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THE NEW POLICY FRONTIER

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Cover Photo:
A nighttime image of Asia
and Australia from the
Suomi NPP Satellite by
NASA

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TABLE *of* CONTENTS

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It is rare to find a journal that examines the collective action issues inherent to space exploration in one chapter and the importance of waste management in rapidly expanding Southeast Asian municipalities in the next; that demystifies the effects of foreign investment in North Korea and dissects the missteps of the governmental response to the Fukushima earthquake. But that is what makes the Journal of International Policy Solutions unique.

Since its inception, the Journal of International Policy Solutions has strived to live up to the mission inherent in its name: to undertake reasoned analysis of complex international policy issues of the world – both widely visible and lesser-known—and provide specific recommendations that might pave the way for meaningful change and progress to be made. Here at the Journal, we firmly believe that international affairs and public policy graduate students have significant contributions to make to the trenchant policy conversations of our day. In this collection, you will find essays from students who spent their graduate studies diving deep into issues they are passionate about, and challenging themselves to provide concrete solutions along with thoughtful and incisive analysis, the type that is often lacking in today's policy debates. These papers represent the best of their scholarship.

The 19th edition of the Journal of International Policy Solutions is made possible through the contributions from countless authors, photographers, editors and administrators at the School of Global Policy and Strategy and international affairs schools across North America, Asia and Europe. I would particularly like to thank our faculty advisor, Elizabeth Lyons, and Jerry Pang, Academic Advisor at GPS, for their steadfast support of our organization. Furthermore, I would like to thank the entirety of the administration at the School of Global Policy and Strategy for believing in the mission of the Journal of International Policy Solutions and investing in its continued legacy. Lastly, and most importantly, I would like to thank the JIPS board members and editors who built this journal, and all the scholars who submitted their work for consideration.

To the reader, my greatest desire through the creation of this collection has been that you might come away from it feeling empowered and hopeful; empowered with knowledge to continue the fight for justice and hopeful that our global community will emerge stronger together from these challenging times.

Ariel Neidermeier

Editor-In-Chief

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POLICYMAKING FOR THE CELESTIAL COMMONS

Optimal Provision of Space Debris Remediation for Marginal Polluters

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The international community is experiencing market failure in the celestial commons. In the face of legal and technical barriers, marginal polluters, like Canada, are precluded from effectively contributing to direct remediation. However, by deconstructing this typical collective action problem into distinct tiers, it is possible to reduce the scope of the problem and change the aggregation strategy needed for optimal provision. Although marginal polluters are ill-suited to provide direct remediation, they may instead contribute development of remediation technology. In this manner, gains from trade allow for greater efficiency and spillover surplus from larger polluters providing direct remediation. The role of leadership and its possible effect on coordinating technology development is also explored. The paper concludes that by adopting a mixed-policy approach of intellectual leadership and technological development provision, marginal polluters can optimize their contributions.

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INTRODUCTION

The international community is witnessing market failure in the celestial commons. The continued generation of space debris is crowding out key orbits around the Earth, increasing the likelihood of catastrophic collisions. Remediation is complicated. The legal regime of outer space establishes that space objects are subject to the exclusive jurisdiction of the state(s) which launched them. Even if one state could be the most efficient provider of remediation, it could only remediate its own debris. For states like Canada, who derive significant benefit from space activities yet are marginal polluters, this presents a difficult collective action problem. How can marginal polluters sustain and expand benefits when they have limited capacity to do so?

Although the international community has been aware of the dangers of debris since the 1960s (Johnson, 2010), serious mitigation efforts did not begin until the 1990s (Chatterjee, 2014).[1] Recent events such as the Chinese destruction of its own satellite in 2007 (Weeden, 2012), the 2009 collision of Russian and American satellites (Listner, n.d.), and the success of the 2013 film Gravity have generated considerable discussion in the space community (Faust, n.d.). The need to implement mitigation and remediation strategies is undisputed if humankind is to sustain access to space (Chatterjee, 2014) (Chatterjee, 2014). Legal issues have made remediation more complicated and have effectively precluded a free-market solution.[2] Unfortunately, an updated international legal regime is not foreseeable in the near future. Without a legal authority to clearly assign rights and obligations (Coase, 1960), an alternative strategy may be found in institutional economics. Regrettably, the issue of space debris has not been greatly researched in this field (University of Liverpool, n.d.).[3] This necessitates a theoretical investigation of the problem. Only by understanding the nature and dynamics of the collective action problem can we make informed policy prescriptions. As the nature and possible solutions to this problem vary depending on the state actor examined, this paper will only focus on the perspective of

marginal polluters. Canada is adopted as the model marginal polluter. Therefore, the purpose of this paper is to investigate and develop a theoretical framework for the optimal provision of space debris remediation by marginal polluters.

Part I surveys the technical and socio-political aspects of the space debris problem. As Sandler demonstrated in his comparison of ozone depletion versus global warming, the particular facts of a collective action problem can profoundly impact the provision decisions of actors (Sandler, Global Collective Action, 2004). Part II examines the various applicable theoretical models and tools to determine optimal provision. Part III expands on the derived optimal provision framework and explores how Canada can operationalize it. Ultimately, this paper will contribute to the larger policy discussion on space by elucidating the institutional economics alternative.

THE REALITY

Space Debris Facts and Statistics

The launch of Sputnik I in 1957 created the first piece of space debris (Salter, 2015). The rate of generation increased significantly by the 1960s (Johnson, 2010). It is estimated that some 100 million pieces of human-made debris orbit the Earth (Ansdell, 2014). Baker identifies four source categories for space debris (Baker, 1989):

- Inactive payloads - payloads that can no longer be controlled by their operators

- Operational debris - objects associated with space activities, mostly comprising of launch hardware

- Fragmentation Debris – created when objects break up after explosions or collisions

- Micro-particulate matter – very small (1-100 microns wide) objects, typically fuel propellant particulate

Chatterjee sorts debris into three categories: 1) small: 100,000,000+ pieces <1cm; 2) medium: ~300,000 pieces from 1-10cm; and, 3) large: ~21,000 pieces >10cm (Salter, 2015). Small debris can be mitigated with proper shielding for spacecraft and large debris can be avoided through vigilant tracking (Ibid). Medium-sized debris poses the greatest challenge: pieces are too small to be tracked but large enough to critically damage a craft (Ansdell, 2014).

The accretion of debris is not uniform, either by orbit type[4] or trajectory. Satellites are slotted into trajectories and altitudes suited to their intended purpose.[5] Consequently, some orbital regions have more activity (al, 2013). As satellites become inactive, debris in these orbits increases. Accretion has reached critical density in some orbits and requires remediation if orbital access is to be sustained (Ibid). The threat of debris poses both an immediate and long-term threat. In the short term, catastrophic collisions in low-earth orbit (LEO) create about $30 million in damages to the craft operator and another $200 million in increased liability to all other operators (Levin & Carroll, 2012). By Salter's assessment of work by of Bradley and Wein, the probability of such collisions is "low" (~1/1000 over the lifetime of a spacecraft) (Bradley & Wein, 2009) (Salter, 2015). However, Salter is unconcerned with subjective assessments. The same probability is grave for the US given that of 1,305 active satellites they own 549, or 42.1% (Yanofsky & Fernholz, n.d.).[6] This means that of the existing "batch" of satellites, the one satellite statistically marked destruction has about a 50% likelihood of belonging to the US. For Canada, the probability remains near 1/1000. However, for marginal polluters alike, this only means the likelihood a satellite they own will be destroyed not a satellite they derive benefit from. Large and marginal polluters alike have vested interest in sustaining orbital access.

At the current rate of accretion, in 200 years the volume of debris will increase threefold and the probability of collision by a factor of 10 (Liou & Johnson, 2006) (Salter, 2015). Unfortunately, the rate of accretion is not constant. The first 10,000 ~10cm pieces of debris took 40 years to accumulate (Zenko, 2014). The next 13,000 took less than a decade (Ibid). This trend led NASA scientist Donald Kessler to predict a mathematical singularity whereby a certain threshold of space debris would set off a "cascading" chain of collisions, annihilating all space objects in large orbital regions (Wouters, 2015). Such an outcome would drastically increase the costs of accessing space (Salter, 2015).[7]

Interests and Efforts in Debris Remediation

Space infrastructure is enabling deeper integration through globalization.[8] The global space industry grew 9% in 2014, reaching USD $330 billion (Space Foundation, 2015), of which $203 billion was from the satellite sector (Satellite Industries Association, 2015). The sector has shown incredible resilience and value, growing by a factor of 2.3 over the last ten years, even through the global recession (Ibid). Of the $203 billion, $87.2 billion (Ibid) was generated by the US (World Bank, 2014).[9] The latest numbers for Canada show that of the 2012 $188.8 billion global total, Canada generated about USD $2.66 billion (Canadian Space Agency, 2012).[10] More importantly, the satellite sector provides crucial infrastructure for the (2013) USD ~3.6 trillion global telecommunications sector (Telecommunications Industry Association, 2014), which added about USD $44.8 billion (Canadian Ra-

dio-Television and Telecommunications Commission, 2014) to the Canadian economy in 2013 (2.5% of GDP) (World Bank, 2014) and about USD $550 billion (United States Census Bureau, 2012) to the American economy in 2012 (3.4% of GPD) (World Bank, 2014). The connection between the satellite and telecomm industries illustrates that states do not need a large space presence to derive significant benefit from space services. Moreover, the benefits extend beyond just economics.[11]

In response to debris accretion, states have begun developing and implementing various standards. This has been done on a cooperative, albeit voluntary, basis through the Inter-Agency Space Debris Coordination Committee (IADC)[12] and the United Nations Committee for the Peaceful Uses of Outer Space (UNCOPUOS) (Chatterjee, 2014). In 2007, UNCOPUOS adopted guidelines drafted earlier by IADC (Ibid). The voluntary guidelines were further endorsed by the United Nations General Assembly in 2008 (Wouters, 2015). These international best practices complement existing national standards such as the EU's 2004 Code of Conduct[13] and the US's mitigation standards of 1994 and 1997 (Salter, 2015).[14] Canada, a strong proponent of debris mitigation, incorporated the UNCOPUOS guidelines through the Remote Sensing Space Systems Act (Government of Canada, SC 2005 c45). The use of unilateral standards is a consequence of the legal regime for outer space:

- Space objects are the exclusive jurisdiction of the state(s) that launched them (United Nations, 27 January 1967; entry into force 10 October 1967) (Chatterjee, 2014).[15]

- States may be liable for damage in outer space by space objects belonging to them and are absolutely liable for any damage on Earth by space objects belonging to them (United Nations, 29 March 1972; entered into force 1 September 1972).[16]

- "Space object" has no clear legal definition and it is uncertain whether it includes space debris (Chatterjee, 2014).[17]

- States have an obligation to "avoid harmful contamination" of the space environment.[18] It is unclear whether this includes the generation of debris (Wouters, 2015). China's 2007 testing of anti-satellite technology and subsequent intentional destruction of Fengyung, a Chinese weather satellite, was not held by the international community as an internationally wrongful act (European Space Agency, n.d.).[19] This single act created more than 150,000 pieces of debris larger than 1cm (Salter, 2015).

The legal framework complicates remediation. Notably, it circumscribes the efficacy of four common approaches to internalizing externalities (Ibid):

- **Market Forces:** private actors must obtain explicit consent from each state potentially affected prior to any operation and may incur international liability to their launching state for any damage caused.

- **Pigouvian taxes:** Because the extent of liability is not clear, it is difficult to determine the optimal tax.

- **Unilateral action:** The barriers to free market actors also exist for public actors. States are limited to remediating only their own debris.

- **Coasian Rights allocation:** Robert Coase submitted that if clear property rights could not be implemented, a central legal authority could delineate rights and obligations. There is no such central legal authority for space issues.

The regime's restrictions are further exacerbated by the disparity in ownership of spacecraft, generation of debris, and variable impact of debris.

Most of these craft are now inactive and are monitored along with thousands of pieces of debris in order to mitigate collisions.[20] Of the fragmentation debris that can be tracked, as of 2008, China is responsible for 42%, the US for 27.5%, and Russia for 25.5% (National Aeronautics and Space Administration, 2008). These proportions have likely shifted since the 2009 collision of Russian satellite Cosmos 2251 and American satellite Iridium 33, creating over 200,000 pieces of debris larger than 1cm (Salter, 2015). Finally, debris mass varies from a few grams to several tons (Ansdell, 2014) (such as ESA's 8-ton giant Envisat) (Salter, 2015). As the ESA has determined, for sustainable use of LEO, 5-10 strategically selected objects must be remediated annually making the variable mass of debris pose another challenge (Wouters, 2015). The variable mass of debris means that even if a state decides to unilaterally remediate, it may not be able to reduce debris below the annual Kessler threshold. Moreover, the variable nature of debris is not limited to mass but also to circumstance (shape, speed, altitude, etc.) requiring various technologies for remediation (Chatterjee, 2014).

Conclusions on the Space Debris Problem

Remediation of space debris is a complicated collective action problem. Discussing the facts above identified various elements of the problem that a state should take into consideration to determine its provision strategy. These elements are summarized below and inform the theoretical discussion.

Figure 1- Spacecraft by ownership (1957-2015) (Ibid). As of March 31, 2015, 7,700 spacecraft have been launched (Lafleur, n.d.).

	Total	USSR/RUS	US	EU	Jpn	China	India	CAN	ISR	OTHER
Total	7,757	3,682	1,941	383	168	237	73	44	16	1,213
%	100	47.5	25.0	4.9	2.2	3.1	0.9	0.6	0.2	15.6

- **Non-proportionality between usage and pollution of space:** As the Fengyung incident demonstrated, China, who has only launched 237 craft, rivals the US and Russia in generated fragment debris. This complicates proposals that top users or beneficiaries of space should be responsible for remediation.

- **Accretion is not uniform by orbital region:** As debris accumulates around heavily used orbital regions, states have varying incentives to which trajectories and altitudes to remediate.

- **Non-proportionality between usage of space and derived benefits:** Some states operate few, if any, satellites, however, this does not diminish the economic and strategic benefits they derive from space services. Most states retain a prima facie interest in remediation.

- **Remediation capacity is not uniform:** Because of legal, circumstantial, and technological barriers, motivated states may not have the capacity to meaningfully remediate.

- **Efficacy of unilateral/voluntary standards:** Unilateral domestic regulations vary by state. Therefore, as evidenced by Figure 1, the efficacy of adopted standards varies depending on which state adopts them. Marginal polluters like Canada could adopt the strictest standards and yet that would contribute little to the overall problem.

THE THEORY

Understanding the Collective Action Problem

Sandler submits that Adam Smith's invisible hand of the market is incapable of remedying all types of market failures (Sandler, Global Collective Action, 2004). In the case of public goods, corrective policy can only be understood in terms of the three elements of publicness: rivalry, excludability, and aggregation technology (Ibid). Subtle differences in any of these three elements can profoundly impact the provision strategy and level (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). Space

debris is a global public bad. The issue is global because it affects most states and a public bad because its negative effects are non-excludable and non-rival (Ibid). Remediation requires providing of the global public good (GPG) of sustainable orbital access (Salter, 2015). Underprovision of GPGs is typical in open access commons like outer space. In critique of Grotius' advocacy for free use of common resources on the high seas, Scottish jurist William Welwood opined that "what is communally owned is neglected due to natural viciousness (Bovenberg, 2008)." Garrit Hardin would expand on this concern and term it "the tragedy of the commons" (Hardin, 1968). The difficulty with sustaining open access commons is that its non-rival characteristic is typically subject to congestion (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). The more that actors use the commons the more they are crowded until the point Pareto optimality is surpassed (Sen, 1987)[21] and each additional unit of use comes at the expense of another user (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). Because there is no central authority or allocation of rights (Salter, 2015), each user is motivated to continue using the resources, irrespective of any negative externalities use may be jointly producing (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). Because the resource is non-excludable, actors understand that the benefits of remediation would be enjoyed by all users, even if they did not contribute (Ibid). This encapsulates the free-rider problem whereby voluntary contributors subsidize the use of other actors (Ibid). Ostensibly, in times of disaster, actors would be much more willing to contribute according to their capacity (Hirshleifer, 1983).[22]

As indicated above, various elements of the problem complicate provision, particularly for marginal polluters like Canada. In Hirshleifer's seminal work on best-shot and weakest link technologies,[23] we are faced with simple collective action problems (Ibid). He assumes actors have capacity to contribute and that the only challenge is to determine how much is optimal. This assumption persists in much of Sandler's work (Sandler, Global Collective Action, 2004) (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). However, this approach fails to include marginal agents who have significant incentive to contribute but may lack some form of capacity. We see this situation with space

debris. Marginal polluters like Canada derive great benefit from space activities but have minor technical or formal capacity to contribute remediation. Consider:

- Canada has no launch capacity.[24] Any remediation craft would need to be launched by another state which could be partially liable for any damage done by Canada.

