative terrorist threat is captured by the nationality of the victim(s). Thus, we compute two proxies for an ally's derived benefit from the war on terror—these proxies will play an important role at a later point in Tables 3–5.

The first benefit proxy calculates each ally's share of transnational terrorist incidents on home soil, relative to all such attacks in NATO for each sample year. If, for instance, Belgium sustains two transnational terrorist incidents in a year when NATO allies in total suffer 20 such attacks, then Belgium's share is 10% that year. Belgium is at risk from such terrorism, and allied efforts to curb transnational terrorism through military expenditures benefit Belgium. The second benefit proxy computes each ally's share of transnational terrorist attacks, based on the victim's nationalities. An ally, whose citizens sustain a greater share of NATO's transnational terrorist attacks, derives more potential benefits from defense-based efforts to inhibit these attacks. If, say, three allies' citizens are attacked in a given incident, then three attacks are included in the total number of incidents sustained by NATO's interests when computing this share measure.

In the next-to-last section, we examine rank correlations between GDP and a broader security burden-sharing measure, which is the sum of ME, UN peacekeeping financial contributions, and foreign development assistance, divided by GDP. Annual data on each ally's actual financial contributions to the special assessment accounts for UN peacekeeping are obtained from the United Nations (2000–2011). Official development assistance (ODA) disbursement data are taken from the Organization For Economic Co-Operation and Development (OECD) (2011). Both peacekeeping and ODA data are in current US dollars. Because all of our burden measures are in terms of the share of GDP, it makes

no difference to use current or constant dollar terms, that is, any deflator would cancel in the numerator and denominator.

Ability to Pay and Burden Sharing

ME/GDP is the standard ability-to-pay burden-sharing measure, used originally by Olson and Zeckhauser (1966) and later employed by others. To test for the exploitation hypothesis, we apply a Spearman rank correlation (ρ) test that relates ME/GDP to GDP. The alternative (H_a) and null (H_0) hypotheses for a rank correlation test are as follows:

> H_a: Within the NATO alliance, there is a positive association between allies' GDP and their share of GDP devoted to military expenditures.
> H_0: There is no association between these two variables.

A rejection of the null hypothesis is indicative of a positive relationship between the allies' *ranks* of ME/GDP and those of GDP. As such, one would conclude that the rich allies are exploited by the poor allies, consistent with the free-riding prediction from a pure public good model of alliance-shared defense. The Spearman rank correlation test is robust to outliers and small measurement errors because ranks, not actual values, of the variables are used. In addition, the Spearman correlation is a parametric-free statistic, which is appropriate when large allies, like the United States, are grouped with small allies, like Luxembourg.

In column 2 of Table 2, the simple rank correlations are listed for 1999–2010. There is no association at the .05 level since the null hypothesis *cannot be rejected.* This is consistent with our priors that there is no exploitation of the rich by the poor for most of the post-1999 era. In fact, the correlation coefficient generally declines until 2010 when it increases greatly but is still not significant. Thus, the rapid falloff of many poorer allies' ME/GDP burdens in 2010, when the United States, the United Kingdom, and France maintained much higher burdens, has brought back the first hints of exploitation in almost 35 years; however, more years of data are needed to put much value on these hints.

TABLE 2. Spearman Rank Correlations between Defense Burden (ME/GDP) and GDP

	ρ_{12}^a	$\rho_{12,3}^b$	$\rho_{12,34}^c$
1999	0.14 (0.57)	0.23 (0.35)	0.13 (0.46)
2000	0.19 (0.46)	0.30 (0.23)	0.20 (0.24)
2001	0.14 (0.57)	0.27 (0.29)	0.16 (0.35)
2002	0.16 (0.53)	0.23 (0.37)	0.14 (0.42)
2003	0.19 (0.44)	0.27 (0.28)	0.19 (0.26)
2004	0.14 (0.50)	0.39** (0.05)	0.15 (0.29)
2005	0.10 (0.64)	0.37* (0.06)	0.12 (0.41)
2006	0.07 (0.74)	0.33* (0.10)	0.09 (0.55)
2007	0.05 (0.80)	0.29 (0.16)	0.06 (0.68)
2008	0.08 (0.71)	0.31 (0.12)	0.09 (0.55)
2009	−0.02 (0.91)	0.23 (0.45)	−0.03 (0.84)
2010	0.27 (0.18)	0.36* (0.06)	0.22 (0.11)

