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Adoption Capacity and the Spread of Suicide Bombing: A Response to Andrea Gilli and Mauro Gilli, "The Spread of Military Innovations: Adoption Capacity Theory, Tactical Incentives, and the Case of Suicide Terrorism," *Security Studies* 23, 3 (2014): 513-547.

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Introduction

In "The Spread of Military Innovations," Andrea Gilli and Mauro Gilli question the importance of organizational factors in explaining whether violent non-state actors decide to use suicide bombing. Instead, they argue that the strategic environment faced by groups generates tactical incentives that better explain who adopts suicide bombing. While they are right to point out that tactical incentives shape the choices made by groups (a perspective shared by adoption capacity theory, the argument they criticize), their argument is based on a misunderstanding of the way that adoption capacity theory functions in the case of suicide bombing. Reassessing their evidence shows that Gilli and Gilli's results actually demonstrate the strong robustness of adoption capacity theory, showing how organizational factors significantly influenced whether violent non-state actors adopted suicide bombing between 1981-2007. It is only their alternative measure of organization size, one inappropriate for testing adoption capacity theory, that is not significant. This reassessment also reveals new insights about the overall relationship between organizational politics and military innovation for both state and non-state actors,

including the conceptual risks involved when importing ideas from the business innovation literature, and the utility of accounting for both capacity and interests in future research.

What follows addresses three critical elements of Gilli and Gilli's article: their critique of using organizational age as a way of understandingthe capacity of organizations to adopt suicide bombing, their use of organizational size as an alternative measure, and their introduction of military mechanization as a way to understand the tactical incentives that lead groups to adopt suicide bombing.

Adoption capacity theory and Clayton Christensen: Similarities, differences, and implications

What explains the choices countries – and actors – make when deciding about the types of strategies to pursue in response to the debut of new military innovations? *The Diffusion of Military Power*[1] presents a new argument, adoption capacity theory, designed to correct for a bias in prior research on diffusion whereby scholars generally assumed that the incentive to adopt an innovation was enough to ensure it would occur. Adoption capacity theory, while recognizing the importance of incentives to adopt innovations,[2] brings capacity back into the equation in the form of financial intensity and organizational capital.

Gilli and Gilli's critique of adoption capacity theory begins with a misunderstanding – the assumption that its underlying core is derived from Clayton Christensen's disruptive innovation theory. Working on disruption in the business world, Christensen famously distinguished between disruptive and sustaining innovations, arguing that large-scale industry transitions are much more likely to occur in the face of disruptive, rather than sustaining innovations. Gilli and Gilli argue that since Christensen does not use organizational age as a proxy for the disruptive potential of organizations, it is inappropriate to use it to test adoption capacity theory.[3]

For adoption capacity theory, organizational capital represents the "change capacity" of a military organization.[4] Rather than being derived primarily from Christensen, however, adoption capacity theory draws on a wide variety of literature on business and state

[1] Michael Horowitz, *The Diffusion of Military Power: Causes and Consequences for International Politics* (Princeton, NJ: Princeton University Press, 2010).

[2] Ibid., 9, 206

[3] Andrea Gilli and Mauro Gilli, "The Spread of Military Innovations: Adoption Capacity Theory, Tactical Incentives, and the Case of Suicide Terrorism," *Security Studies* 23, 3 (2014):, 525; Clayton M. Christensen, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Boston, MA: Harvard Business School Press, 1997).

[4] The longer-form definition comes from Cummins Jason G. Cummins, "A New Approach to the Valuation of Intangible Capital," (Federal Reserve Board Finance and Economics Discussion Series, 2004)., 4. See Horowitz, *The Diffusion of Military Power*, 33.

innovation, including Darby and Zucker, Henderson and Clark, Clark,Tushman and Anderson, and others .[5]. In particular, adoption capacity theory explicitly draws on Rebecca Henderson's work on radical innovation in the photolithographic alignment equipment industry.[6] Christensen does not even use the phrase organizational capital, after all, and distinguishes his argument from that of Tushman and Anderson, Henderson, and others.[7]