- Canada only has a few dozen inactive satellites and they may not have the mass necessary to meaningfully contribute towards the "5-10 strategically selected" satellites for annual remediation, i.e. Canada cannot unilaterally contribute past the threshold for more than a few years, if at all, and if it cooperates with other states its contributions may be marginal.

- As a matter of law, Canada may not remediate the debris of other states.

Therefore, Canada either cannot contribute at all or could only contribute with massive investment in exchange for no long-term efficacy. Because negotiating a new international regime is not an option (Wouters, 2015), Sandler and others would likely prescribe Canada free-ride on the contributions of other, more efficient/capable states. Assuming other states with capacity have the same or greater motivation to contribute (marginal willingness to provide (MWTP) ≤ marginal cost (MC)), they will do so and Canada will benefit from the spillover benefits (benefits are non-excludable) (Montero & Perrings, 2011) (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). However, there is an alternative strategy wherein the marginal cost for Canada could be decreased and its capacity increased. If we deconstruct the provision problem into two distinct parts we can reduce the scope of provision and thereby decrease the costs to marginal polluters. We borrow this approach from Young and his three stage process to establishing an environmental regime (Young, Political Leadership and Regime Formation: On the Development of Institutions in International Society, 1991) (Arce, 2001).[25]

Young advocates that some collective action problems can be better understood and solved if they are recognized as having distinct parts, each requiring a different aggregation technology for provision (Ibid). The space debris issue as a whole seems to be a threshold-weighted sum problem. Remediation by some states provides more sustainable orbital access than others (contributions are not perfectly substitutable) (Sandler, Global Collective Action, 2004) and the total level of provision must meet or exceed a certain level (because debris mass is variable). However, if we treat the development of technology as a separate collective action problem we can reduce the scope of the problem and increase the potential capacity of marginal polluters to contribute. Bosetti et al recognize the crucial role innovation and technology diffusion play in the mitigation of climate change (Boseti, 2009). The ESA has explicitly recognized the need for various debris remediation platforms (Wouters, 2015).

Alternative Contribution Strategies

The development of technology in this context is a threshold-summation collective action problem. Because the efficacy of a technology does not vary with the state that develops it, it is perfectly substitutable. When contributions are perfectly substitutable (Hirshleifer, 1983),[26] summation technology is optimal (Sandler, Assessing the Optimal Provision of Public Goods: In Search of the Holy Grail, 2003). However, because various types of debris require remediation, various types of technologies require development. Without a minimum set of technologies, states may not be able to collectively meet their yearly remediation targets. Therefore, there is a threshold of provision states need to meet before they can derive benefits from remediation technology. (Sandler, Global Collective Action, 2004)

By changing the provision activity from debris remediation to developing remediation technology, the scope and cost of the problem are significantly reduced. If Canada determines that it should contribute technology, it only needs to increase outlays to its existing innovation infrastructure. This is a provision activity that Canada has competence to deliver. Furthermore, by having different states operate in different tiers there can be gains from trade (each can produce at or closer to MC = marginal rate of substitution (Hirshleifer, 1983)) (Salter, 2015). This is consistent with Hirshleifer's maxim that actual provision does not equate efficient provision (Hirshleifer, 1983). By reducing costs for both types of contributors, the likelihood of their provision increases because more surplus is generated, i.e. MC falls relative to MWTP. However, there are trade-offs technology providers need to consider. The more technologies they produce, the more costs fall for remediation providers who can then employ the most efficient technology for each type of debris,[27] generating greater spillover benefits for technology providers. However, the more technologies being developed by one state, the less they can specialize on any one technology, thereby losing economies of scale and increasing their costs, subsequently reducing their incentive to contribute technology (MC rises relative to MWTP). The coordination of technology development and diffusion becomes another problem that impacts provision.

Leadership and Coordination

Arce argues that leaders can play an important role in the provision of underprovided goods or in the organization of its production (Montero & Perrings, 2011). As discussed above, coordination problems between technology developers can lead to underprovision. A leader may remedy this through coordination expectations (Ibid). This strategy is well suited for the problem at hand as states already have access to the IADC and UNCOPUOS wherein established relationships reduce transaction (coordination) costs (Ibid). Moreover, unlike other scenarios wherein leaders derive benefits in the form of prestige, votes, or some other intangible good, in this scenario every state is a possible "built-in leader." Each would be a direct beneficiary of the provided good, offsetting the costs of providing leadership (Ibid). Canada is particularly well-suited to provide leadership because of its unique position between NASA and ESA (Goss GIlroy Inc, 2010).[28]

The decision of whether Canada should provide leadership returns us to the rule of MWTP ≤ MC. If the additional costs of leadership exceed the gains, provision is not efficient. The costs of leadership vary by the style and type of leadership (Montero & Perrings, 2011). Young identifies three types: structural, entrepreneurial, and intellectual. Structural leaders influence through the institution, entrepreneurial leaders through skill, and intellectual leaders through their normative ideas (Young, Political Leadership and Regime Formation: On the Development of Institutions in International Society, 1991). Because there are multiple institutions and most states have a strong interest to remediate space debris, it may be more efficient to provide intellectual leadership and coordinate informal research partnerships rather than try to accomplish everything in formal settings (which may also duplicate efforts). In this scenario, intellectual leadership could coordinate technology production by stressing the gravity of the problem, capacity of each state to contribute, and domestic economic benefits each state would receive from investing in innovation. Canada could also encourage greater international private sector participation, slowly acclimatizing states to the risk of commercial actors applying remediation technologies. To some extent, Canada is already providing leadership. In addition to being a strong proponent of the UNCOPUOS guidelines, Canada is also currently supporting several remediation technology development projects.[29]

Alternatively, Canada may lead by example (i.e. act unilaterally). This would entail Canada providing a minimum level of technology investment and matching higher contributions by others (Montero & Perrings, 2011).[30] This may not coordinate contributions as well and may not be feasible for relatively small economic powers like Canada.

Finally, there may be coordination problems if more than one state desires leadership (Ibid). For example, the ESA is quite active in developing remediation technologies (Wouters, 2015)[31] and is currently working to launch a de-orbiting satellite by 2021 (European Space Agency, n.d.).[32] Although Canada cannot financially compete with the ESA, there could still be gains from both providing leadership. The ESA could lead by example in technology development and Canada in diffusing technology. For example, Canada could offer remediation contracts or enact salvage laws to encourage international commercial entities to remediate Canadian debris (Salter, 2015). This form of diffusion could create a valuable private-public ecosystem (Ibid).[33]

THE POLICY PROPOSAL

A Mixed-Policy Approach

Providing the GPG of sustainable orbital access is analogous to the issue of global warming. Marginal carbon polluters like Canada (Canadian Association of Petroleum Exporters, n.d.)[34] have limited capacity to directly remediate the problem. However, the space debris problem in general is also similar to the issue of ozone depletion, in that (Sandler, Global Collective Action, 2004):

- Concentration of major polluters
  - Remediation of their debris would outpace any increase in generation by marginal polluters
  - Cooperation easier to achieve and manage
- Time-horizon for benefits are medium to long-term
  - Current generation would benefit, inducing willingness to act
- No major political/commercial opposition to action
- Scientific evidence is conclusive and clear
  - Probability, pecuniary and strategic harms identified and quantified
- Consequences of inaction harmful to all actors
  - Dominant strategy is action, irrespective of other parties' choices

By splitting the collective action problem into two tiers, the scope and aggregation strategy of the problem is changed. States previously not able to contribute at all, or effectively, to remediation could now contribute instead to the development and diffusion of technology. Determining the optimal provision of technology development requires the state to consider several questions:

1. Is technology development the only effective contribution?

2. Would the benefits of leadership outweigh the costs?

    a. Which style of leadership would be effective?

3. How important is preserving the legal regime as status quo?

    a. Are the risks of having domestic or international companies remediate debris greater than the norm-creating power of unilaterally changing your legal rights and obligations (to the extent legally possible)?

For marginal polluters like Canada that cannot meaningfully remediate space debris, technology development is the alternative, efficient solution. Although the actual level of provision is subject to various socio-economic factors beyond the scope of this paper, it is sufficient to state that a mixture of investment in innovation and investment in intellectual leadership would allow Canada to optimally provide sustainable orbital access vis-à-vis other states. The mixture of options is important. Purely providing technology development is capital intensive and not efficient for relatively small economic powers like Canada. Likewise, pure intellectual leadership is inefficient for marginal polluters because of how little debris they contribute. Even if they permitted commercial actors to remediate their debris, it would not provide much value beyond the norm itself. Moreover, it also assumes other states will develop the technology. If too many states make the same or similar assumption, there will be under-provision of technology.

The mixed-policy approach enables marginal polluters to shape norms while also providing the means by which large polluters can give effect to those norms and/or remediate debris, providing spillover benefits. Furthermore, the dividends from technology diffusion (economic growth and patent royalties) help mitigate the liability risk of permitting commercial actors to remediate debris. Finally, this proposal is not competitive. The more polluters that employ a mixed-policy approach the more they perpetuate the norm and create a larger market for private remediation services. This reduces the eventual costs of renegotiating the existing legal regime[35] and fuels future space activities (Salter, 2015).[36]

CONCLUSION

A key assumption by theorists such as Hirshleifer and Sandler, when approaching collective action problems, is that actors motivated to contribute can contribute. The space debris problem demonstrates that, due to legal and technical barriers, marginal polluters, irrespective of their motivation, are severely restricted in their capacity to remediate. However, by deconstructing the problem into tiers, it is possible to reduce its scope and enable marginal polluters to contribute. The provision of technology development is a viable alternative to direct remediation. By diffusing new technology to larger polluters, gains from trade and greater spillover benefits are generated from the direct remediation provided by large polluters. Technology development can be further optimized through leadership, which a marginal polluter is also capable of providing. The mixed-policy approach of providing both technology and leadership allows marginal polluters, like Canada, to efficiently contribute to remediating this market failure.

NOTES

1 In the early 1990s, space faring states like the US began implementing regulatory standards for new spacecraft. In the early 2000s, voluntary guidelines were developed by various international organizations, see Part. I.II for more details.

2 All objects launched into space must be registered to a state, who perennially retains sovereignty over the object and liability for any damage it may cause. This means a private company would need permission not only from their own state to conduct salvage or remediation operations but also permission from every state whose object(s) they interact with. As discussed later, the international regime regulating state liability for space objects is unclear and poorly tested, creating further uncertainty and barriers for private actors.

3 Although a group of researchers at the University of Liverpool are currently simulating game theory models to predict state behaviour.

4 The orbit types are: low earth orbit (LEO), medium earth orbit (MEO), elliptical, and geosynchronous orbit (GEO).

5 The allocation of orbital slots is organized by the International Telecommunications Union, an international body delegated authority by states to ensure for equal and efficient access.

6 549 belong to the US, 142 to China, 131 to Russia, and 483 to others, 8 to Canada.

7 Given the continued growth of the satellite industry and progress towards space tourism and mining, it is reasonable to infer that the rate of accretion will continue to

increase exponentially.

8 Space infrastructure provides services such as: GPS, global banking, climate and geographic observation, remote sensing, and commercial and military logistics.

9 Or 0.5% of the $17.42 trillion US economy in 2014.

10 Or 0.1% of the $1.83 USD trillion Canadian economy in 2012.

11 Supra note vii.

12 The IADC was established in 1993. Its membership consists of national and regional space agencies. The IADC is a more technical body and is used to bypass the more political issues in UNCOPUOS.

13 Now replaced with a 2008 version incorporating the UNCOPUOS guidelines.

14 Under US law, the Federal Aviation Administration is responsible for distributing launch licenses. In order to procure a launch license, an operator must meet FAA standards, including demonstrating that launched space objects meet mitigation standards.

15 See Art. VI in Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies.

16 See Art. III and II in Convention on International Liability for Damage Caused by Space Objects.

17 The Liability Convention defined "space object" but it remains unclear whether that includes space debris: "component parts of a space object as well as its launch vehicle and parts thereof."

18 See Art. IX in Remote Sensing Space Systems Act.

19 Either under the ILC DASR or OST; For discussion on the test, see: Space Debris and Europe. 7; see also the UK's response to China's test, an action not believed to "contravene international law": http://www.spacewar.com/reports/Britain_Concerned_By_Chinese_Satellite_Shoot_Down_999.html.

20 The US Strategic Command's Joint Space Operations Centre (JSpOC) sends over 10,000 warnings per year to public and private operators about potential collisions with their active space objects. Such measures are imperfect and collisions still occur, generating thousands of pieces of debris, see in supra note 2 at 4.

21 Pareto optimality is the market equilibrium at which benefit to any party can only come at the expense of another.

22 This could partially explain why the US is willing to provide debris monitoring services to private and public satellite operators, see supra note xx.

23 "Aggregation technologies" are collective action strategies by which one or more actors provide the necessary amount of a good to address a public bad. "Best shot", "weakest link", and "summation" are such strategies. Under best shot, optimal provision can be achieved by one or few actors acting unilaterally. For example, in a defensive alliance, it may be sufficient for only one member to provide a missile defence system. Under weakest link, the efficacy of provision is subject to the smallest contribution. For example, in trying to reduce the hijacking of planes, the overall security level is set by the member with the worst secured international airport. Under summation technology, all contributions have value and add to the total provision level. Under weighted-summation, contributions are not perfectly substitutable. For example, Canada is a marginal carbon polluter compared to the United States or China. Even if Canada reduced its carbon footprint to 0, it would have a relatively marginally effect on global carbon emissions than if major polluters reduced their output. Strategies may also be subject to a threshold wherein until a minimum provision amount is contributed, all preceding contributions have no actual effect.

24 Canada's contribution to space debris is facilitated by launch states such as the US, Russia, or India.

25 Young describes environmental regimes as having three stages (agenda formation, negotiation, and operationalization) and that each was a different collective action problem. He submitted that consensus building was a weakest link problem and that operationalization was best-shot.

26 That is, the scenario is not best-shot or weakest-link.

27 Supra note 92 at 17.

28 The CSA is a close partner of NASA and the only non-European member of ESA; see also: Goss Gilroy Inc, Summative Evaluation of the 2000-2009 Canada/ESA Cooperation Agreement: Final Report: (Goss Gilroy Inc, Feb 22 2010), online at: http://www.asc-csa.gc.ca/pdf/evaluation_2010-canada-esa_eng.pdf.

29 For example, Canada is currently partnered with the École Polytechnique Fédérale de Lausanne in Switzerland (EPFL) and Swiss Space Systems (S3) operating in North Bay, Ontario; with ESA in Ottawa; and, with the Canadian satellite giant, MDA simultaneously developing three distinct de-orbiting technologies. The EPFL/S3 option is a chaser-satellite, the ESA option is a

netting-satellite, and the MDA a robotics based pulling system. See respectively, see online: https://www.youtube.com/watch?v=pgxWuFj7d9I; http://www.theglobeandmail.com/technology/technology-video/video-how-canada-is-helping-in-the-fight-against-space-junk/article23597944/; and, https://www.mcgill.ca/iasl/files/iasl/sdc2011_1_kendall.pdf.

30 Canada would always provides one unit, if another state provides two, so does Canada.

31 For example, through the ESA "Clean Space Initiative" debris activities are sorted into four branches: 1) eco-design; 2) green-tech; 3) debris mitigation; and, 4) remediation tech.