(*Notes.* Numbers in parentheses are prob-values, indicating the probability of a type I error when testing the null hypothesis of no association between ME/GDP and GDP ranks. ***significant at .01 level; **significant at .05 level; and *significant at .10 level.

Variables: 1 = ME/GDP; 2 = GDP; 3 = GDP/POP; 4 = exposed borders.

[a]Simple rank correlation coefficient.

[b]Partial rank correlation coefficient with GDP/POP held constant.

[c]Partial rank correlation with GDP/POP and exposed borders held constant.)

Next, we adjust for confounding factors that may induce greater defense burdens, that is, longer exposed borders and greater well-being in terms of per capita GDP (GDP/POP). The latter holds because wealth means that a country has more to lose from conflict or invasion and will spend more on defense. To adjust for these confounding factors, we compute partial rank correlation coefficients in columns 3 and 4 of Table 2 that holds GDP/POP, or GDP/POP *and* exposed borders constant. We obtain a somewhat different finding to that of the simple rank correlation coefficient. For the partial correlation holding GDP/POP constant, there is some small evidence of exploitation in 2010 since the null hypothesis is now rejected at the .10 level. Moreover, there is evidence of exploitation when GDP/POP is held constant in 2004, 2005, and 2006 at the .10 level or better. For the partial correlation coefficient that holds per capita GDP and exposed borders constant, we do not discern an increased correlation between defense burdens and GDP except for 2010. In 2010, this partial correlation has a prob-value of 0.11, which is not quite significant at the .10 level. What we discern is that if NATO continues its very recent course, then burdens may be shared disproportionately. NATO is just beginning to rely on a few rich allies to conduct out-of-area missions and the war on terror. NATO appears poised on a precipice of change and this change is not good for the cohesion of the alliance.[6] Further evidence of this will come if defense burdens and derived benefits no longer match, because this implies that the joint product model no longer underlies NATO behavior.

The Concordance between Defense Burdens and Benefit Shares

Following Sandler and Forbes (1980) and others, we investigate the concordance between an average benefit share measure (defined below) and a between-ally defense burden. This latter burden is each ally's ME as a share of NATO ME. For each ally, derived benefits are proxied by the ally's share of NATO GDP, its share of NATO population, and its share of NATO's exposed borders. Guarding these borders not only protects an ally from conventional warfare, but it also protects an ally from transnational terrorists, international criminals, and illegal immigrants. Given the enhanced importance of transnational terrorism for our sample period of 1999–2010, we include a fourth benefit share to reflect an ally's threat of terrorism. Sandler and Forbes (1980) averaged only three benefit shares, while Khanna and Sandler (1996) averaged four benefit shares in one set of tests. However, no previous study used a terrorism share measure.

We compute two average benefit shares, each of which is an average of four share measures for each ally. The first average benefit share includes GDP, population, exposed borders, and venue-based transnational terrorism attacks, while the second benefit share substitutes target-based transnational terrorism attacks for venue-based attacks. To ascertain the correspondence between defense burdens and its benefit proxies, we applied a Wilcoxon signed rank test, which is a nonparametric test that assigns ranks based on the absolute value of the differences between the two measures. The test then computes the sum of the ranks with positive differences and that with negative differences. The smaller of these two rank sums is the R statistic. The alternative hypotheses are as follows:

> H'_a: The distributions of defense burdens and average benefit shares for the NATO allies are different.