Horowitz outlines three metrics to operationalize organizational capital: experimental research and development spending (more is better), critical tasks focus (less is more), and organizational age (for disruptive innovations, younger is better). Like the shadows on the wall in Platos's cave, however, the metrics designed to test Horowitz's argument about organizational capital are proxies for the thing, rather than the thing itself. Only organizational age is really amenable to systematic coding.[8]

Adoption capacity theory combines the literature on business innovation described above with Mancur Olson's[9] arguments about bureaucratic sclerosis in older organizations to produce its prediction that, on average, as organizations age, they add bureaucratic layers that make major military innovations harder to adopt. Reducing organizational capital and adoption capacity theory to Christensen's argument is therefore not just technically incorrect, but also has substantive consequences. Given that adoption capacity theory is not derived from Christensen, the fact that Christensen does not think age is related to disruptive innovation success for firms is theoretically irrelevant.[10]

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[5] See, for example, Lynne G. Zucker and Michael R. Darby, "Costly Information: Firm Transformation, Exit, or Persistent Failure," *American Behavioral Scientist* 39, 8 (1996): 959-974; Rebecca M. Henderson and Kim B. Clark, "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms," *Administrative Science Quarterly* 35, 1 (1990); Kim B. Clark, "The Interaction of Design Hierarchies and Market Concepts in Technological Evolution," *Research Policy* 14, (1985): 235-251; Michael L. Tushman and Philip Anderson, "Technological Discontinuities and Organizational Environments," *Administrative Science Quarterly* 31, 3 (1986): 439-465.

[6] Rebecca M. Henderson, "Underinvestment and Incompetence as Responses to Radical Innovation: Evidence from the Photolithographic Alignment Equipment Industry," *The RAND Journal of Economics* 24, 2 (1993): pp. 248-270; Horowitz, *The Diffusion of Military Power*, 46-47

[7] Christensen, *The Innovator's Dilemma*, 27

[8] Horowitz, *The Diffusion of Military Power*, 39. Thus, even if Gilli and Gilli's results show that organizational age is not a significant predictor of suicide bombing it would not be definitive evidence about organizational capital as a whole.

[9] Mancur Olson, *The Rise and Decline of Nations: Economic Growth, Stagflation, and Social Rigidities* (New Haven: Yale University Press, 1982).

[10] Even if one believed adoption capacity theory was necessarily yoked to all of Christensen's arguments, that young firms can be "overwhelmed" by newer innovations, as Gilli and Gilli argue (Gilli and Gilli, "The Spread of Military Innovations," 525), is irrelevant to the point that younger firms will be better at implementing disruptive innovations. Depending on the pace of change, they could be overwhelmed later. That is unrelated to the theory.

Revisiting Organizational Age

Gilli and Gilli also raise practical objections to using organizational age to measure organizational capital, though interestingly, the results presented by Gilli and Gilli actually provide strong support for adoption capacity theory by demonstrating the robustness of the relationship between organizational age and suicide bombing adoption. Even when incorporating their measure of mechanization (to measure tactical incentives), for example, organizational age is negative and significant, as adoption capacity theory predicts.[11]

Gilli and Gilli point out, however, that the original measure of organizational age simply counted backwards from 2007 in order to code a group's age.[12] The formulation for the link between organization age and suicide bombing centers, as it does for all innovations, on the relationship between the start year of a group and the 'debut' of an innovation. In the case of suicide bombing, it debuted with an initial attack in 1981 by a group in Lebanon, followed by the first real suicide bombing 'campaign,' launched by Hezbollah, beginning in 1982. According to adoption capacity theory, the core prediction is that groups founded before 1981 should be less likely to adopt than groups that started after 1981.

To shed light on this question, a correlation matrix looking at age and the year of adoption shows clearly that it is younger groups, even outside the context of a complicated statistical model, that are more likely to adopt suicide bombing.[13] Building from that correlation matrix, Table 1 which is appended to this paper shows a series of regression models presenting new evidence on the relationship between organizational age and the adoption of suicide bombing.