32 ESA Heading Towards Removing Space Debris, online: The European Space Agency http://www.esa.int/Our_Activities/Space_Engineering_Technology/Clean_Space/ESA_heading_towards_removing_space_debris.

33 Technology diffusion is itself an interesting GPG and it is unclear which tier it would belong to: remediation technology development or remediation itself.

34 Canada only contributes 2% to global emissions, see in: Greenhouse Gas Emissions, online: Canadian Association of Petroleum Exporters http://www.capp.ca/responsible-development/air-and-climate/greenhouse-gas-emissions.

35 By changing norms, state practice on space debris might crystallize as customary international law which would likely be codified in any renegotiated space treaty, for comprehensive discussion on customary international law, particularly its development, see in: Currie, H; et al, International Law Doctrine, Practice, and Theory, 2ed (Toronto: Irwin Law, 2014) at 116.

36 It is very expensive to launch resources into orbit. There are currently several tons of resources available in space debris, including 1,000 tons of aluminum. Launching such an amount into space, at current prices, would cost between USD $5-$10 billion and take several years. Emerging space activities like tourism and mining would make efficient use of debris resources.

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WASTE NOT, WANT NOT

Opportunities and Challenges in Solid Waste Management in Vientiane

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Amid entering the ASEAN Economic Community and a push to graduate from least developed country status, Laos is undergoing rapid growth. In Vientiane Capital, it is clear that this development is coupled with the additional challenge of adapting city services to meet a growing population and wealthier consumers. One example is the solid waste management system in Vientiane. This paper outlines and analyzes the waste production, collection, and disposal situation in Vientiane Capital with the goal of highlighting specific challenges faced by the municipal government and other stakeholders. We found that there are supply and demand issues with the waste collection services in Vientiane. On the demand side, this includes price and quality concerns with the existing services, and the widespread use of burning and dumping to dispose of waste in the absence of a strong legal framework related to waste. On the supply side, this includes the high transportation and operation costs that inhibit services to expand to other parts of the city, and limitations on the market that make it challenging for new companies to enter and for existing companies to adjust the pricing scheme. Lastly we offer some suggestions for policy makers and researchers concerned with waste in Vientiane that can be applied to other rapidly-expanding municipalities. These suggestions are focused on expanding public awareness, supporting the recycling sector, and adjusting official waste collection services to reflect willingness to pay and reach more communities. In this way, this paper should be considered a useful framework for reducing and managing waste in other developing country urban centers throughout the world.

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INTRODUCTION

Solid waste management is an important challenge around the world. Improper management can pose dangers to the environment and to public health, as trash can serve as breeding grounds for the spread of disease, pollute natural resources, and increase the risk of flooding, among other issues. Addressing waste management is an opportunity to boost sustainable development and open new economic opportunities. These issues are particularly pointed in countries and cities that are developing and urbanizing quickly. With greater wealth and access to convenient, on-the-go, packaged items, the amount of waste, particularly non-biodegradable waste, can increase rapidly (Zhang et al., 2010. Pg. 1623). Additionally, the government or local authorities responsible for overseeing waste management may have fewer resources at their disposal, along with the added challenges of narrow city streets, the need for greater awareness or significant changes in behavior, limited data, or a weak legal framework, just to name a few (Al-Khatib et al., 2010. Pg. 1137).

For urban areas of Laos, a landlocked, least developed country in the heart of Southeast Asia, many of these challenges ring true. Examining solid waste management in the capital and largest city, Vientiane, exemplifies the tension between economic growth and municipal governments' ability to expand city services. Though Laos remains a relatively poor, rural, and small country in the region, the story of waste management in Vientiane can provide insight into the challenges, opportunities, and potential policy solutions related to urban development elsewhere. Moreover, the health and environmental impacts of solid waste have implications for

countries downstream along the Mekong, making this case immediately relevant to other countries on mainland Southeast Asia.

By and large, much of Vientiane appears clean, particularly the bustling streets in the heart of the tourist-filled section of downtown. However, littering is widespread and particularly bothersome in a few areas, including in and along the Mekong River. Even along many streets in town, the littering of bottles, plastic bags, and other items becomes a pressing problem during the rainy season because the trash can block drains and exacerbate flooding issues (Sangsomboun, 2014). As is the case in many developed countries, recycling is largely relegated to the informal sector, meaning that it is not taxed or regulated by the government (Guerrero, 2013).

In this paper, we suggest that, with less than half of the city's waste being collected and transported to the landfill each day, there are demand and supply issues with the existing collection services. On the demand side, the major issues are a lack of incentive to contract collection services due to a weak legal framework that enables dumping and burning, and some consumer dissatisfaction with the price and quality of collection services currently offered. On the supply side, collection companies are faced with high transportation costs that inhibit the expansion of services, and government controls limit the market's ability to make collection services more competitive and to incentivize consumers to reduce waste and recycle.

Material and Methods

In this study, we use data and information gathered from interviews, presentations, observations, and reports from stakeholders in Vientiane. The data for Vientiane and other cities in Laos is very limited, coming in large part from periodic studies carried out from the 1990s to recent years by development partners. To augment the data available, we have relied on interviews with, presentations by, and information from people working on waste issues in local government, civil society, academia, and development agencies.

ANALYSIS

Baseline Conditions & Policy Priorities

The importance of waste management policy is currently tied to the context of Laos' participation in the Association of Southeast Asian Nations (ASEAN) and also in the ASEAN Economic Community (AEC) since the start of 2016 (Tholatha, 2015). Cooperation in developing Environmentally Sustainable Cities has been a priority of ASEAN since 2008, with the sharing of expertise in solid waste management as one component (ASEAN, 2015). Additionally, the government is focused on spurring development with the goal of being removed from least developed country status in the coming years. With agriculture, hydropower, forestry, and mining among critical sectors, conversations of development in Laos inevitably are intertwined with environmental issues. Waste is no exception since the plastic pollution in urban areas continues to grow as more people become empowered consumers (Cleary, 2015). Public health challenges are also an important component of boosting development. Mosquito-borne illnesses, especially malaria and dengue fever, are already a major issue. While burning trash can release harmful toxins and pollution, improperly dumped or littered trash can store still water and serve as additional breeding ground for mosquitoes, thereby tying waste to the public health discourse as well (Doussantousse & Siriphongsavath, 2015).

As for the legal framework regarding waste management in particular, it is slim. There is no formal law governing waste management specifically, but general environmental laws and the Lao Constitution highlight the responsibility of all citizens to protect the environment. The Environmental Protection Law from 1999 has a section on pollution, which includes waste. The law prohibits littering, requires compliance with regulations for hazardous waste disposal, and states that everyone has an obligation to participate in environmental restoration (Viyakhet, 1999).

There have been many calls to strengthen the legal framework, and enforcement, for solid waste management. In the absence of formal laws, different initiatives have been started by the government and other partners to encourage better behavior. One example is the Lao Pilot Program for Narrowing the Development Gap Towards ASEAN Integration and its Environmental Management Component (LPPE), which has a strong emphasis on improving waste management in three ASEAN Environmentally Sustainable model cities: Vientiane, Luang Prabang, and Xayaboury. The focus on waste management for this initiative specifically was chosen because after many discussions, it was clear that people across different stakeholder groups recognized the importance of the issue (Shimura and Inamori, 2014).

Table 1: Demographics and Economic Indicators of Laos

Year	Population	GDP per capita (in US$)	Growth Rate of GDP	Land Area
2014	6,809,000	1,725	7.517	235,800 Km2

Demographics and Economic Indicators

Over the last decade, the Lao economy has been growing quickly. In 2007, the gross domestic product (GDP) grew by 7 percent compared to 2006 (Kyophilavong & Phongsay, 2013). In 2013, the GDP growth rate was 8 percent (Lao Statistics Bureau, 2014), though it has since declined slightly to 7.4 percent in 2015 (World Bank, 2015). Table 1 (Lao Statistics Bureau, 2015; World Bank, 2016) shows the demographics and economic indicators of Laos.

Vientiane Capital has the fastest growing economy and population in Laos (Kyophilavong & Bennett, 2011, Pg. 12). Vientiane's population in 2011 was 667,000 (Kyophilavong & Bennett, 2011, Pg. 12), and by 2014 had increased to 828,000 people (Lao Statistics Bureau, 2015). The city's economic growth rate was more than 10 percent in 2011 (Kyophilavong & Bennett, 2011, Pg. 12), and it increased to 10.92 percent in 2016 (Laotian Times, 2017).

Characteristics of Urban Waste in Laos

In the past, composting and waste separation were important strategies for managing waste in Laos. Food waste was the main component of rubbish, and people could use their food waste to feed domestic animals or fertilize their land. Now, however, Laos is developing and urbanizing quickly, and as incomes rise and consumption grows, the amount of waste increases and its composition changes (World Bank, 2012, Pg 8). Plastic packaging and bags in particular have become ubiquitous in the cities. Economic growth also brings in an influx of tourists, who add to the problem of increasing waste, and the urgent desire to ensure that cities are kept clean and attractive.

Sections of many cities have companies or government agencies coordinating household rubbish collection, though there is still dumping and burning of waste, and it is a challenge to expand collection services to everyone in a city. Formal recycling is at a minimum, though there are many people pushing carts or driving motorbikes through cities to collect cardboard boxes, cans, water bottles, metal, and other items. Collectors generally sell things to Thai, Chinese, and Vietnamese traders, which makes it more difficult to recycle in cities far from those borders, like Luang Prabang (Shimura & Inamori, 2014). Additionally, crates of glass bottles are taken back to the corresponding company (like Beer Lao or Pepsi) for washing and reuse.

At present, there are many development partners, NGOs, and government offices engaged in environmental issues, including waste management. In particular, environmental health and sustainability have been prioritized in the context of ASEAN and the AEC. For example, the LPPE project in Luang Prabang, in conjunction with the provincial Department of Natural Resources and the Environment and the Luang Prabang Urban Development Administration Authority, has supported the construction of a new landfill with a good access road, a recycling program at two local schools, and a pilot composting program to make use of food waste from more than 30 hotels and restaurants, just to name a few (Shimura & Inamori, 2014).

Characteristics of Waste in Vientiane

In order to understand the waste management system in Vientiane, it is important to first understand the characteristics of the waste itself. In particular, it is critical to know how much waste is generated and of what materials that waste is comprised (Kum et al., 2005. Pg. 101-9). Historic and present data on waste management in Vientiane (as with elsewhere in Laos) is limited, but there are nonetheless many helpful statistics as indicated in Tables 2 (Shimura, 2014) and Table 3 (Shimura, 2014; Kyophilavong & Phongsay, 2013; Shimura & Inamori, 2014; Lao Statistics Bureau, 2014, Pg. 23; Tholatha, 2015; Tholatha, 2015).

In Vientiane, residents produce an average of 0.653 kg per person per day, meaning that just over 600 tons of waste are generated every day (Tholatha, 2015). Up to 70% of a family's waste can be composted (Nanthanavone, 2015). However, actual levels of composting today are much lower, particularly as fewer people still have domestic animals that would eat kitchen waste or crops that would use compost. In the past, one reason so little trash was collected was that there was a considerable amount of recycling, including using kitchen waste for domestic animal feed. For the non-collected waste, other methods of self-disposal included illegal dumping and burning.

Today, less than half of the waste generated is collected and taken to the landfill. In part this is because many households lack collection access because of their location or because they are not signed up for a collection service. Thus, roughly half of the waste in Vientiane is disposed of through other methods, like burning and dumping in the Mekong or along the road.

Table 2: Composition of Waste in Vientiane

Year	Kitchen	Wood	Paper	Plastic	Textile	Rubber, Leather	Metal	Other
2011	35%	29%	7%	12%	5%	3%	1%	8%

The amount of waste has increased steadily as the population has grown. Collection services have struggled to keep pace with the growth, though services, offered by both the Vientiane Urban Development Administration Authority (VUDAA) and multiple private sector enterprises, have succeeded in collecting more trash over time.

Table 3: Waste Over Time in Vientiane

Year	Population	Metric Tons Generated/Day	Metric Tons Collected/Day	Collection Rate (%)
1991*	142,723	140.8	13.9	9.9
1999*	186,400	183.8	80.8	44
2005	633,100 (2002)	300	150	50
2011	731,118	637	209	32.8**
2014	810,846	637***	249	47****

Note: *The 1991 and 1999 statistics are based on data for the four central districts of Vientiane, while the other years include all nine districts of Vientiane Capital
** Only 14.1% of households had a contract for waste collection
*** No updated figure, though assumed to be around or just above the 2011 figure
**** Only 25% of households have signed contracts for collection services.

Existing Solid Waste Management System

Before discussing the challenges and potential solutions or opportunities for the solid waste management system in Vientiane, it is necessary to first review the current technical, institutional, and financial arrangements for the existing system.

Technical Arrangement

In terms of waste storage, households have traditionally kept waste in open bamboo baskets, but now households more commonly store their waste in plastic bags, which are set outside houses on collection days. Aside from some specific locations (like parks or streets under particular arrangement to share communal bins), there is no standardized container or location to keep waste at the household level. There are also no official bins for separation of waste at the household level, so those participating in recycling activities must separate recyclable items on their own.

In terms of waste collection and transportation, there are nine private companies that offer formal household waste collection services, however, much of the city and most households are not served (Tholatha, 2015). There are about 279 villages (about 58% of all villages in the city) whose waste is collected under one of the service plans. However, just under half of the households in the inner city districts take advantage of available collection service, and fewer than 15% of households in the districts further from the center make use of waste collection services (Bieger & Peters, 2014. Pg. 2). This means that even where collection services are offered, the number of households and businesses contracting private companies or government to collect waste remains low. For all of Vientiane, only 25 percent of the population has a contract to use trash collection services (Tholatha, 2015). Formal household collection of recycling or food waste does not exist, so waste is not necessarily separated before collection. There are, however, some recycling stations throughout the city and there are many people going through streets to collect recyclable goods that residents either sell or place in front of their homes for free.

In June 2014, there were 74 waste collection vehicles operating in eight districts (four districts downtown and four further from the town center) (Bieger & Peters, 2014. Pg. 2). Because the trek to the only landfill for the capital – called the Kilometer 32 landfill – is expensive in terms of time and money, the Japanese International Cooperation Agency (JICA) is supporting the construction of a transfer station about 12 kilometers from the city center to help with management.

Once collected, the waste is taken to the new landfill at Kilometer 32, which was opened in 2008 with support from JICA and LPPE. The old landfill was located at Km 18. It opened in 1988 but was closed about 20 years later because of construction for the Southeast Asian Games facilities. This new landfill is 32 kilometers from the city center and is 100 hectares (Shimura, 2014). The grounds include the dumping area, a settling pond for septic waste, a section to keep hazardous

health care waste, a health care waste incinerator, and a recycling center (established with support from the Asian Development Bank and the Japanese Poverty Fund), which purchases recyclable items collected by people working in the landfill (Shimura & Inamori, 2014). Workers at the center then wash and bundle goods properly for sale to Thailand, Vietnam, China, and within Laos. In 2014, they recovered 2,320 tons of recyclables from the landfill and sold 1,710 tons (Vongtham, 2015). After paying all the expenses for labor, supplies, and operation, the recycling center had a profit of 149,801,000 LAK, or roughly 18,600 USD (Vongtham, 2015). There are about 15 items that are recycled by the center, including plastic bags, plastic bottles, cement sacks, cardboard, broken glass, metal, copper, brass, old batteries, and PVC (Vongtham, 2015).

Institutional Arrangement

VUDAA is responsible for waste collection and waste management at the city level. This includes overseeing and monitoring the private companies operating waste collection throughout the city, managing major streets and parks of the city, coordinating festival clean up, and managing the Kilometer 32 landfill.

Additional government ministries play a supporting role. For example, the Ministry of Natural Resources and Environment (MONRE) is invested in helping to manage a number of waste-related projects, typically in partnership with VUDAA, as they fit in with overall national policy goals to reduce pollution and boost sustainable development. The Ministry of Public Works and Transport also has a role coordinating access to the landfill and access to roads within Vientiane for waste collection and transportation.