H$'_0$: The distributions of defense burdens and average benefit share for the NATO allies are the same.

A large Wilcoxon R statistic favors *not rejecting the null hypothesis* so that defense burdens and average benefits shares are drawn from the same distribution, thereby implying a concordance between defense burdens and its benefits.

We merely average the benefit shares for two reasons. First, we do not know the preferences of the NATO allies nor how they would differentially weigh safeguards to the economy over, say, protection to the population. In the absence of this information, we treat each of the benefit shares equivalently. Second, previous studies, except for Solomon (2004), applied equal weights to an alternative set of benefit shares. For comparability, we also use equal weights so that we can ascertain whether things have changed after 1999. Any alternative set of weights can be quite arbitrary.

In Table 3, we display for each sample year the defense burden and its average benefit share using GDP, population, exposed borders, and venue-based transnational terrorism for the relevant allies. A similar table using target-based terrorism is available upon request. In a given year, allies are only included if they are NATO members. Iceland is left out because it has virtually no defense spending. For a given year, the left column is the defense burden as a share of NATO, while the right column is the average benefit share. For example, in 1999, Belgium assumed 0.89% of NATO's total defense spending, while Belgium received a benefit share of 0.67%. The other entries are interpreted similarly. For example, in 2010, Denmark assumed only 0.46% of NATO defense burden, but received 2.85% of NATO benefit shares, thereby making it an undercontributor. With the exception of the United States and the United Kingdom, all allies are undercontributors in 2010. In earlier years, there was a more balanced mix of overcontributors and undercontributors. For example, in 1999, Belgium, France, Italy, the Netherlands, the United Kingdom, and the United States were overcontributors, while the Czech Republic, Luxembourg, and Portugal contributed the right amount according to our benefit measure. Over the sample period, the US defense burden rose from 55.5% to 70.44% of NATO's total defense spending. This huge burden increase came during a time where there is no discernible increase in US average benefit share. As a consequence, the United States is underwriting an ever-increasing burden of NATO without a compensating increase in its benefits. The fluctuation in the US benefit share is stemming from the variability of the terrorism share. In the bottom two rows of Table 3, the defense burden and benefit shares for NATO-Europe and NATO-North America (United States and Canada) are displayed. Clearly, these burdens and benefit shares have become more unbalanced over time with North America shouldering a burden that far outweighs its benefit share. Because the United States has defense interests and commitments that lie outside of NATO's concerns, US "overcontributions" must be deemphasized somewhat. This same imbalance characterizes the set of NATO allies over time in Table 3 with the number of undercontributors increasing after 1999 according to our measures. The average benefit share variability, displayed by a few countries (for example, Greece), stems from terrorist attacks by venue.

In Table 4, we report the Wilcoxon R statistic for testing the null hypothesis that defense burdens and derived benefits are drawn from the same distribution. The dates are displayed in Column 1, followed in Column 2 by the sample size, which varies primarily because of NATO expansion. The next three columns indicate the R statistic associated with three alternative benefit share measures. Prob-values are given in parentheses. Average share 1 includes GDP, population, and exposed borders; average share 2 contains these three benefit proxies and venue-based terrorism; and average share 3 incorporates the first three benefit proxies

TABLE 3. Defense Burdens and Average Benefit Shares in NATO Using GDP, Population, Exposed Borders, and Terrorism in Venue Country as Proxies for Benefits: 1999–2010