Given that organizational age and organizational size measure different things, model 1 adds the original organizational age measure to model 3 in table 2 of Gilli and Gilli.[14] Organizational age is negative and significant, as predicted.[15] This shows that the organizational age variable is especially robust since the model includes both organizational size and Gilli and Gilli's mechanization variable. Models 2-4 address Gilli and

[11] Gilli and Gilli, "The Spread of Military Innovations," 535. The theory itself is also probabilistic. The claim is not that organizational age explains all of the variation in suicide bombing adoption. While Gilli and Gilli point out that groups such as the Committee on the Security of the Highway were "young" but did not adopt, on balance, the statistical results show that most groups conform with the predictions of the theory.

[12] There was originally a more dynamic age measure cut at the request of some reviewers.

[13] Horowitz, *The Diffusion of Military Power*, 191

[14] Gilli and Gilli, "The Spread of Military Innovations," 535

[15] This is consistent with results including both age and size in the online appendix in Michael C. Horowitz, "Nonstate Actors and the Diffusion of Innovations: The Case of Suicide Terrorism," *International Organization* 64, 1 (2010): 33-64.

Gilli's objection about the original organizational age coding capturing groups that ceased to exist prior to 2007. Model 2 adds a variable, *Last Attack Year*, controlling for the last year that a group conducted an attack.

Model 3 restricts the universe of cases to only look at those groups that existed for at least 5 years after the suicide bombing era started. This excludes those groups that did not have sufficient 'exposure' to the suicide bombing era to adopt the innovation, dropping potentially spurious groups from the 1970s that could be biasing the results. Model 4 creates a new variable, *Organizational Age Revised*, that is the total age before a group ceases to exist for non-adopters of suicide bombing, and the age before adoption for adopters. It is negative and significant, as is organizational age in models 2 and 3. A simple t-test looking at the relationship between *Organizational Age Revised* and suicide bombing adoption confirms that this significant relationship is not simply a statistical artifact, but one that shines through in the data as well.

Organizational size: An inappropriate test for adoption capacity theory

Due to their reliance on Christensen, Gilli and Gilli argue that organizational size, rather than age, is a better way to proxy for the change capacity of organizations. The problem is that organizational size is not an accurate test of adoption capacity theory for several reasons. First, as discussed above, and as Horowitz originally argued, because adoption capacity theory is not simply an application of Christensen's argument to military innovations, there is no theoretical reason to expect organizational size is related to suicide bombing adoption.[16]

Second, Gilli and Gilli's measure of organizational size, drawn from Asal and Rethemeyer[17] is an ordinal variable that runs from 1 to 4, as groups increase in size. This ordinal set has limits even as a test of Christensen's disruptive innovation theory (rather than adoption capacity theory). Christensen's argument that small organizations are more likely to engage in disruptive innovation describes how the market sizes in potentially disruptive areas are often too small for large firms, which require larger markets to preserve growth.[18] Since small companies value the smaller markets that disruptive innovations initially capture more than larger companies do, they are more likely to pursue them.

Applying this logic in a linear fashion to thinking about military innovation is inappropriate, because it would suggest that a country like the Seychelles would be the most likely to come up with a military innovation. For militaries, there is undoubtedly at least some sort of threshold of size and sophistication at which becoming an innovator in a

[16] Horowitz, *The Diffusion of Military Power*, 45

[17] Victor Asal and R. Karl Rethemeyer, "The Nature of the Beast: Organizational Structures and the Lethality of Terrorist Attacks," *Journal of Politics* 70, 2 (2008): 437-449.

[18] Christensen, *The Innovator's Dilemma*, xx-xxi, 129

particular area becomes plausible. Empirically, it is often the second-tier states, i.e. those striving for power, that pursue disruptive innovations. In the case of carrier warfare, for example, it was Japan and the United States, secondary naval powers, that adopted, while the largest naval power of the day, Great Britain, had a much narrower vision of how to use carriers. More work is necessary to identify where that threshold might exist, and it likely would vary across different types of innovations, but that is a potentially promising path for future research.