In addition to the municipal and national government departments involved with waste management, there is significant technical support from JICA, both through the LPPE partnership and through separate JICA projects. Lastly, the nine private companies operating trash collection services are responsible for providing services to different households and establishments, setting up contracts, and ensuring that the waste is disposed of properly at the landfill.

Financial Arrangement

Much of the infrastructure and equipment for waste management was donated by or acquired with the financial support of donor partners like JICA. The financial arrangement for day-to-day management of the waste management system, however, is less reliant on donors. For the most part, the waste collection system follows that the beneficiary pays all

principle (Shimura & Inamori, 2014). This means the system is funded by waste collection fees paid by households and establishments that contract with a company or with the local government authority to have waste collection. Generally, households pay a monthly collection fee (of roughly 30,000 Kip or about 3.75 USD), which covers one bag or basket of waste per week (Shimura & Inamori, 2014). Additional waste or more frequent collection services sometimes incur a higher fee. Costs incurred by the waste collection operators include the gas for travel around the city and to the landfill and the dumping fee at the landfill, in addition to salaries and maintenance costs.

Evaluating Existing Solid Waste Management System

Based on the statistics from Tables 2 and 3, it is evident that the city's growth (in terms of people and waste generated) is outpacing its expansion of collection services. Additionally, as biodegradable waste from food is replaced with more plastic, the need to bolster recycling systems and ensure proper disposal is clear. Table 4 (Japan International Cooperation Agency, 1992) offers an overview of the challenges, impacts, and possible responses for solid waste management in Vientiane.

Storage Evaluation

There is currently no standardized container that households and establishments must use to set out their waste for collection. As a result, the waste stored in open bamboo baskets or plastic bags is easily accessible to dogs and other animals, which can tear through the bags or spill waste in the neighborhood. The lack of a standardized container can also present challenges to the workers, who load the waste into the trucks. Lastly, the trucks are, for the most part, open rather than covered, allowing loose waste to fly from the truck and get scattered in the streets.

There are also no formalized recycling collection services, so there is no standardized storage system to encourage households and establishments to separate their waste. This can make it more difficult for people working in recycling to fish out recyclable goods or for useful food waste to be used as compost or animal feed on a larger scale.

Collection and Transportation Evaluation

There are a few major challenges related to collection and transportation. One of the major challenges is finding a way to expand waste collection service to more households. Part of this challenge is logistical—how to organize services

Table 4: Summary of Challenges and Opportunities

Issue	Impact	Opportunities
No standardized storage container or separation	Waste is easily scattered in the neighborhood, difficult to load onto trucks, and can fly from trucks driving to the landfill; it is difficult to divert food waste or sort out recyclables.	Collection companies or VUDAA could create a system with a standardized storage and separation system.
Contract rate for collection is low in Vientiane, in part because of money, logistical challenges, and low willingness to pay.	Waste companies may struggle to receive adequate income to operate; low collection rates mean most households do not have access to or do not participate in proper waste disposal.	VUDAA and partners can innovate to expand community-level collection in hard-to-reach areas, increase awareness about proper disposal, and adjust rates to reflect willingness to pay.
Landfill is located far from the city	Companies use considerable time and fuel to on each trip to and from landfill.	JICA is supporting the construction of a transfer station at Km 12.
Improper disposal (burning, dumping, littering) is widespread	Littering impacts the city's image. Burning creates air pollution that causes respiratory problems. Dumping clogs drains, worsens flooding, and facilitates the spread of mosquito-borne diseases.	Strengthening the legal framework and enforcement mechanisms; increasing public awareness of the importance of proper disposal.
Resistance to proper disposal of health care waste (and other hazardous or infectious waste)	Without proper incinerator use, infectious waste posed a concern to workers and could leak into the environment.	The Ministry of Health supported proper disposal by helping to pay for the fuel to run the incinerator.
Large amount of plastic consumption	Plastic bags and bottles are of particular concern, and bags as they have a low recycling value. As plastic use increases, the waste that is burned, dumped, littered, and sent to the landfill increases as well.	Increasing awareness about the impact of plastic on the environment; working with NGOs and vendors to promote reusable bags and containers; using festivals as a platform to reduce consumption.

so that residents living on streets too small for trucks can have waste collected and how to expand collection services to more villages and sections of the city. JICA has worked to address this challenge by providing shared rollaway bins for those living on streets too small for trucks to fit through (Kishiue, 2014). Other such ideas are important if collection service is to be offered to more of the city. Part of this challenge is a matter of money on the supply side—setting up the system so that it is profitable for the companies involved, or at the very least, covers the cost of operations, and also ensuring that households are able to pay for the service offered. And the last part of this challenge is one of attitudes and will on the demand side—how to encourage more households to sign up and how to increase people's willingness to pay for collection services. Concerns about the reliability of collection services may exacerbate the resistance to collection contracts.

A second challenge is how far the landfill is from the city. The distance makes it difficult to expand collection services in the villages farther from the direction of the landfill, as the added fuel cost and time for collection companies are disincentives.

Disposal Evaluation

At the landfill, the waste is, for the most part, well organized. The hazardous waste is dumped in a separate section where the waste pickers are not allowed to work. The regular waste is dumped in the main area, and the access road is currently kept clear and well maintained, facilitating better disposal. Additionally, the waste pickers and the recycling center help recover many items from the waste, reducing the quantity that stays in the landfill. The recycling center's balance

sheet demonstrates that recycling is profitable in the city (Vongtham, 2015). When done on a large scale and managed well, there may be a place for more formalized recycling in Vientiane.

There are, however, many challenges with disposal outside of the landfill. Many sections of the city are clean, including the temples, which are cleaned regularly by monks and cared for by many temple-goers, as well as the city parks, which are cleaned regularly by VUDAA. However, littering is ubiquitous, dumping of waste in parts of town or along the Mekong is common, and burning is yet another way that people remove trash. All of these methods impact the environment and affect public health. When waste was primarily organic and did not include much plastic, this was less of an issue, as banana leaves and other organic items will decompose more quickly. However, the growth in plastic and non-organic waste calls for a change in disposal practices. Because a lack of awareness and understanding is an issue, and because of the difficulty in upending longtime practices, boosting education about and awareness of proper disposal methods is important (Bieger & Peters, 2014). Incorporating the need to dispose of health care and infectious or hazardous waste properly is a related concern to ensure the safety of those responsible for collecting and working with the waste and to protect environmental health. A weak legal framework and lack of enforcement may enable these practices and reduce the incentive to contract with a collection company, reduce waste, and recycle.

Evaluation of Institutional and Financial Arrangements

VUDAA works closely with many partners to manage Vientiane's waste management system. Overseeing and monitoring the nine waste companies can be challenging when some companies want to change the contract details, but VUDAA strives to set a standard rate.

Additionally, even with investments in proper equipment and systems from partners, it can be hard to encourage use. Support from the Ministry of Health has been essential in encouraging use of the incinerator in Vientiane for health care waste. The fuel for incinerators is expensive, so even once hospitals had access to an incinerator, they were not using it frequently. For two years from 2012 to 2014, the incinerator in Vientiane only processed 1,551 kilograms of health care waste. But in August 2014 alone, after much programming to increase awareness among the workers and support from the Ministry of Health to pay for the fuel, the incinerator processed 933 kg. In September 2014, the incinerator processed 1,641 kg—more than in the past two years combined (Shimura & Inamori, 2014). This suggests that adjustments in the financial arrangements can enable improved waste management.

Public Participation

Public participation is an essential aspect of the waste management (Kum et al., 2005). Given that only roughly a quarter of households have contracted waste collection services and seeing the evidence of burning, dumping, and littering throughout Vientiane, it is important to increase awareness of the health and environmental impacts of improper disposal. A focus on reducing consumption may be another aspect of public awareness, and is one focus of development partners and NGOs. A stronger legal framework and enforcement mechanism for waste management could serve as an incentive for proper waste management.

POLICY RECOMMENDATIONS

Recommendation One

The lack of enforcement of existing environmental laws and the absence of a legal framework specific to waste management means that people can easily burn, dump, litter, or otherwise dispose of their waste improperly without legal repercussions. However, solid waste, when improperly disposed, can threaten environmental goods including clean air and clean water. Therefore, a strong legal framework is needed to ensure proper disposal, accompanied by diligent enforcement.

Recommendation Two

Consumers may refuse or stop contracts with collection companies because of concerns about price and quality of the services offered.

Recommendation Three

The suppliers of collection services face high transportation costs with the landfill far from the city center, and expanding collection to villages even further from the landfill would be an even greater financial burden.

Recommendation Four

There are a limited number of collection companies that are permitted to operate and collection prices are generally fixed by the city. This limits competition in terms of the quality of collection services offered and also hampers the use of market mechanisms to determine price. Though the system does operate on the polluter-pays-all principle, in many villages, there is a flat rate for collection of up to one or two baskets, with loose restrictions of the size of bags or baskets. Markets and businesses with considerable waste pay more and receive more frequent waste collection. In principle, additional bags or baskets of waste at the household level incur additional costs, though this system is not always employed. Such a pol-

icy that requires consumers to pay additional fees for extra waste would provide consumers with the incentive to reduce waste and recycle.

CONCLUSION

Given the many challenges facing the waste management system in Vientiane, organizations working in this sector should also recognize the areas that present particularly promising and unique opportunities. First, there is a healthy and growing community of individuals and organizations interested in improving solid waste management in Vientiane. This includes individual residents who have taken an active role in cleaning waste in their communities, NGOs like Green Vientiane that are in the process of campaigns to reduce the use of plastic, development partners like JICA investing in infrastructure, and government officials eager to find sustainable solutions to the problems presented by waste. This means that it is a promising time to collaborate, share ideas and experiences, and better coordinate projects and campaigns in the future. This is particularly true at present because waste is getting increasing attention as ASEAN activities are highlighting sustainable, clean cities, and Vientiane (along with other Lao cities) would like to be held up as an example.

Second, though a lack of awareness and education about the importance of proper waste management is a challenge, there are other attitudes and patterns of behavior that may be harnessed to encourage proper disposal and valuing a litter-free environment. For example, people take care to ensure that temples throughout Vientiane are kept clean and know not to litter on temple grounds. This suggests there may be an opportunity to expand the idea of caring for a space in the city just as one cares for and respects the temple and surrounding grounds. Another example is that people gather for Red Saturdays to clean their villages or schools. Residents work hand in hand to remove waste, sweep, and ensure the place looks clean. This ethos of cleaning, local responsibility, and pride in one's neighborhood could also be used as a way to spur people to reflect on their own behavior.

Third, the landfill recycling center operations are thriving. With the workers officially organized and recognized, they now have access to additional benefits and consistent work. In order to further expand and improve the efficiency of recycling in the city, the local government could begin organizing and managing the existing informal system based off of lessons learned from the recycling center. Though other informal recycling operations that are performed outside of government oversight are not the same as the landfill recycling center, similar efforts could provide job opportunities and better protect the health and welfare of workers (Zhang et al., 2010. Pg. 1630). Additionally, most recyclable goods are eventually sold to neighboring countries like Vietnam or Thailand, so there is an opportunity to grow such a sector in Laos and contribute to the Lao economy.

Lastly, as more data is collected and more information is shared, there will be opportunities to improve waste collection services, to better target future programming, and to monitor changes in waste quantity and composition. This should include a greater exchange of knowledge and experience between officials from Vientiane and other cities throughout Laos. Though the situation in two cities may differ, it is important to recognize that officials and companies throughout the country have been experimenting and innovating in response to the problems posed by growing amounts of waste.

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BUILDING BRIDGES AND BURNING TIES

Potential Futures of Chinese Foreign Aid and Investment Activity in Latin America

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At the turn of the millennium, China began providing large amounts of foreign aid and government-sponsored investment (FAGIA) to Latin America. While previous research has focused on determining China's motives for increasing its financial presence in the region, little work has been done to explain the future role of Chinese foreign aid and investment in the region. In this study we explain China's provision of FAGIA to the region and forecast potential scenarios of what China's foreign aid and government-sponsored investment activity will look like in the near future. We forecast that China's financial activity in Latin America will continue to expand, but without reaching the peaks seen following the 2008 Financial Crisis. Even with a slowdown of the Chinese economy, China would continue to provide substantial FAGIA to Latin America. However, Chinese FAGIA to the region has the potential to grow more rapidly if the United States reduces foreign aid to Latin America.

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INTRODUCTION

Since the turn of the 21st century, China has rapidly become a major player in the developing world. Although a newcomer to providing foreign aid, intergovernmental loans and government-sponsored investment activity (FAGIA), China has become one of Latin America's largest donors.[1] In 2010, Chinese lending to Latin America surpassed that of the World Bank, Inter-American Development Bank and the U.S. Export-Import Bank combined (Gallagher & Myers, 2014). While the rapid increase in foreign aid and investment activity (FAGIA)[2] may be helpful to some Latin American nations, it has caused concern among many of Latin America's traditional donors (CRS, 2008; Lancaster, 2007; Lum, 2009). This concern comes from the uncertainty of China's specific objectives in the region and the different forms of conditionality attached to Chinese development financing.

Furthermore, Chinese FAGIA is not very transparent (Lancaster, 2007; Lum, 2009; Wolf et al., 2013). The lack of transparency increases concerns over China's role in the region.[3] Some scholars view China's rapid entrance into Latin American development financing as a direct challenge to traditional US hegemony in the Western Hemisphere (Ellis, 2011; Johnson, 2005; Paz, 2006). Other scholars focus on China's economic interests in the region as a driver of Chinese financing (ECLAC, 2013; Lancaster, 2007; Miller, 2010). While these are useful explanations of China's increasing role in Latin America, other scholars propose that China uses foreign aid in an effort to urge other nations to recognize the Chinese government over Taiwan (Ellis, 2011; Lancaster, 2007; Will, 2012). Although a recent econometric analysis of Chinese aid to Latin America suggests that the role of Chinese aid is predominantly to balance against U.S. influence in the region (Urdinez et al., 2016), opposing views are still prevalent. The uncertainty surrounding the increased role of China in Latin America has created concern among policy makers both in the United States and abroad as to how Chinese influence will impact the region or whether development aid from China will continue to flow to Latin America.

Little research has been conducted on whether the rise of Chinese FAGIA to Latin America is part of a new global trend, or if Chinese aid to Latin America is simply a phase. This paper seeks to fill this void and explore the future of Chinese foreign aid and government-sponsored investment activity in Latin America. First, we look at existing literature on China's increased activity in Latin America and discuss what scholars view as the primary drivers of China's increased presence in the region. In the following section, we build upon existing literature by developing a methodological framework that allows us to forecast future expectations of Chinese financial involvement in Latin America under various scenarios. In the third section of this paper, we discuss the results of this analysis and the potential impacts of a slowdown in Chinese growth or a reduction in U.S. foreign aid flows to Latin America. We then conclude with some of the policy implications of this research.

The Rise of China's Involvement in Latin America

Since 2000, China's economic growth, as measured by annual GDP growth, has been between 7.3 and 14.2% per year (World Bank, 2016). Additionally, China's international profile has increased, as it became a member of numerous international and regional organizations including the World Trade Organization (WTO) and the Inter-American Development Bank (IDB). China has also become more active within regional organizations by participating in regional and international dialogues with groups including the UN Economic Commission on Latin American (ECLAC) and the Community of Latin American and Caribbean States (CELAC). Additionally, China has become an observer nation in groups such as the Organization of American States (OAS).

As China's economic power grew, it started to provide foreign aid to other nations. Between 2000 and 2014, China provided more than $1.4 trillion in foreign aid, government-sponsored investment, and inter-governmental loans to nations throughout the globe (Gallagher & Myers, 2014; Wolf et al., 2013). While this started at a relatively low amount in 2000, Chinese FAGIA has grown rapidly since 2004 with Chinese FAGIA recipients receiving $338.9 billion in 2013 (See Figure 1). Overall, China has provided financial support and investment to over 95 different countries (Gallagher & Myers, 2014; Wolf et al., 2013).