	1999		2000		2001		2002	
	Defense Burden	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*
Albania								
Belgium	0.89	0.67	0.87	0.64	0.83	0.63	0.74	0.64
Bulgaria								
Canada	2.02	17.27	1.94	19.53	1.98	17.32	1.85	17.30
Croatia								
Czech Rep.	0.44	0.45	0.45	0.44	0.43	0.44	0.42	0.45
Denmark	0.68	0.96	0.65	0.94	0.69	0.94	0.63	1.83
Estonia								
France	9.23	6.87	8.92	6.28	8.86	6.01	8.36	9.49
Germany	7.63	12.64	7.34	8.66	7.20	5.32	6.68	7.11
Greece	1.31	7.68	1.35	8.15	1.31	1.64	1.19	1.65
Hungary	0.26	0.56	0.28	0.55	0.30	0.56	0.27	0.56
Italy	5.93	4.10	6.18	3.94	6.06	5.85	5.76	9.33
Latvia								
Lithuania								
Luxembourg	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Netherlands	1.73	1.09	1.63	1.05	1.66	1.06	1.54	1.08
Norway	0.77	2.47	0.73	2.48	0.73	2.48	0.81	2.49
Poland	0.89	1.64	0.84	1.63	0.87	1.63	0.82	1.62
Portugal	0.62	0.63	0.63	0.62	0.65	0.62	0.62	0.62
Romania								
Slovak Rep.								
Slovenia								
Spain	2.02	5.07	2.05	6.78	2.06	2.46	1.95	3.41
Turkey	3.08	5.65	2.91	4.19	2.66	8.78	2.62	5.74
UK	6.95	6.57	6.83	9.15	7.04	12.44	6.91	8.38
USA	55.50	25.65	56.37	24.94	56.62	31.77	58.80	28.26
NATO-Europe	42.48	57.08	41.69	55.53	41.40	50.90	39.35	54.44
NATO-North America	57.52	42.92	58.31	44.47	58.60	49.10	60.65	45.56

	2003		2004		2005		2006	
	Defense Burden	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*
Albania								
Belgium	0.69	4.90	0.64	7.61	0.60	0.65	0.58	0.65
Bulgaria			0.12	0.31	0.12	0.31	0.12	0.31
Canada	1.73	17.34	1.69	17.01	1.72	17.08	1.77	17.15
Croatia								
Czech Rep.	0.42	0.46	0.38	1.13	0.41	0.44	0.37	0.44
Denmark	0.56	0.96	0.53	0.94	0.49	0.94	0.53	0.94
Estonia			0.04	0.36	0.04	0.36	0.05	0.36
France	7.95	5.57	7.68	4.93	7.31	4.20	7.25	4.18
Germany	6.08	8.04	5.53	6.73	5.30	5.21	5.11	5.14
Greece	0.94	4.64	0.97	4.39	1.02	1.61	1.05	1.61
Hungary	0.27	0.57	0.24	0.47	0.23	0.46	0.20	0.46

TABLE 3. *(continued)*

	2003		2004		2005		2006	
	Defense Burden	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*
Italy	5.36	6.66	5.05	5.42	4.73	3.98	4.51	3.95
Latvia			0.04	0.15	0.05	0.15	0.06	0.15
Lithuania			0.06	0.20	0.06	0.20	0.07	0.20
Luxembourg	0.04	0.05	0.04	0.05	0.03	0.05	0.03	0.05
Netherlands	1.44	1.97	1.36	1.10	1.33	1.09	1.37	1.09
Norway	0.72	2.92	0.70	2.46	0.64	2.48	0.63	2.49
Poland	0.78	1.60	0.77	1.50	0.80	1.52	0.84	1.53
Portugal	0.55	0.64	0.55	0.62	0.57	0.61	0.54	0.61
Romania			0.27	0.83	0.28	0.84	0.28	0.85
Slovak Rep.			0.15	0.22	0.16	0.23	0.16	0.23
Slovenia			0.08	0.15	0.08	0.15	0.09	0.15
Spain	1.79	3.50	1.73	4.03	1.70	2.67	1.96	6.87
Turkey	2.18	10.74	1.87	12.07	1.72	7.66	1.82	15.64
UK	6.73	6.55	6.29	5.54	6.13	22.98	6.03	8.97
USA	61.76	22.88	63.23	21.79	64.49	24.12	64.57	25.96
NATO-Europe	36.50	59.77	35.08	61.21	33.80	58.80	33.65	56.89
NATO-North America	63.50	40.23	64.92	38.79	66.20	41.20	66.35	43.11