This highlights the complexities involved in taking ideas from fields such as business innovation and applying them to the military realm. It is not surprising, therefore, that the simple attempt to just 'copy' Christensen's argument into the military realm does not work as expected (i.e. Gilli and Gilli find that the organizational size variable has a positive effect, rather than the negative one predicted by Christensen).

Third, the lack of granularity in Gilli and Gilli's organizational size data means too many groups of what are in reality very different sizes are grouped together. For example, a group with a "1" in their coding scheme could have membership anywhere from 100 to 1000, a ten-fold difference likely to have a large effect on how a group operates, given the small size of most terrorist groups. Gilli and Gilli have no argument about the group size that is 'enough' to adopt suicide bombing. The real question, if one wished to use organizational size data to test Christensen's argument, would be whether groups were large 'enough' to adopt while still being small enough to innovate. Without such a threshold, one that is theoretically derived, it is inappropriate to use the data they use to test Christensen's organizational size argument.

Christensen's theory, modified to be appropriate for violent non-state actors, would predict that the largest terrorist groups should be unlikely to adopt suicide bombing for the same reasons that large firms are less likely to innovate. However, extremely small groups should also be unlikely to adopt because the organizational cost of losing members will be too large. This more appropriate threshold-based analysis is a much more accurate way to adapt Christensen's theory to the suicide bombing case.

Model 5 in Table 1 below shows the results from a model that replicates Model 3 from Table 2 in Gilli and Gilli, but recodes the organizational size variable to more accurately test Christensen's argument. Optimal Size is a binary variable created to reflect the fact that the relationship between size and adoption should not be linear – there should be a sweet spot where groups are large enough to have a stable organization, but small enough not to be subject to the negative bureaucratic effects identified by Christensen (and Mancur Olson in the government context). It is coded 1 if the size of the organization is between 1000 and 10,000 members based on Asal and Rethemyer's coding, and 0 otherwise. The results show that groups in this sweet spot, those smaller than the largest terrorist groups, but large enough to plan significant operations, are, in fact, significantly more likely to adopt suicide bombing than groups that are either smaller or larger. An alternative coding (Model 6), where the "sweet spot" is coded for groups at the next level smaller – between 100 and 1000 members, reveals no relationship between size and adoption. While only an initial test, these results, though irrelevant for adoption capacity theory, do suggest that the

relationship between organizational size and adoption is more complicated than that suggested by Gilli and Gilli.[19]

What about Mechanization?

Finally, though unrelated to adoption capacity theory, it is worth noting that Gilli and Gilli's measure of tactical necessity – mechanization, drawn from Sechser and Saunders,[20] has some serious shortcomings in its ability to help scholars understand the incentives for terrorist groups to conduct suicide bombings. The proposed mechanism linking mechanization to suicide bombing is that suicide bombing is a strategy for attacking hard targets – and mechanization, in the form of tanks, means that targets are likely to be 'harder.'

The problem is that mechanization, even where it exists, is unrelated to the targets of most suicide attacks. Suicide bombing attacks, even against security targets, generally occur against static targets such as military bases or police stations, but not anything related to mechanization' in the form of tanks. There is no evidence presented to support the idea that an increase in mechanization goes along with an increase in the hardening of other targets. And while is it is true that more than 60% of suicide attacks occur against security targets, as Gilli and Gilli point out,[21] that still leaves a significant set of terrorist attacks against targets that are certainly not plausibly hardened, such as suicide attacks on Israeli buses by members of Hamas in the 1990s. Moreover, the variable is very sparse – without data after 2001, it is hard to know whether the pattern identified by Gilli and Gilli applies in the most prominent decade of suicide bombing (after the 9/11 attacks).

Finally, to the extent that there is a relationship between mechanization and suicide attacks, it likely means that countries with stronger militaries facing terrorist campaigns are more likely to face suicide attacks. But that is endogenous to why terrorist campaigns happen in the first place, given that terrorist campaigns are weapons of the weak to begin with.