Although a relatively new recipient of Chinese foreign aid and government-sponsored investment activity, Latin America has rapidly become a major beneficiary of Chinese FAGIA (See Figure 1). Between 2000 and 2014, the LAC-17 nations received over $400 billion in Chinese FAGIA, of which 93.4% has been received since 2009 (See Figure 2). While the

Figure 1. Chinese Foreign Aid and Government-Sponsored Investment Activity by Region
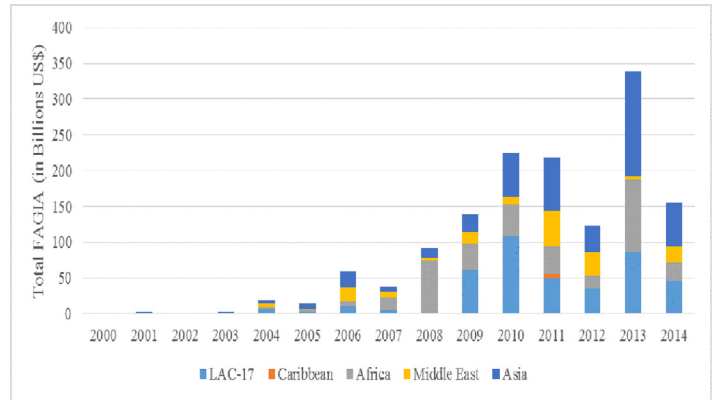
Data Sources: Gallagher and Myers, 2014; Wolf et al., 2013.

Figure 2. Growth of Chinese Foreign Aid and Government-Sponsored Investment Activity in LAC-17
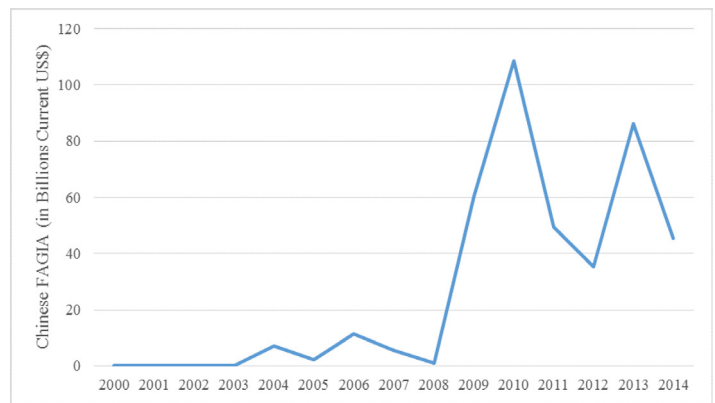
Data Sources: Gallagher and Myers, 2014; Wolf et al., 2013.

majority of Chinese FAGIA has gone to other Asian nations, the LAC-17 has become a major recipient. Since 2000, the LAC-17 received 28.9% of total Chinese FAGIA, while in some years the region has received nearly half of total Chinese FAGIA.

The rapid influx of Chinese foreign aid and government-sponsored investment has been highly heterogeneous across Latin American nations (See Table 1). While some countries have never received Chinese FAGIA,[4] other countries have received a substantial amount. The single largest Latin American recipient of Chinese FAGIA is Venezuela, which received approximately 50.8% of total FAGIA between 2000 and 2014. The second largest recipient, Brazil, accounts for 21.6% of total Chinese FAGIA.

China's rapid growth as a provider of foreign aid has led many scholars and practitioners, both within the United States and Latin America, to question the motives of Chinese financial

activity. Furthermore, the differentiation in the amount of

Country	Total FAGIA (in Billions Current U.S.$) 2000-2014
Argentina	47.56
Bolivia	1.24
Brazil	89.29
Chile	4.03
Colombia	1.93
Costa Rica	2.27
Ecuador	30.81
El Salvador	0.26
Honduras	0.38
Mexico	3.70
Peru	21.22
Uruguay	0.09
Venezuela	209.67

Data Sources: Gallagher and Myers, 2014; Wolf et al., 2013.

FAGIA received by various nations raises questions about how China targets its financial activity. Scholars studying this topic identify various possibilities for describing why China has recently taken an interest in providing financial support and investment to Latin America and for describing who receives this financial aid. These motives can be split into two distinct categories: those that promote China's political objectives and those that promote its economic interests.

Many scholars look at the rise of China's involvement in Latin America as being driven largely by political motives. Many realist scholars view China's increased interest in Latin America as a direct challenge to traditional U.S. hegemony in the region (Ellis, 2011; Johnson, 2005; Paz, 2006). According to this perspective, as China's political and economic power has grown relative to the United States, it began to challenge the United States within its own "backyard." By increasing its soft power within Latin America, China is able to challenge U.S. interests in the region. Although some claim that Chinese aid has little to do with balancing U.S. influence in the region, a recent econometric analysis claims that balancing influence is the lead factor in determining Chinese FAGIA to Latin American nations (Urdinez et al., 2016). Another area that is often viewed as a U.S. interest is the stability of democratic regimes within Latin America (Feinberg et al., 2015). According to some, China challenges this by providing economic support to non-democratic regimes, thus strengthening them (Ellis, 2011).

China also uses foreign aid to affect Latin American countries' recognition of Taiwan. As of 2008, there were 23 nations around the globe that recognized Taiwan over China. Of these 23, 11 were located in Latin America and the Caribbean.[6] In a process regularly referred to as "checkbook diplomacy," China actively uses foreign aid in an effort to "outbid" Taiwan for political support to ensure that smaller states recognize Beijing as the capital of China rather than Taipei (CRS, 2008). Since 2004, three Latin American and Caribbean countries have switched recognition from Taiwan to the People's Republic of China: Dominica in 2004, Grenada in 2005 and Costa Rica in 2007 (CRS, 2008; Ellis, 2011).[7] High levels of Chinese foreign aid spending and investment followed these changes in recognition of China over Taiwan. For example, after it formally recognized China, Costa Rica "received an aid package that included an $83 million soccer stadium, the purchase of $300 million in government bonds, various highway, public works, and aid projects, and a $1 billion joint venture to expand the country's petroleum refinery, as well as PRC aid in facilitating access to Chinese markets by traditional Costa Rican products such as coffee" (Ellis, 2011). This and similar projects in Africa have labeled China's foreign policy activities as "stadium diplomacy" due to the types of aid that China often provides (Will, 2012).

Economically, Chinese motives for providing foreign aid and government-sponsored investment can be split into two distinct categories: promoting Sino-Latin American trade and ensuring the production and accessibility of raw materials. Chinese trade with Latin America has grown at an astounding rate since the turn of the millennium (Dussel Peters, 2015;

Figure 3. Total Chinese Foreign Aid and Government-Sponsored Investment Activity in LAC-17 by Sector
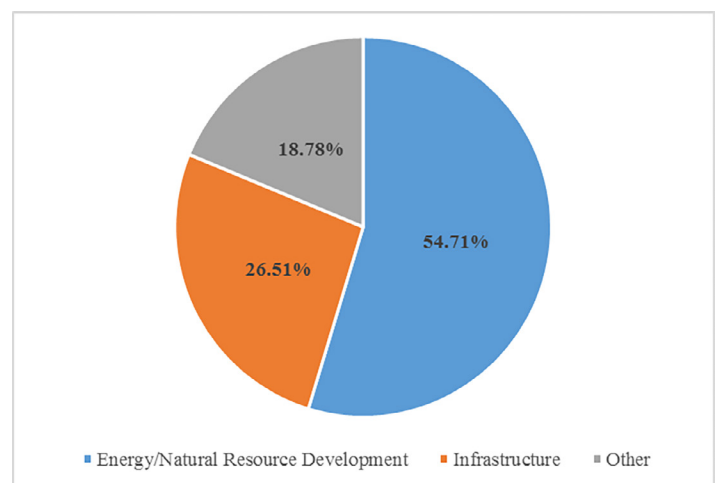
Data Sources: Gallagher and Myers, 2014; Wolf et al., 2013.

Jenkins, 2010; Paz, 2006). Between 2000 and 2012, Chinese imports from Latin America (in nominal U.S. dollars) grew from approximately $3.7 to $83.1 million (IDB, 2015; UN, 2016). This rapid increase was accompanied by a similar increase in Chinese exports to Latin America. In order to ensure that Chinese trade with the region continued to flourish, Chinese foreign aid and government-sponsored investment activity was heavily utilized to boost trade. Through the Chinese Import-Export Bank, trade credits were established with many Latin American nations (Gallagher & Myers, 2014). Additionally, one of the conditions that typically applied to Chinese foreign aid and government-sponsored investment was the use of Chinese labor and goods in the production of projects sponsored through this aid (CRS, 2008; Gallagher et al., 2012; Lancaster, 2007; Lum, 2009; Miller, 2010).[8] This has led one scholar to claim that "…the principal aim of China's financial foreign policy is to stimulate economic growth and job creation at home" (Miller, 2010).

The increase in Chinese trade with Latin America has largely been driven by increased Latin American exports in the form of commodities (CRS, 2008; ECLAC, 2013; Lancaster, 2007; Jenkins, 2010). This is of particular importance to China, as their rapid development requires importing large quantities of raw materials. In order to ensure that Latin American production of commodities keeps up with Chinese demand for these materials, 54.7% of total Chinese FAGIA to Latin America has been geared at promoting the development of energy and natural resource extraction (Gallagher & Myers, 2014; Wolf et al., 2013).[9] Additionally, much of Chinese FAGIA for infrastructure indirectly supports the trade of these raw materials. This includes investments in ports and roads (Wolf et al., 2013).

METHODOLOGY

As discussed in the previous section, scholars point to various motives for China's increased financial presence in Latin America. These, however, can be divided into two broad areas: China's economic and political objectives. China's primary economic objectives include boosting export demand for Chinese products and accessing Latin American commodities to fuel Chinese national growth. In the political realm, scholars suggest that China's motives include challenging the United States, supporting undemocratic or anti-American regimes and ensuring recognition of the People's Republic of China over Taiwan. In order to forecast the values of future FAGIA, we utilize a mixed methods approach including: multivariate regression, extrapolation, logistic regressions, and the Monte Carlo method. First, we present an overview of the data utilized in this analysis followed by a detailed explanation of each method used in this forecast.

Data

To operationalize and model the drivers of Chinese financial involvement in Latin America, we selected several independent variables to test the robustness of these objectives in determining if a country receives FAGIA and the quantity of FAGIA China provides to a country (Gallagher & Myers, 2014; Wolf et al., 2013). To measure China's economic objectives, we collected each Latin American countries' total exports (IDB, 2015; UN, 2016)[10] and GDP, in current U.S. dollars at market price (Hughes, 2016; World Bank, 2016).[11] As China's other economic objective, its need for raw materials was taken into account using each Latin American countries' total rents from natural resources, in current U.S. dollars at market price (World Bank, 2016).[12]

To measure China's political objectives in terms of Sino-Latin American relations, we used a composite score looking at political rights and civil liberties (Freedom House, 2015), as well as a dummy variable that dichotomizes Latin American countries into two groups based on national recognition of Taiwan or the PRC (Lum, 2009).[13] In order to measure the rivalry between the United States and China, we utilized dif-

$$\frac{U.S.\ total\ military\ expenditure}{Chinese\ total\ military\ expenditure} * \frac{U.S.\ total\ armed\ personnel}{Chinese\ total\ armed\ personnel} * \frac{Total\ U.S.\ arms\ exports}{Total\ Chinese\ Arms\ Exports}$$

ferent measures for military and economic rivalries. To measure levels of Sino-U.S. military rivalry, we created a pooled ratio of total military expenditure, total number of armed personnel[14] and arms exports (World Bank, 2016).[15] This was computed as:

Given the potential importance of Chinese economic indicators for determining the quantity of Chinese FAGIA provided to Latin American countries, a composite indicator for Sino-American economic rivalry was not utilized.[16] Rather, each nation's GDP, in current U.S. dollars at market price (World Bank, 2016), and bilateral exports to each Latin American country, in current U.S. dollars (IDB, 2015; UN, 2016) was used to determine if there were important effects of economic rivalry on the amount of Chines foreign aid and investment provided to Latin American nations.[17] Note that as bilateral exports are country specific, these values differ across countries. Finally, as an additional measure of rivalry and a counterbalance to Chinese FAGIA, we considered total U.S. foreign economic aid and total U.S. foreign military aid to each country as part of the analysis (USAID, 2016). Although there are large differences in the quantity of U.S. aid provided to different countries, recent studies suggest that China uses its aid to balance against U.S. aid and influence in the region (Urdinez et al., 2016).

We collected data on these variables for the total period for which data on Chinese foreign aid and government-spon-

sored investment activity was available (2000-2014; Gallagher and Myers, 2014; Wolf et al., 2013). We then transformed all independent variables using normal quantile distributions to determine their best fit. Next, we ran a pairwise correlation to test for multicollinearity among the independent variables and eliminated the variables with the highest levels of multicollinearity. This left natural logarithm of exports to China, recognition of Taiwan, composite political rights and civil liberties, the natural logarithm of U.S. foreign aid, the square root of U.S.-Chinese military rivalry, China's GDP, in current U.S. dollars at market price, and the square root of total natural resource rents for use in our econometric regressions.

Expected FAGIA: Multilinear Regression

Using these variables, we ran stepwise regressions to determine the relationship between the drivers of Chinese involvement in the region and the amount of foreign aid and government-sponsored investment provided by China to each country between 2004 and 2014. We did this for all country-year combinations where FAGIA was received.[18] Results for the best fit regression model of the three-year

$$\ln(FAGIA) = 25.58 - 0.36 \ln(x_1) - 0.45\sqrt{x_2} + 1.5e^{-5}\sqrt{x_3}$$

moving average of FAGIA[19] and the regression using all variables can be found in Appendix 1. Using the best fit results, we were able to calculate the expected value of Chinese FAGIA to each country *assuming* that the country received foreign aid and government-sponsored investment in the given year as:

Where:

x_1 = U.S. Foreign Economic Aid

x_2 = Composite Sino-American Military Rivalry Indicator

x_3 = Natural Resource Rents in each Latin American Country

It is important to note that no country in the data set received Chinese FAGIA every year in the sample. As such, if we were to simply use these results to predict the value of FAGIA going to Latin America in a given year, we would be overestimating.

Probabilities of Receiving FAGIA: Logistic Regression and Monte Carlo

In order to account for non-recipients in a given year, we de-

termined each country's annual probability of receiving aid. To do this, we ran a logit regression using the same variables that were initially included in the general regression model. After removing variables that were not statistically significant, it was determined that recognition of Taiwan, political rights and civil liberties, value of exports to China and China's GDP were all statistically significant in explaining a country's probability of receiving FAGIA in a given year (See Appendix 2 for regression results using the best fit model as well as all variables). It is important to note that none of the variables that were statistically significant in determining the probability of receiving FAGIA were significant in determining the quantity of FAGIA received in a given year. The best fit results of this regression allow us to determine the probability of each country receiving Chinese FAGIA in a given year as:

$$P(FAGIA) = -39.88 - 2.5\,x_1 + 0.26\,x_2 + .297\ln(x_3) + 1.196\ln(x_4)$$

Where:

x_1 = Recognition of Taiwan (Dummy)

x_2 = Total Freedom House Score (Political Rights plus Civil Liberties)

x_3 = National Exports to China

x_4 = China's Gross Domestic Product

Using the results of the logit and general regression models above, we utilized the Monte Carlo method to predict expected values of FAGIA received by the region in a given year. We then ran this model 500 times for each country, summed the values for each run, and used this distribution to provide the expected amount of Chinese foreign aid and government-sponsored investment received by Latin America in each year.

Independent Variable Estimates: Extrapolation

In order to forecast the expected values of Chinese foreign aid and government-sponsored investment activity in the coming years using this model, we forecasted the expected values of each of the dependent variables used in the regression analysis. U.S. foreign aid to Latin America differs greatly from year to year. This is in part due to the U.S. legislative process and its priorities. Additionally, natural disasters may lead to the unanticipated delivery of emergency foreign aid to the region in any given year. Additionally, the political atmosphere of different countries plays a role in U.S. decisions to provide foreign aid. The large amount of variation in annual foreign aid data by country makes estimating a specific

value for any given year difficult. Given these differences, we used the average amount of economic aid received between 2000 and 2014 for each of the countries included in the analysis. These annual values range from a low of $0.45 million (Uruguay) to a high of $513.9 million (Colombia; USAID, 2016). Although there are a number of complex decisions that U.S. policy makers take when deciding the quantity and destination of foreign aid, we chose to keep these numbers constant over our forecasted time frame of 2015 to 2020.