	2007		2008		2009		2010	
	Defense Burden	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*
Albania					0.03	0.16	0.02	0.16
Belgium	0.62	0.67	0.64	0.68	0.56	2.60	0.54	0.67
Bulgaria	0.14	0.31	0.11	0.32	0.10	0.31	0.07	0.31
Canada	1.90	17.16	1.94	17.16	1.96	16.81	2.01	16.97
Croatia					0.11	0.69	0.11	0.69
Czech Rep.	0.35	0.46	0.28	0.48	0.27	0.47	0.25	0.47
Denmark	0.50	3.03	0.49	4.53	0.44	0.93	0.46	2.85
Estonia	0.06	0.36	0.05	0.36	0.04	0.35	0.03	0.35
France	7.14	6.33	6.70	7.89	6.72	4.28	6.10	7.07
Germany	5.02	7.29	4.89	5.28	4.77	5.18	4.66	6.04
Greece	1.03	3.71	1.08	5.21	1.06	5.44	0.93	13.11
Hungary	0.20	0.47	0.18	0.47	0.15	0.43	0.13	0.42
Italy	4.29	4.00	4.21	4.05	3.85	7.84	3.80	7.75
Latvia	0.07	0.16	0.06	0.16	0.04	0.15	0.03	0.15
Lithuania	0.07	0.20	0.07	0.20	0.05	0.20	0.04	0.19
Luxembourg	0.03	0.05	0.02	0.06	0.02	0.06	0.03	0.06
Netherlands	1.36	1.11	1.27	1.15	1.22	3.05	1.16	2.06
Norway	0.66	2.51	0.62	2.54	0.62	2.46	0.63	3.45
Poland	0.93	1.56	0.79	1.61	0.80	3.47	0.83	1.56
Portugal	0.51	0.62	0.48	0.62	0.48	0.61	0.52	0.60
Romania	0.27	0.87	0.28	0.88	0.22	0.85	0.22	0.84
Slovak Rep.	0.15	0.23	0.15	0.24	0.12	0.23	0.10	0.23
Slovenia	0.08	0.16	0.08	0.16	0.08	0.12	0.08	0.12
Spain	1.99	2.78	1.89	6.42	1.70	2.81	1.57	2.74

(continued)

TABLE 3.   *(continued)*

	2007		2008		2009		2010	
	Defense Burden	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*	*Defense Burden*	*Average Benefit Share*
Turkey	1.57	9.45	1.63	13.96	1.64	5.10	1.56	3.28
UK	6.00	11.14	5.91	4.66	5.82	6.31	5.72	5.36
USA	65.07	25.40	66.16	20.92	67.15	29.08	68.41	22.50
NATO-Europe	33.04	57.44	31.90	61.92	30.89	54.11	29.58	60.53
NATO-North America	66.96	42.56	68.10	38.08	69.11	45.89	70.42	39.47

(*Notes.* Figures represent percentage share of NATO's total for each variable. For example, defense burden indicates the ally's defense spending divided by total NATO defense spending. Average benefit share denotes the sum of each ally's shares of NATO GDP, NATO population, NATO exposed borders, and NATO terrorist attacks on home soil, divided by four. The totals for NATO-Europe and NATO-North America may not add up due to rounding.)