Conclusion

Gilli and Gilli's article on adoption capacity and tactical necessity in the case of suicide bombing raises very important questions not only about the case of suicide bombing, but about research on the diffusion of military innovations. The results presented above suggest two key factors that can help guide future research. First, all organizational

[19] Also, the limited data available on organizational size cuts the number of observations available for analysis by nearly 45%, from 233 to 130 (Table 2, Model 3). This makes any results less reliable. Gilli and Gilli, "The Spread of Military Innovations," 535

[20] Todd S. Sechser and Elizabeth N. Saunders, "The Army You Have: The Determinants of Military Mechanization, 1979-2001," *International Studies Quarterly* 54, 2 (2010): 481-511.

[21] Ibid., 539.

characteristics are not created equal. Scholars interested in breaking apart organizations in order to understand the attributes most likely to lead to the adoption of innovation need to come up with next generation measures of age, size, and other attributes. Second, care needs to be taken when importing theories from the business world into political science. Differences between firms and countries may be larger than scholars have previously imagined.

More generally, Gilli and Gilli's research, in combination with the evidence presented above, suggests a way forward in the study of the diffusion of military innovation that combines the focus on capacity introduced by adoption capacity theory with the more traditional emphasis on the differing strategic incentives that groups have to adopt innovations. Hopefully, this exchange can help advance the debate about military innovation in general by suggesting the important role that several different factors play in influencing how groups behave.

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Table 1: Organizational Age, Organizational Size, and the Adoption of Suicide Bombing

	(1) Add Org Age to G&G Model 3, Table 2	(2) Control For Last Attack Year	(3) Only Groups With Suicide Bombing Era Exposure	(4) Revised Org Age Variable	(5) Org Size Threshold Test	(6) Org Size Threshold Test #2
	B/SE	B/SE	B/SE	B/SE	B/SE	B/SE
Organizational Age	-0.0505**	-0.0359*	-0.0491**			
	(0.0216)	(0.0219)	(0.0219)			
Organizational Age Revised				-0.0948***		
				(0.0257)		

Optimal Size					1.269**	
					(0.604)	
Optimal Size (Small)						-0.407
						(0.532)
Last Attack Year		0.173				
		(0.123)				
Organizational Size	1.031***	1.068***	1.012***	1.184***		
	(0.299)	(0.347)	(0.298)	(0.337)		
Military Mechanization	0.586**	0.744**	0.580**	0.514*	0.439*	0.336
	(0.266)	(0.291)	(0.263)	(0.294)	(0.244)	(0.206)
Religious	1.133*	1.036	1.101	1.102	1.262**	1.108*
	(0.678)	(0.685)	(0.677)	(0.739)	(0.630)	(0.614)
Leftist	1.532	2.308	1.442	1.702	0.919	0.850
	(1.583)	(1.522)	(1.644)	(1.527)	(1.528)	(1.530)
Communist/Socialist	0.798	0.601	0.765	1.089	0.118	0.211
	(0.961)	(1.004)	(0.965)	(0.931)	(0.863)	(0.948)
Nationalist/Separatist	0.565	0.614	0.556	0.724	0.364	0.516
	(0.618)	(0.590)	(0.617)	(0.664)	(0.627)	(0.661)
Group In Lebanon	0.544	1.152	0.653	0.142	0.562	0.629
	(1.360)	(1.780)	(1.437)	(1.220)	(1.110)	(1.079)
Iraq War-related	0.596	0.333	0.606	0.655	0.849	0.855
Group	(0.815)	(0.801)	(0.810)	(0.857)	(0.722)	(0.715)
Group In Israel	1.620	0.790	1.607	2.108*	1.775*	1.586
	(1.090)	(1.115)	(1.081)	(1.156)	(1.043)	(1.036)
Group Linked To Al	1.808**	1.704**	1.799**	2.044**	1.789**	1.863**
Qaeda	(0.812)	(0.836)	(0.806)	(0.844)	(0.794)	(0.794)
Constant	-0.704	-347.7	-0.692	-1.187	-1.090	-1.095
	(1.282)	(245.7)	(1.278)	(1.402)	(1.152)	(1.139)
Observations	130	130	127	130	130	130
Pseudo R^2	0.321	0.346	0.315	0.361	0.273	0.254
ll	-51.38	-49.54	-51.22	-48.39	-55.06	-56.49

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$