The indicator used to measure military rivalry between the United States and China is a composite indicator taking into account military expenditure, number of personnel serving in the armed forces and arms exports for both the United States and China. Despite being a composite indicator, there is a clear trend towards equilibrium between these two nations. In order to forecast the level of rivalry through 2020, we ran a simple linear regression of the rivalry indicator over time. This showed that the military capacities of these two nations (as measured by the aforementioned variable) would continue to converge. We then used the regression results to extrapolate future levels of military rivalry between China and the United States.

Rents from natural resources in Latin America are difficult to forecast given the complexity of the potential drivers that affect outcomes. These include factors such as prices of natural resources, domestic and foreign demand for these resources, improvements in extraction, and potential disasters. Given the complexity of these measures, we decided to determine the value of rents from natural resources using data on GDP growth. The natural resource share of GDP in 2013[20] was taken as a constant value for each country. To determine the values for the model, we multiplied these shares by the forecasted value of GDP. To forecast future GDP in each country, we used GDP growth rates taken from the International Futures (IFs) Database (Hughes, 2016) and applied them to 2014 GDP levels from the World Development Indicators (World Bank, 2016). As such, rents from natural resources grow at the same rates as total economic growth.

Composite Freedom House scores in Latin America have hardly changed since the turn of the millennium, with a maximum change of two over fifteen years (Freedom House, 2015). Given the small changes and the short time horizon of this forecast, we decided to leave this variable as a constant for each county using data from 2014, which was the last year for which data was available.

While these forecasts of our independent variables allowed us to model the future of Chinese foreign aid and government-sponsored investment activity in Latin America, there was a large amount of uncertainty surrounding these variables. To take some of this uncertainty into account, we developed alternative scenarios based on the potential impacts

of a slowdown in China's growth rate and a potential shift in American politics.

Discussion of Base Case Results and Scenarios

When we utilize the model discussed above, it becomes evident that Chinese FAGIA to Latin America is likely to continue to grow (See Figure 4). The base case model predicts that between 2015 and 2020 China will provide approximately $286 billion in foreign aid and government-sponsored investment to Latin America. Furthermore, our forecast projects that the amount of FAGIA provided by China is projected will increase annually throughout the forecasted time frame. However, despite forecasted growth in Chinese foreign aid and government-sponsored investment to Latin America, given forecasted economic and political conditions, Chinese FAGIA to the region will remain well below that of the peaks seen in 2009 during the global financial crisis. Furthermore, the decline in FAGIA experienced in 2014 is likely to have continued during 2015. Although complete numbers for 2015 are not available, preliminary data using the Inter-American Dialogue's China Latin America Finance database, which only includes Chinese intergovernmental loans, yields results slightly below forecasted estimates (Gallagher & Myers, 2014).

Figure 4. Base Case Analysis
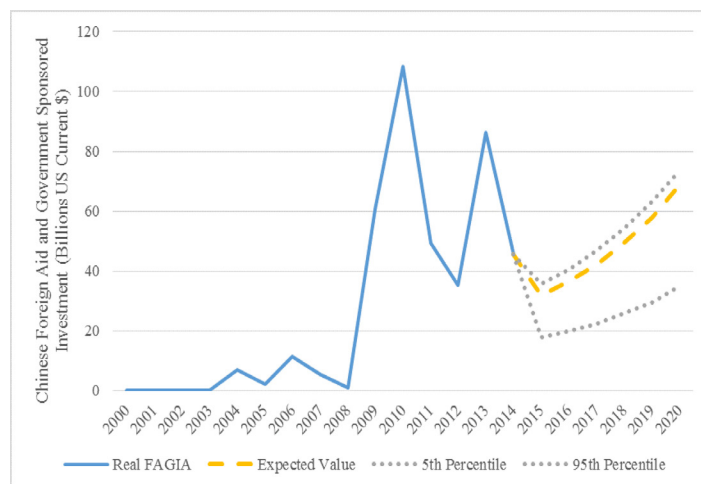
Data Sources: Freedom House, 2015; Gallagher and Myers, 2014; Hughes, 2016; USAID, 2016; Wolf et al., 2013 and World Bank, 2016.

While there are those that would claim that the continued provision of Chinese FAGIA to Latin America, or to any other region for that matter, is unlikely given the slowdown in the Chinese economy (East-Asia Latin America Task Force, 2015), our model suggests that the Chinese government is likely to continue providing an increasing amount of foreign

aid and investment to Latin America through 2020. This model includes a forecasted decline in China's growth rate from the high rates seen in the first decade of the 21st century, with forecasted Chinese GDP growth rates between 5.8 and 8% from 2015 to 2020 (Hughes, 2016). Furthermore, many China experts also believe that China will likely continue investing abroad and providing foreign aid (Greenberg, 2016). This is likely due to the continued need for raw materials and China's desire to become a world power. It is important to remember that Chinese conditionality on much of its foreign aid and investment includes provisions for utilizing Chinese labor and products. As such, Chinese FAGIA to Latin America can serve as a stimulus to the Chinese economy rather than simply benefitting the recipient country.

These forecasts rely on a large number of assumptions regarding future political and economic outcomes. Each of these assumptions injects a large degree of uncertainty into our forecast. In order to account for some of this uncertainty, we forecasted alternative scenarios to explain what may occur under different conditions. The two alternative scenarios that are examined in this paper look at the implications of a slowdown of the Chinese economy and a reduction in the amount of U.S. economic aid provided to Latin America.

The Wheezing Dragon

In the base case scenario, we use Chinese GDP growth rate forecasts from the International Futures project, which projects China's growth to be between 5.8 and 8 % annually from 2015 to 2020 (Hughes, 2016). According to one report, over two thirds of forecasters who participated in a workshop on the future of Chinese growth believe that Chinese growth will be less than 3 % annually in the coming years (Greenberg, 2016). Experts disagree on the extent to which

this will impact Chinese foreign aid and investment. While some believe that the slowdown of the Chinese economy will lead to a precipitous decline in Chinese investment in Latin America (East Asia-Latin America Taskforce, 2015), others believe that China will continue to invest abroad and provide foreign aid (Greenberg, 2016). To determine which of these hypotheses is more likely, we forecasted an alternative scenario looking at the impact of a slowdown in China's economic growth on the provision of FAGIA to Latin America.[21]

Assuming an economic slowdown, there is a reduction in Chinese foreign aid and government-sponsored investment activity to Latin America; however, the drop is not as drastic as some suggest. If China's growth continues to slow, we forecast that China would still provide FAGIA to Latin America, but that the amount of FAGIA provided would not grow as rapidly and, by 2020, China would provide over $20 billion less annually than under the base case scenario (See Figure 5). As discussed above, the base case scenario forecasted that China would provide approximately $286 billion in foreign aid and investment to Latin America between 2015 and 2020. However, with slower Chinese growth rates, we project that China will still provide approximately $230 billion in FAGIA to Latin America. This would represent a 20 % reduction in the total forecasted Chinese FAGIA between 2015 and 2020. While the slowdown of the Chinese economy could lead the Chinese government to need to reprioritize spending on domestic issues, we do not foresee this causing too many further reductions in the provision of FAGIA than those presented above. This is due to the fact that the conditionality of Chinese aid and investment allow Chinese FAGIA to act as a stimulus to the Chinese economy by creating jobs for Chinese citizens abroad and generating demand for Chinese products and inputs.

Figure 5. Wheezing Dragon Analysis
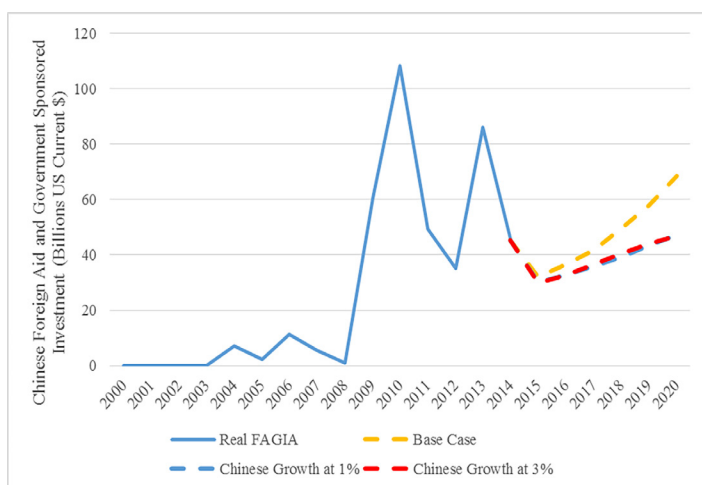
Data Sources: Freedom House, 2015; Gallagher and Myers, 2014; Hughes, 2016; USAID, 2016; Wolf et al., 2013 and World Bank, 2016.

Cutting U.S. Foreign Aid

President Trump as well as several of his political rivals expressed their desire to cut foreign aid or focus on domestic policy considerations (CNN, 2016; Wright, 2016). This however, could have drastic effects on the provision of Chinese foreign aid and investment in Latin America as well as on the balance of soft power in the region. It is important for policy makers to understand how U.S. policy may impact China's foreign aid and government-sponsored investment activity to Latin America as well as its implications for U.S. national interests. To model some of the potential impacts of cutting U.S. aid to Latin America on the Chinese provision of FAGIA to the region we have generated this alternative scenario. .

Under our base case scenario, U.S. foreign economic aid was set at the average amount of aid received by an individual country between 2000 and 2014 (USAID, 2016). To explore the potential impacts of reducing aid, we ran the model fore-

casting U.S. foreign economic aid at 75 and 50% of the original assumed values. While these may be extreme reductions, we chose these values to illustrate the potential impact a reduction in U.S. foreign aid to Latin America could have on China's soft power, as measured by FAGIA, in the region.

Figure 6. Implications of U.S. Cutting Foreign Aid to Latin America

Data Sources: Freedom House, 2015; Gallagher and Myers, 2014; Hughes, 2016; USAID, 2016; Wolf et al., 2013 and World Bank, 2016.
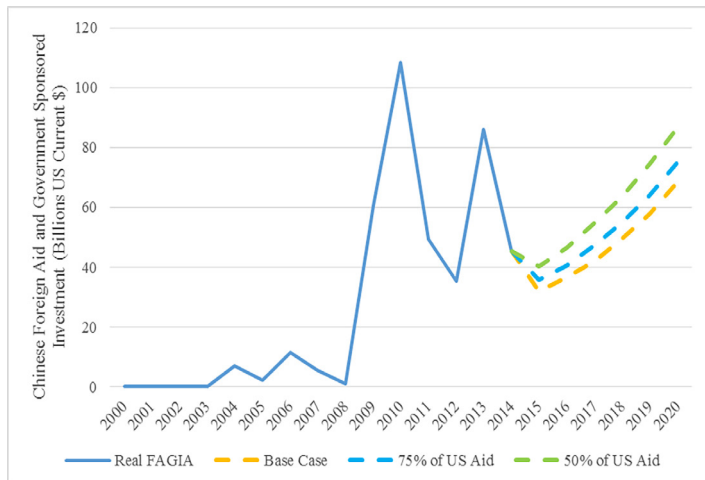
A reduction in U.S. foreign aid to Latin America would likely result in an increase in Chinese foreign aid and government-sponsored investment activity in the region (See Figure 6). While Chinese FAGIA would unlikely reach the peaks seen during the financial crisis, it would increase substantially. This model suggests that a 25% reduction in the provision of U.S. foreign economic aid to Latin America would result in an increase of approximately $3.7 to $6.6 billion per year of Chinese aid to the region, or an increase of approximately 11 % of the base case forecast between 2015 and 2020. Furthermore, a 50% reduction would lead to an increase of $80.3 billion between 2015 and 2020, or approximately 28.1% of the base case forecast.

There are supply and demand reasons as to why this may occur. On the supply side, China's history of "checkbook diplomacy" (CRS, 2008) suggests that China would supply additional aid in these situations as a way to gain power vis-a-vis the United States. On the demand side, the reduction in U.S. foreign aid would lead to a greater demand among Latin American countries for financial support, even if under conditions less favorable than the provision of U.S. aid. The rise of Chinese soft power in the region should be considered as future presidents look at the role of foreign aid, both in Latin America as well as in other developing regions.

POLICY RECOMMENDATIONS

Policy Recommendations for Latin American Nations

While Chinese foreign aid and investment to the region provides financing for development, Chinese FAGIA does not generate the positive externalities often associated with other aid and investment opportunities, including the hiring of local labor and purchase of local goods (Gallagher et al., 2012). As such, Latin American governments should seek to leverage Chinese aid and investments to promote their development and seek mechanisms that increase the positive externalities of Chinese aid so that it is similar to the benefits of other donor nations. Additionally, Latin American governments should be weary of some of the negative externalities that can be associated with accepting too much Chinese aid and investment for fear of becoming path dependent and for the potential of the deindustrialization of certain sectors, a phenomenon that has occurred within some Latin American countries as a result of Chinese involvement already (Dussel Peters, 2015). Furthermore, given the growing rivalry between the United States and China, the role of foreign aid and investment is becoming increasingly difficult to navigate. In order to ensure that Latin American nations are able to gain the most from foreign aid and government investment, it is necessary that their governments carefully navigate this rivalry so as to maximize gains without risking the loss of a potential partner in their development process (Gallagher, 2016).

Policy Recommendations for the United States

Recent studies have suggested that Chinese involvement in Latin America is not only for economic reasons, but also to balance against the United States in the region (Urdinez et al., 2016). If China is taking a zero-sum approach and supporting regimes throughout the region that actively oppose the United States, it is necessary that the United States takes a more active role in the Hemisphere. As evident in one of the scenarios analyzed in this paper, if the United States chooses to stop providing aid to Latin American nations, China will fill this void. In addition to reducing the amount of U.S. influence in the region, the lack of environmental and governance related conditions on Chinese foreign aid and government-sponsored investment may weaken the efforts of other donor countries to promote sustainable development and democratic governance in Latin America (Lancaster, 2007). In order to promote good governance in the region and promote U.S. interests, the United States should seek to become more involved in the region. This can be done in a number of ways including; expanding foreign aid to the region, encouraging both governmental and non-governmental exchange programs, and increasing participation in regional institu-

tions such as the Inter-American Development Bank and the Organization of American States. Additionally, the United States should not appear to dictate policies to Latin American nations, but rather to seek areas where the United States can support Latin American political and development objectives.

While the future of China's role in Latin America remains uncertain, it is clear that Chinese involvement in Latin America has become a political reality and one that must be handled carefully in order to ensure that U.S. and Latin American interests are not harmed by this new player in Hemispheric affairs.

CONCLUSION

Although a relatively new phenomenon, Chinese foreign aid and government-sponsored investment to Latin America is likely to continue for the foreseeable future. While there is uncertainty surrounding the future of China's economic growth and of U.S. interest in providing foreign aid, the continuation and expansion of Chinese aid and investment to Latin America is likely to endure. For China, this provides an opportunity to boost its standing in the world as well as a means of stimulating its domestic economy by providing labor and goods to Latin American nations. However, the rise of Chinese involvement in the region also has important implications both for the development of Latin America, politically and economically, as well as for the foreign policy of the United States, China and all Latin American nations.

Appendix 1. Multilinear Regression Results for Natural Log of Three Year Moving Average of Chinese Foreign Aid and Government Sponsored Investment Activity (FAGIA)25

Variables	(1) Log of FAGIA 3 year average	(2) Log of FAGIA 3 year average
Log of US Foreign Aid	-0.358* (-2.16)	-0.448** (-2.80)
Composite Sino-American Rivalry	-0.447*** (-3.78)	-0.369 (-1.23)
Square Root of Natural Resource Rents	0.0000149*** (9.57)	0.0000103*** (3.61)
If Recognize Taiwan		0.320 (0.38)
Political Similarity		0.316* (2.40)
Log of Exports to China		0.326 (1.57)
Log of Chinese GDP		0.0382 (0.03)
Constant	25.58*** (8.42)	20.16 (0.49)
N	111	111
adj. R²	0.413	0.411
rmse	2.413	2.416

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data Sources: Freedom House, 2015; Gallagher and Myers, 2014; Hughes, 2016; USAID, 2016; Wolf et al., 2013 and World Bank, 2016.