TABLE 4. Wilcoxon Signed Rank Correlation of ME/NATO ME and Alternative Average Benefit Shares

	Sample Size	*R Statistic Average Share 1*	*R Statistic Average Share 2*	*R Statistic Average Share 3*
1999	18	56 (0.21)	60 (0.28)	57 (0.23)
2000	18	63 (0.35)	59 (0.26)	47* (0.10)
2001	18	62 (0.32)	68 (0.47)	73 (0.61)
2002	18	52 (0.15)	30*** (0.01)	59 (0.26)
2003	18	39** (0.04)	35** (0.03)	42* (0.06)
2004	25	46*** (0.00)	70*** (0.01)	47*** (0.00)
2005	25	45*** (0.00)	82** (0.03)	54*** (0.00)
2006	25	45*** (0.00)	73*** (0.01)	47*** (0.00)
2007	25	44*** (0.00)	64*** (0.00)	40*** (0.00)
2008	25	41*** (0.00)	58*** (0.00)	27*** (0.00)
2009	27	45*** (0.00)	48*** (0.00)	27*** (0.00)
2010	27	42*** (0.00)	40*** (0.00)	27*** (0.00)

(*Notes.* Numbers in parentheses are prob-values. The critical values for rejecting the null hypothesis of a match between defense burdens and benefit shares are 40 at .05 level and 27 at .01 level for 1999–2003; are 89 at .05 level and 68 at .01 level for 2004–2008; and are 107 at .05 level and 83 at .01 level for 2009–2010. Iceland is excluded for all years. Average share 1 includes GDP share, POP share, and exposed border share. Average share 2 includes GDP share, POP share, exposed border share, and transnational terrorist attacks share by venue; Average share 3 includes GDP share, POP share, exposed border share, and transnational terrorist attacks share by target. ***significant at .01 level; **significant at .05 level; and *significant at .10 level.)

and target-based terrorism. We include the three-benefit average share 1 for comparison to the literature. After 2002, we reject the null hypothesis at the .05 level and conclude that defense burdens no longer match derived defense benefits. A similar story holds for average shares 2 and 3, except that average share 3 is not rejected at the .05 level until 2004 and the large expansion of NATO. Thus, the target-based terrorism benefit share maintains concordance between defense burdens and benefits for another couple of years. This match changed with some crucial events, that is, NATO expansion, the war on terror, NATO's focus on crisis management, and the technology gap. The findings here, when combined with the Spearman rank correlation results, suggest a greater share of pure public benefits and the concomitant increase in free riding.

In Table 5, we can pinpoint which benefit proxies are behind the lost concordance. The five right-hand columns of Table 5 display the R statistic and

TABLE 5. Wilcoxon Signed Rank Correlation of ME/NATO ME and Single Benefit Shares

	R Statistic GDP Share	R Statistic POP Share	R Statistic Border Share	R Statistic Venue Share	R Statistic Target Share
1999	66 (0.42)	35** (0.03)	61 (0.30)	72 (0.58)	79 (0.80)
2000	74 (0.64)	34** (0.02)	63 (0.35)	84 (0.97)	70 (0.52)
2001	74 (0.64)	36** (0.03)	67 (0.44)	44* (0.07)	56 (0.21)
2002	57 (0.28)	31** (0.02)	68 (0.47)	81 (0.87)	59 (0.26)
2003	36** (0.03)	25*** (0.00)	71 (0.55)	66 (0.42)	73 (0.61)
2004	53*** (0.00)	39*** (0.00)	158 (0.92)	119 (0.25)	162 (1.00)
2005	39*** (0.00)	30*** (0.00)	157 (0.89)	48*** (0.00)	122 (0.29)
2006	36*** (0.00)	28*** (0.00)	152 (0.79)	70*** (0.01)	124 (0.31)
2007	31*** (0.00)	28*** (0.00)	155 (0.85)	124 (0.31)	119 (0.25)
2008	29*** (0.00)	27*** (0.00)	162 (1.00)	110 (0.16)	134 (0.91)
2009	30*** (0.00)	29*** (0.00)	174 (0.73)	156 (0.44)	163 (0.55)
2010	27*** (0.00)	29*** (0.00)	173 (0.71)	141 (0.26)	119* (0.10)

(*Notes.* Numbers in parentheses are prob-values. The critical values for rejecting the null hypothesis of match between defense burdens and the single benefit share are 40 at .05 level and 27 at .01 level for 1999–2003; are 89 at .05 level and 68 at .01 level for 2004–2008; and are 107 at .05 level and 83 at .01 level for 2009–2010. Iceland is excluded for all years. See Table 4 for sample sizes for each year. Venue share consists of transnational terrorist attacks in each ally as a share of all such attacks in NATO. Target share consists of transnational terrorist attacks against an ally's interests as a share of all such attacks in NATO. ***significant at .01 level; **significant at .05 level; and *significant at .10 level.)

prob-values when defense burdens are related to a single benefit measure. In the second column, the concordance between defense burdens and GDP share ends in 2003, not to return. Thus, the economic base is no longer a driver of burden sharing for most of the NATO allies. A similar story holds for population, because an ally's share of NATO population does not relate to its defense burden for any sample year. The remaining three measures generally display a concordance between defense burden and what is being protected. An ally's exposed border share motivates its assumption of NATO defense burdens. Generally, both terrorism benefit proxies are related to the share of NATO defense burden that an ally underwrites. This is true for target-based terrorism, which more heavily impacts the United States, the United Kingdom, and France. These countries spend the most in Afghanistan. The last two columns of Table 5 show that terrorism motivates the most-at-risk allies to spend more on defense. By testing each of the five benefit proxies separately, we can *eliminate* changes in exposed borders from NATO expansion and the enhanced terrorism risk as causing the imbalance between defense burdens and benefits. Table 5 goes beyond our equal weighting scheme to show how each proxy influences the match between defense burdens and benefits. In particular, our findings are robust provided that not too much weight is given to the border share or terrorism share measures.

Security Burden Sharing

As a final exercise, we follow Sandler and Murdoch (2000) and test the exploitation hypothesis with a broader security burden-sharing measure that includes allies' defense spending, UN peacekeeping support, and foreign aid contributions. By quelling unrest in trouble spots that may affect NATO assets and interests, peacekeeping bolsters overall security for the allies. Foreign assistance does the same by creating more robust and stable economies in developing countries. The assistance also makes for healthy population, thereby limiting the spread of disease. The difficulty in devising a security burden-sharing measure is to account for differing spending magnitudes associated with each of these

TABLE 6. Spearman Rank Correlations between Security Burden (SE/GDP) and GDP

	ρ_{12}^{a}	$\rho_{12,3}^{b}$	$\rho_{12,34}^{c}$
1999	0.21 (0.39)	0.23 (0.37)	0.17 (0.34)
2000	0.27 (0.28)	0.28 (0.26)	0.23 (0.18)
2001	0.13 (0.61)	0.14 (0.59)	0.09 (0.60)
2002	0.14 (0.57)	0.13 (0.62)	0.09 (0.59)
2003	0.23 (0.36)	0.21 (0.40)	0.19 (0.26)
2004	0.31 (0.14)	0.31 (0.12)	0.25* (0.07)
2005	0.34* (0.10)	0.35* (0.08)	0.29** (0.04)
2006	0.31 (0.13)	0.29 (0.15)	0.26* (0.07)
2007	0.31 (0.13)	0.27 (0.18)	0.26* (0.06)
2008	0.35* (0.09)	0.35* (0.08)	0.31** (0.03)
2009	0.24 (0.23)	0.22 (0.26)	0.16 (0.23)
2010	0.54*** (0.00)	0.40** (0.03)	0.46*** (0.00)

(*Notes.* Numbers in parentheses are prob-values, indicating the probability of a type I error when testing the null hypothesis of no association between SE/GDP and GDP. ***significant at .01 level; **significant at .05 level; and *significant at .10 level.

Variables: 1 = SE/GDP; 2 = GDP; 3 = GDP/POP; 4 = exposed borders.

[a]Simple rank correlation coefficient.

[b]Partial rank correlation coefficient with GDP/POP held constant.