Appendix 2. LOGIT Regression Results For Probability of Latin American Nation Receiving Chinese Foreign Aid and Government Sponsored Investment Activity (FAGIA) in a Given Year[26]

Variables	(1) Log of FAGIA 3 year average	(2) Log of FAGIA 3 year average
Log of US Foreign Aid	-0.358*	-0.448**
	(-2.16)	(-2.80)
Composite Sino-American Rivalry	-0.447***	-0.369
	(-3.78)	(-1.23)
Square Root of Natural Resource Rents	0.0000149***	0.0000103***
	(9.57)	(3.61)
If Recognize Taiwan		0.320
		(0.38)
Political Similarity		0.316*
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Log of Exports to China		0.326
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Log of Chinese GDP		0.0382
		(0.03)
Constant	25.58***	20.16
	(8.42)	(0.49)
N	111	111
adj. R^2	0.413	0.411
rmse	2.413	2.416

t statistics in parentheses * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Data Sources: Freedom House, 2015; Gallagher and Myers, 2014; Hughes, 2016; USAID, 2016; Wolf et al., 2013 and World Bank, 2016.

NOTES

1   For the purpose of this paper, Latin America is used to refer to the LAC-17, or the Spanish and Portuguese speaking nations of the continental Americas. These include: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela.

2   As discussed above, Chinese Foreign Aid and Government-Sponsored Investment Activity is not very transparent. Additionally, the definition of foreign aid utilized by the Chinese is different from that utilized by the Organisation for Economic Cooperation and Development's Development Assistance Committee (DAC). While there have been many studies that have attempted to calculate the total value of Chinese foreign aid going to different regions (Gallagher and Myers, 2014; Kitano and Harada, 2014; Lum, 2009; Wolf et al., 2013). However, few of these studies provide data disaggregated at the country level. For the purpose of this paper, we are merging the Rand Corporation's Chinese Foreign Aid and Government-Sponsored Investment Data set (Wolf et al., 2013) and the Inter-American Dialogue's China Latin America Finance Database (Gallagher and Myers, 2014) to measure Chinese financial activity in Latin America. Both of these datasets rely on media analysis to determine the value of Chinese foreign aid and government-sponsored investment. Data in these two datasets is available by project and during the data merging process, duplicate programs were eliminated.

3   Due to the lack of transparency and the aggregation of different public and semi-public actors in determining the amount of FAGIA provided to Latin America, for the purpose of this paper, China refers to the Chinese government and government owned companies and banks that are involved in providing FAGIA to the region.

4   According to our dataset, Guatemala, Nicaragua, Panama and Paraguay have never received Chinese FAGIA.

5   Although Guatemala, Nicaragua, Panama and Paraguay did not receive any Chinese FAGIA between 2000 and 2014, they are included in the analysis.

6   Belize, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, Panama, Paraguay, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines. Note that while the Caribbean countries are not included in this analysis, it is important to understand that China has used foreign aid and government-sponsored in the Caribbean to pressure Caribbean governments to recognize Beijing over Taipei.

7   It is also important to note that in 2007 the small Caribbean island nation of St. Lucia switched its recognition status back to Taiwan after recognizing the People's Republic of China for ten years (CRS, 2008).

8   It is important to note that the conditionality of Chinese foreign aid and government-sponsored investment activity reduces the spill over benefits of this money on recipient country economies (Gallagher et al., 2012).

9   It is important to note here that while China has invested heavily in the production of natural resources in Latin America, they have also invested heavily in developing domestic sectors for the processing of these materials. As such, several Latin American countries have seen down grading in the production chain as China stops importing processed products in favor of raw commodities. Two clear examples of this are the down grading of Argentine exports of soy products for soy beans and Brazil's downgrading of steel exports for iron ore (Dussel Peters, 2015).

10 Trade data was primarily collected from the Inter-American Development Bank's *Instituto para la Integración de América Latina y el Caribe* (INTAL; Institute for the Integration of Latin America and the Caribbean) dataset. Missing values for some years within particular countries were however evident. Data for Nicaragua (2003) and Venezuela (2007) was missing. To calculate these, the simple average of the proceeding and following years was used to determine the value of imports and exports in the missing year. Additionally, data on Venezuelan trade from 2009 to 2013 was not available within the INTAL dataset. Trade data for Venezuela for these years comes from the United Nation's Comtrade dataset (UN, 2016).

11 The World Bank Development Indicators (World Bank, 2016) does not report Venezuela's GDP for 2013 or 2014. In order to avoid missing values for these years, GDP growth rates for 2013 and 2014 were taken from the International Futures program (Hughes, 2016) and applied to GDP levels from 2012 to generate Venezuela's 2013 and 2014 GDP figures.

12 Total natural resource rents is calculated using the natural resource rents as a percentage of GDP and Current GDP at market prices (World Bank, 2016). However, natural resource rents as a percentage of GDP was not available for the year 2014. To correct for this, it was assumed that natural resource rents as a percentage of GDP for 2014 was equal to the share of GDP in 2013. For additional caveats on GDP, please refer to footnote 12.

13 Dummy variable value was assigned at one if the country recognized Taiwan and zero if the government recognized the government in Beijing.

14 Data on total armed forces personnel was not available for 2014 (World Bank, 2016), as such data from 2013 was used in the production of the 2014 military rivalry indicator.

15 Note that as all of the component variables of the military rivalry indicator are specific to the United States and China, this variable is constant across Latin American countries.

16 Note that pooled ratio of these economic variables was initially used, but dropped from the analysis due to multicollinearity and reconsidered as separate measures.

17 Please refer to footnote number 11 for caveats on the trade figures used for calculating the economic rivalry indicator.

18 The years 2004 to 2014 were utilized for running this regression as 2004 was when Chinese financial activity in Latin America really took off. Additionally, zero values for FAGIA were removed from the regression as no country in the dataset received Chinese FAGIA every year. This allows us to interpret the regression results as the expected value of Chinese foreign aid and government-sponsored investment received by a country assuming that they received aid in any given year.

19 Three year moving averages were calculated using the average value of the previous, current and proceeding years. This was done so as to remove some of the variability within our dependent variable.

20 Note that country specific data on natural resources as a share of GDP for 2014 was not available within our dataset.

21 For running these scenarios, Chinese GDP growth was cut to 1 percent and 3 percent annually. The slowdown of the Chinese economy would likely be accompanied by a reduction in many of our other explanatory variables. Following the results of Cruz et al. (2015), we reduced the annual GDP growth rates from International Futures (Hughes, 2016) of each Latin American country by 0.6 percentage points for each percentage point decline in Chinese GDP growth (which impacts natural resource rents). Additionally, we cut Latin American export growth to China to remain constant over our time horizon.

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FACULTY SPOTLIGHT
Elizabeth Lyons

Dickson Su

✳✳✳

Elizabeth Lyons is one happy faculty member at the School of Global Policy and Strategy in UC San Diego. With an office view facing the ocean and the moderate springtime weather in full swing, there's very little to be unhappy about. Throughout the interview, the warm, affable disposition of Lyons was reflective of a clear, sunny day on the La Jolla coast. She carries none, if any, of the exhaustion commonly seen among younger faculty members juggling the demands of teaching and research. The satisfaction of being at UC San Diego, however, extends to more than being able to luxuriate in a location with one of the most agreeable climate in the country. The ability to discuss cutting-edge research ideas with her colleagues has provided her with immense satisfaction at the School of Global Policy and Strategy. Moreover, "students at GPS are professional and concerned with making their impact felt in the real world," Lyons adds, "you do not necessarily get that from students from other graduate programs".

> *"Students at GPS are professional and concerned with making their impact felt in the real world... you do not necessarily get that from students from other graduate programs."*

As an Assistant Professor of management at the School of Global Policy since 2014, Lyons' research is largely motivated by broad questions of how globalization and technological developments change the ways in which firms manage workers, and how workers supply labor. Invariably, these questions relate to organizational economics on teamwork, training, incentives and monitoring, in novel but also increasingly important contexts such as remote work, cross-country interactions, and contingent labor contracts. It also includes questions about how and why individuals enter into entrepreneurial and innovative careers and how policy makers and firms can improve these individuals' performance.

Lyons' focus of research is especially timely and pertinent given the vast and rapid improvements in technological development and their potential for enhancing people's welfare. When new innovations are created, firms may not necessarily know how best to utilize them, or fully appreciate the implications for employees or their workplace. For instance, the rise of digital labor platforms, such as Upwork, has allowed employers to hire employees across countries, but the comparison of worker qualifications remains a key concern among firms. Further, in many multi-national corporations today, communication technologies enable employees from different parts of the world to regularly work together on team projects. While it is a common conception that employees of different cultural background may promote a diversity of ideas for a project, Lyons cautions that the performance and output in a team project may sometimes falter if the frictional costs of communication and information-sharing are not adequately addressed.

Growing up in Ottawa, Canada Lyons came from a family with a father who worked as an electrical engineer and entrepreneur, an economist mother, and two sisters. Despite both her parents having multiple advanced degrees, they did not actively steer their children toward academia. Rather, she mused over how being the middle-child who was mostly left alone – like going out unnoticed by her parents until 2 o'clock in the morning – and accorded free rein to pursue her own interests, led her into eventually pursuing a PhD at the University of Toronto. The academic life, which demanded an agency over the use of time, was a natural fit for Lyons.

contemporary policy issues to be shared among graduate students at international affairs and policy programs around the world. The papers not only reflect key policy issues important to the global community, but how a diversity of individuals think about the same issues. According to Lyons, this collaboration provides a novel networking opportunity between GPS students who participate in the Journal's publication and students at other programs interested in policy research. Finally, as Lyons adds, the production of the Journal is an invaluable way to demonstrate to potential employers, future students, and alumni the competence and initiative of GPS students, and their critical engagement with the complex policy issues of the day.

On teachers who have made a lasting impression on her, Lyons recalled her lack of motivation in high school but the encouragement of her teachers, Mr. Sferrazza and Mr. O'Neill who taught physics had helped mold her

"When new innovations are created, firms may not know how best to utilize them or fully appreciate the implication for employees or the workplace."

high school experience into a positive one. Back then, Lyons played hockey and subsequently attended a prep school in Pennsylvania on a hockey scholarship. In prep school, the late Ms. Levy who taught economics, planted the first seed of interest in the subject in Lyons. The enthusiasm for economics took a more distinctive focus during college as Lyons read up on economic development and innovation. However, the pivotal moment was not until the second year of her Economics undergraduate program, when Lyons worked as a research assistant for a professor of strategic management who focused on the economics of innovation. It was this professor, Ajay Agrawal at the University of Toronto, who persuaded her to pursue a PhD in strategic management. Of these teachers who have etched an indelible impression on Lyons, she credits all of them for emphasizing the values of teaching and learning over grades. As an educator herself now, Lyons aspires to the same values inculcated by her teaching role models, although she concedes simultaneously that grading criteria is necessarily constrained to reward the quality of output instead of the amount of effort that students put in.

As faculty advisor to the Journal of International Policy Solutions, Lyons recognizes the value of the publication which allows graduate students to share high quality research papers they have worked on, across the different programs in GPS. The Journal also provides an avenue for a diversity of

Lyons with her young daughter Nia at the beach.

Around The World With GPS Students

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Bottom Left: Nagasaki, Japan, 2015. Students in Nagasaki take a break in the shade during the annual sports festival.
By Sammy Huang.

Top: Shanghai, China, 2013. Shanghai's skyline is reflective of the city's impressive history and rich culture. Today, the city is the country's fincancial and transport hub, boasting a population of 24 million people. *By Angie Zhou.*

Bottom Right: Laguna de Mojanda, Ecuador, 2015.
Mojanda lagoon is located at the center of a stratovolcano in the Eastern Cordillera of the Andes in northern Ecuador. It is one of Ecuador's protected areas, hosting a preserved *páramo*, or high altitude grassland. *By Dani Pardo-Yepez.*
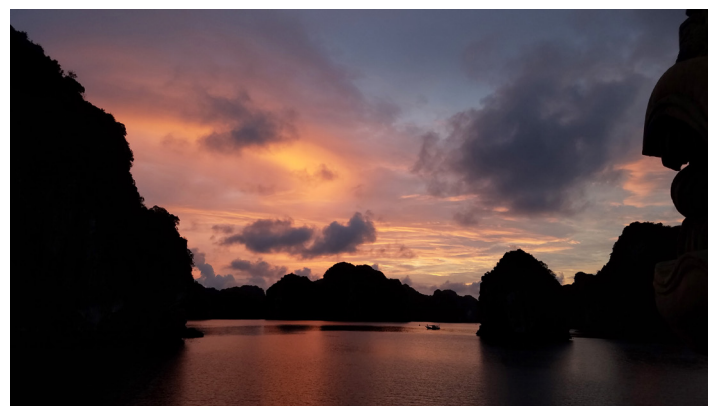
Top Left: Batu Caves, Malaysia, 2015.
The Batu Cave temples are the most popular Hindu shrine in Malaysia. Visitors must climb 272 steps up a limestone mountain to reach the main temple. *By Sadia Abdullahi Hassan*

Top Right: Inle Lake, Myanmar, 2016.
A Burmese fisherman using a traditional fishing method of balanching on the oar of the boat while paddling in shallow water.
By Kurt Nguyen.

Bottom Left: Bangkok, Thailand, 2016.
A woman selling foods at one of the 8,000 stalls at the Chatuchek Weekend Market.
By Jennifer Glaeser.

Middle Right: Brazil, 2016. Men playing capoeira at Brasilia TV Tower.
By Kristen Hamel.

Bottom Right: Ha Long Bay, Vietnam, 2016. Ha Long Bay is an UNESCO world heritage site featuring thousands of limestone islands.
By Ashlee Ellsworth.

REMOTE SENSING AND SANCTIONS ENFORCEMENT

A Case Study on North Korea

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Edited by Travis Lindsay and Sammy Huang

Over the last two decades, North Korea has attempted to bolster its struggling economy by creating "Special Economic Zones" where the country's restrictive laws against foreign investment are relaxed and the use of foreign currency is permitted. However, hard data on the local economic impact of foreign investment is scarce at best and nonexistent at worst. This paper seeks to determine if there is a visible impact of foreign investment by using remote sensing analysis of two special economic zones, Kaesong and Rason, through Google Earth Engine. Results indicate that the construction of an industrial complex in Kaesong resulted in slight but visible increases in built-up areas, night time illumination, and rates of local deforestation, indicating local development. However, only very slight differences emerge for Rason, suggesting foreign investment may have been less successful at stimulating the area's local economy. This methodology is then considered in a geopolitical context, where such analysis could have applications in measuring and verifying international sanctions enforcement in North Korea.

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INTRODUCTION

In recent years, the isolated nation of North Korea has attempted to strengthen its economy through the creation of Special Economic Zones (SEZs) where laws against foreign investment and tourism have been relaxed in order to encourage regional development. As of 2015, over a dozen SEZs existed in North Korea, but few have seen any actual investment (Silberstein, 2016). Among those few that have experienced development, two zones stand out: the Rason Special Economic Zone, located in the northeastern extreme of the country bordering Russia and China; and the Kaesong Industrial Region, home to a number of joint industrial ventures with South Korean firms. Both zones have received a considerable amount of foreign investment since the early 2000s, making them ideal case studies for evaluating the success of foreign investment in North Korea as a whole.