[c]Partial rank correlation coefficient with GDP/POP and exposed borders held constant.)

activities. Shimizu and Sandler (2002) demonstrated that NATO defense spending far exceeds peacekeeping expenditures. For most NATO allies, the same is true of foreign assistance. To adjust for these different magnitudes, we merely sum an ally's expenditure on defense, peacekeeping, and foreign aid and then divide by the ally's GDP. Ranks are assigned for these security expenditure (SE) burdens and then compared to each ally's GDP rank during the sample period.

In Table 6, we display the Spearman rank correlations, associated with the security burden and GDP.[7] A simple rank correlation and two partial rank correlations are shown for the sample years. In the second column, there is clear evidence of exploitation in 2010 at the .05 level and weak evidence in 2005 and 2008 at the .10 level. When GDP/POP is held constant, the same outcome appears. Finally, holding GDP/POP and exposed borders constant, we find weak support for the exploitation hypothesis for 2004, 2006, and 2007 at the .10 level, and stronger support for 2005, 2008, and 2010 at the .05 level. When UN peacekeeping and foreign assistance are included with defense spending, some rich countries contribute a larger share of GDP to the security measure. These countries include Canada, Denmark, Germany, and Norway, which explain the differences between Tables 2 and 6. In 2010, there is clear evidence of the exploitation hypothesis as most NATO entrants, which are relatively poor, cut their security expenditures. The results for 2010 may portend continued exploitation in the future, consistent with concerns articulated by the Secretary of Defense Gates.

Concluding Remarks

Our results show that burden sharing has changed since around 2002 and the start of the war on terror. Evidence is beginning to emerge for the first time since 1975 that the rich allies are shouldering more of the defense burden for

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[7] ODA expenditures for 2010 are missing for Estonia, Latvia, Lithuania, and Romania and are replaced with these countries' 2009 ODA expenditures. ODA expenditures are set at 0 because of missing data for Albania, 2009–2010; Bulgaria, 2004–2010; Croatia, 2009–2010; Hungary, 1999–2002; Romania, 2004–2007; and Slovenia, 2004. When they contributed to ODA, these countries gave very little to ODA; hence, these 0 values are reasonable proxies.

the poor allies. This exploitation finding is clearer for a more broad-based security measure. Evidence of this exploitation starts to show up around 2005 and is present in 2010. When NATO defense burdens are matched with various benefit share proxies, we find that the match, prevalent for most years after 1975, disappeared by 2003—see Table 4. Thus, NATO allies' derived excludable benefits from defense no longer drive NATO burden-sharing behavior. This is indicative of a less cohesive alliance, where many allies have reduced interest in the outputs of NATO. This is a worrisome result that may weaken the alliance over time as fewer allies contribute to NATO's missions, which raises policy concerns.

By inference, we attribute this change in burden sharing to NATO expansion, the war on terror, out-of-area missions, and the weapon technology gap. A two-tiered alliance with relatively few allies both willing and able to embrace NATO's new strategic doctrine, adopted at 2010 Lisbon summit, calls into question the ability of NATO to meet its new mandate with its emphasis on out-of-area crisis management and cooperative security. The euro debt crisis will further strain the ability of many European allies to fulfill this new strategic doctrine. US budget deficit concerns will curb US defense spending, requiring other allies to make up the difference or else accept a less formidable collective defense capability. As the United States increasingly turns its attention to the Pacific, new strains in NATO will appear. Our analysis underscores that a significant policy challenge confronts NATO that must be addressed if the alliance is going to remain relevant. One possible solution will be a two-tiered alliance with European allies led by France and the United Kingdom, and North America led by the United States. Such a scenario will require much closer links among European allies so that many weapon platforms are shared. Although such tighter links have been discussed, they are yet to surface. Stark economic realities may break down past resistance to such linkages.

In 5 years as more data are generated, it will be important to ascertain whether the recent changes in burden sharing remain, that is, will exploitation of the rich remain and will the lack of concordance between burdens and benefits remain?

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