Rason is North Korea's oldest SEZ, having been founded in 1991 primarily to attract Chinese investment. Before 1991, the city was used as a warm-water port by the Soviet Union; since then, the city has served as a beach haven for Chinese and Russian tourists, even attracting the development of a large beachfront casino by Hong Kong investors in 1999 (Whitehead, 2013). Despite foreign capital inflows of over $37 million in 1996 by 51 Chinese companies, most development have failed to materialize, and the region languished until 2010, when it was designated a "special city" under the direct control of the central government, and granted more liberal foreign investment laws ("Introduction: Pipa Tourist Hotel", 2012). Since then, the region has been the target of joint development projects meant to upgrade infrastructure and rebuild railways connecting the city to Jilin province in China (Abrahamian & Melvin, 2015, p. 9). Additionally, in 2013, joint ventures with Russia resulted in the completion of a new pier in Rajin Port, Rason's economic center, and a rail link to the Russian border town of Khasan (Abrahamian & Melvin, 2015, p. 9). Nevertheless, outside observers report little development since 2013 (Abrahamian & Melvin, 2015, p. 11).

The Kaesong Industrial Region is North Korea's most economically successful special economic zone. Formed in 2002 as a part of the direct-governed city of Kaesong, the

region was established to host joint light-industry ventures with South Korean firms. Its most notable feature is the Kaesong Industrial Complex, where at its peak in April 2013, 123 South Korean companies employed 53,000 North Korean workers, generating annual wages of $90 million per year, paid directly to the North Korean government (Gale, 2013). Although political tensions have led to the occasional shutdown (at the time of this writing, March 2016, the complex was closed), the industrial complex continues to represent the best example of successful foreign investment in North Korea.

CONCEPTUAL FRAMEWORK

Thanks to remote sensing analysis made possible by the Google Earth Engine platform, we can circumvent the nearly impossible task of gathering data on economic development in North Korea by evaluating visible changes in our areas of study, Rason and Kaesong, over roughly the last 15 years. If foreign investment has indeed been successful in spurring local economic development, we should expect to see visible changes in the urban environment: new buildings and infrastructure should appear, cities should grow brighter at night, and for North Korea in particular, where biomass serves as an important source of energy, local rates of deforestation should accelerate.

Accordingly, this paper employs three methods for determining changes in the local economy in the areas of study. First, images obtained from the Landsat Top of Atmosphere (TOA) Percentile Composite and the annual Landsat 8 Normalized Difference Vegetation Index (NDVI) are used in conjunction with a random forest classifier provided by the Google Earth Engine platform to detect changes in built-up areas between 2000 to 2014. An increase in built-up areas would suggest that foreign investment or even simply status as an SEZ has spurred local development. The next method involves comparison of changes in nighttime illumination using images obtained from the DMSP-OLS Nighttime Lights provided by the US National Oceanic and Atmospheric Association. Increases in nighttime illumination over the study period would indicate increased economic activity that may be associated with local economic development. Finally, since many in North Korea rely on biomass as a primary source of fuel and energy, increased economic development would plausibly be associated with increases in local deforestation (Hayes, 2009). Accordingly, forest cover images from 2000 to 2015 were obtained from the Hansen Global Forest Change v1.2 dataset to evaluate local rates of deforestation in the study areas.

METHODOLOGY AND RESULTS

Detecting Built-up Areas

Maps 1a through 1c present a visual comparison of the Kaesong Industrial Region between 2002 and 2015 using satellite images made available through Google Earth (high-resolution images for Rason earlier than 2013 are not available). While buildup in the southeastern portion of the image, where a new industrial park began construction in 2003 and was completed in 2012, is visible to the naked eye, changes in buildup can be quantified using Google Earth Engine. The results are displayed in Maps 2a and 2b.

To achieve this result, bands from the Landsat TOA Percentile Composite Dataset were combined with the Landsat 8 Annual NDVI Composite using Google Earth Engine. Since extensive data on urban land cover in North Korea is currently unavailable, readily built-up and non-built-up areas were classified manually to create the classifier's training dataset, using approximately 50-60 hand-drawn polygon features for each class. The composite image and polygon features were then input into a random forest classifier with 30 trees, set to an image resolution of 100 meters. This process was repeated four times, once for the year 2000 and once for 2014 in both study areas. Rasters of built-up areas were then extracted and superimposed on the most recent satellite images of each study area using ArcGIS. Given the granularity of the TOA Percentile and NDVI Composite, in combination with the manual classification of the training dataset, a significant amount of noise in the form of misclassified pixels is apparent. Nevertheless, the general concentration allows for a rough approximation of changes in built-up areas in both regions between 2000 and 2014.

The results for Kaesong are displayed in Map 2a. Built-up area extent in the year 2000 is displayed in red; areas experiencing urban buildup since then are displayed in blue. The most obvious increase in built-up areas is the industrial park in the southeast region of the picture, which considering the visual comparison in Maps 1a to 1c, is not surprising. However, there does seem to be a slight increase in built-up areas along the outskirts of Kaesong city proper, as evidenced by the blue outline along the mass of red, visible in the northwestern portion of the image. Nevertheless, we do not see any large increase in built-up areas outside of the industrial park, indicating that foreign investment by South Korean firms has likely not spurred new construction in local areas.

The results for Rajin Port, the economic center of the Rason SEZ, are displayed in Map 2b.[1] There does seem to be some increase in built-up areas in the northwestern area of the city, as evidenced by the slight preponderance of blue pixels. However, judging by the overall distribution of red and blue pixels, there seem to be no dramatic increases in built-up

areas between 2000 and 2014. Given that foreign investment in Rason has yet failed to materialize any large-scale projects besides several improvements to infrastructure, this lack of difference in built-up areas should not come as a surprise.

Changes in Nighttime Illumination

Even in the absence of growth in built-up areas, economic development may manifest itself through increased urban illumination as existing enterprises open for longer hours and new infrastructure is added to accommodate increasing amounts of nighttime traffic. For this method, nighttime illumination levels in both 1993 and 2012 were compared from both Rason and Kaesong to see if foreign investment and status as SEZs has resulted in noticeable increases in nighttime illumination.

Images of illumination in 1993 and 2012 for both study areas were obtained from the NOAA's DMSP-OLS Nighttime Illumination dataset available on Google Earth Engine Coder. Using the "stable_lights" band, which contains values from cities, towns and other sites with persistent lighting and deletes background noise and outliers due to fires and gas flares, the maximum illumination values for 1993 were subtracted from the maximum illumination values from 2012 to generate raster of differences. For visualization purposes, increases in illumination are colored green; decreases are colored red. Although the illumination values for the "stable_lights" band extend to 255, visualization here was limited to a maximum value of 40, which given the relative absence of nighttime lighting in North Korea, was necessary in order to generate meaningful visualizations. The difference rasters were then clipped to the boundaries of each study area and superimposed on a map of North Korea.

There is a clear increase in illumination centered over the newly constructed industrial park in Kaesong, as shown in Figure 1. However, outside of this localized growth in nighttime lights, there seems to be no significant difference in illumination between 1993 and 2012. This is consistent with our findings regarding built-up areas: changes due to foreign investment have been primarily limited to the the immediate area of the industrial complex.

For Rason, there is a smaller but still significant increase in lights centered over Rajin Port, in the southwestern portion of Figure 2. Much smaller increases are centered around the smaller port of Sonbong to the immediate northeast. This corroborates our findings regarding Rason in the previous section: there is some apparent change in land cover that may be due to increased development, but the area lacks any sort of clear and concentrated increase in illumination. Nevertheless, the Rajin Port area has grown slightly brighter over the years 1993-2012.

Google Earth Engine also allows us to graph yearly mean illumination values for the study areas as a whole over time, as seen below in Figure 3.[2] For Kaesong, we see a large spike in nighttime lights in 2010, following a general increase since construction on the industrial park began in 2003. For Rason, we see a sharp increase following the beginning of Chinese investment in 1996, followed by a steady decline until 2009 and 2010, when Rason was declared a "directly-governed city." It should also be noted that Rason is relatively dark at night as a whole: the average pixel values as illustrated on the Y-axis are roughly a tenth of their counterparts for Kaesong.

Deforestation

Figures 4 and 5 illustrate aggregate forest cover (green pixels) and loss occurring since the year 2000 (red pixels) in the study areas (red pixels denote a loss in forest cover of any magnitude). Immediately apparent is the relative lack of forest cover in Kaesong – most of the area except the northern fringes seems to lack any concentration of trees. A small cluster of deforested pixels towards the southeast of the area coincides with the present location of the Kaesong Industrial Park. On the other hand, Rason is more heavily forested, although a prevalence of red pixels indicates significant deforestation has taken place since 2000, especially to the east of Rajin Port in the central southwest of the area. This area of deforestation may be illustrative of the slight increases in urbanization apparent in the previous analyses of built-up areas and nighttime lights.

Maps 3a and 3b illustrates deforestation by separate five-year periods from 2000-2015 in order to give a sense of the relative rates of deforestation over time. To generate these images, the "loss" and "lossYear" bands of the Hansen dataset were used to calculate rasters of deforested areas for each relevant time period. The images were then exported to ArcGIS and superimposed on the latest satellite image of each area for display.

Map 3a displays deforestation in the mountainous region north of Kaesong city proper, the only area of widespread deforestation in the Kaesong area over the study period. The most extensive deforestation seems to have taken place between 2005 and 2010, which would coincide with the main construction period of the Kaesong Industrial Park. However, deforestation seems to have died down following 2010, as evidence by the relatively smaller area of red pixels. While this data does not provide information as to the causes behind deforestation, it may be plausible to assume that construction of the industrial park generated a need for lumber and/or biomass that led to deforestation in this area.

Map 3b shows deforestation by time period for Rajin Port in Rason. The most notable area of deforestation occurs in the hills just east of Rajin, where there is a concentration of red pixels indicating deforestation taking place between 2010-2015. Given that Rason was given special status as a directly-governed city in 2010, and that this was accompanied by a relaxation of foreign investment laws, this accelerated deforestation may be the result of an associated increase in economic activity.

Figure 6 graphs the total annual area of deforestation as detected by the Hansen Global Forest Change dataset, calculated in Google Earth Engine. Large increases in deforestation are apparent for Kaesong in 2003 and again in 2005 and following years, roughly coinciding with the construction period of the Kaesong Industrial Park. Interestingly, there was sharp decrease in deforestation in 2010, the peak year for nighttime illumination. However, deforestation sharply increases again in 2011 and 2012, perhaps reflecting the energy needs of the industrial park.

As a whole, deforestation in Rason is much more prevalent, although fluctuating year to year. As noted in Map 3b, the largest increase in deforestation occurs in 2010, coinciding with the city's reclassification as a directly-governed city. However, based on these graphs alone, we cannot determine if these increases in deforestation are a direct result of foreign investment.

POLICY IMPLICATIONS

Under the auspices of the United Nations Security Council, the international community has repeatedly moved to exact economic sanctions on North Korea to inveigle cooperation on key international issues. Most prominent among these issue areas has been the struggle to dissuade North Korea from continuing development of weaponized nuclear and missile technologies. For example, UN Resolution 2270, passed in January 2016, imposed sanctions forbidding the export of North Korean coal, iron, and rare metals, among other resources (United Nations, 2016).

While economic sanctions have been applied *de jure* per UN Security Council fiat, the question of actual enforcement of these sanctions is one that is often debated but rarely definitively answered (Lindsay, 2016); in particular, the question most often raised is whether these sanctions are being enforced on the DPRK's northern border (shared by China and Russia). With an estimated 90% or more of North Korean trade passing over the Chinese border, any question of the effectiveness of economic sanctions on the DPRK revolves around China's decision to enforce.

The use and development of remote sensing analysis on the Korean peninsula can be a key lens through which to evaluate Chinese enforcement, as a lens to measure shifts in commercial and economic activity within North Korea itself. Precious little reliable economic data is released by the North Korean government; rather, outside observers must use a variety of strategies to impute or estimate economic fluctuations as they take place within North Korea. The development of a robust set of remote sensing capabilities applicable directly to North Korea can provide cheap and reliable means to measure sanctions enforcement. Once the problem of measurement is solved, the international community can design and implement North Korea related resolutions that are feasible, effective, and quantifiable.

CONCLUSION

Our three methods of investigation, while showing slight hints of increased economic activity, do not provide a clear picture of any large, physically visible gain in development that can be interpreted as the result of increased foreign investment, with the sole exception of the Kaesong Industrial Park. While this paper does not incorporate any actual economic data (should it exist) from the North Korean government or elsewhere regarding the Kaesong and Rason SEZs, the results strongly suggest that allowing increased foreign development has yet to deliver tangible benefits for the immediate areas surrounding the zones. It may be the case that whatever benefits that have materialized are being funneled to the capital, Pyongyang, or that foreign investment has simply failed to bring any benefit whatsoever.

Further analysis may provide a more satisfying answer. If foreign investment in these zones did contribute to the national economy, an analysis of the country's capital and major economic center, Pyongyang, may demonstrate changes in land cover and nighttime illumination that correspond with economic growth. Alternatively, a country-level analysis of land-cover, illumination, and deforestation may provide clues as to the nationwide trends of economic growth, and help determine if local changes in visible economic activity are really the result of foreign investment, or rather vestiges of a larger, country-wide trend.

Figure 1 – Changes in Nighttime Illumination 1993-2012, Kaesong Industrial Region

Green indicates positive change; red indicates negative change.

(Calculated using the NOAA DMSP-OLS Nighttime Lights dataset in Google Earth Engine)
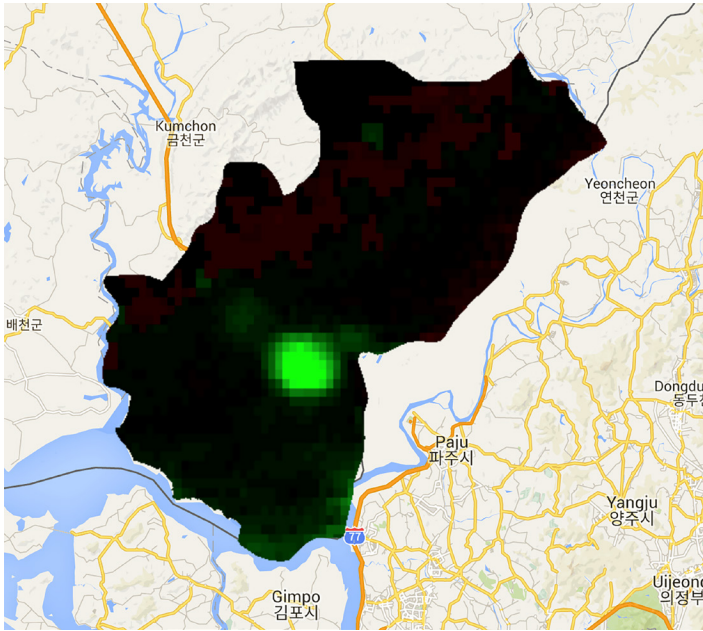
Figure 4 – Forest Cover and Loss in Kaesong, 2000 -2014
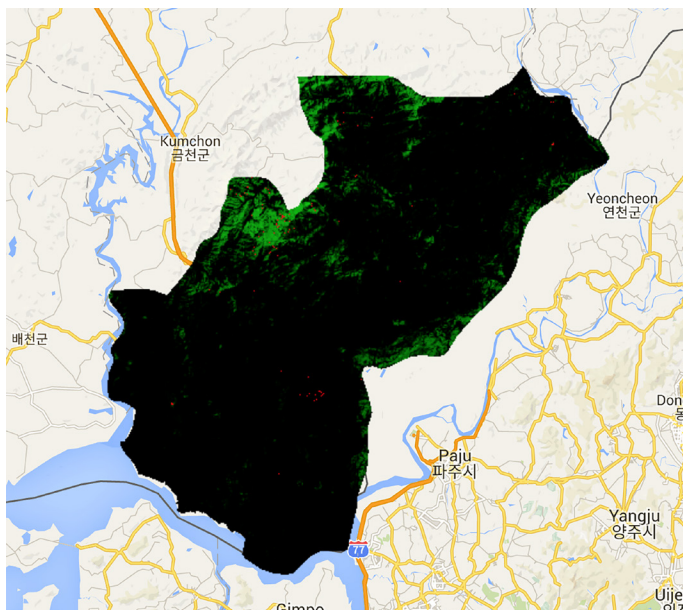
Figure 2 – Changes in Nighttime Illumination 1993-2012, Rason Special Economic Zone

Green indicates positive change; red indicates negative change.

(Calculated using the NOAA DMSP-OLS Nighttime Lights dataset in Google Earth Engine)
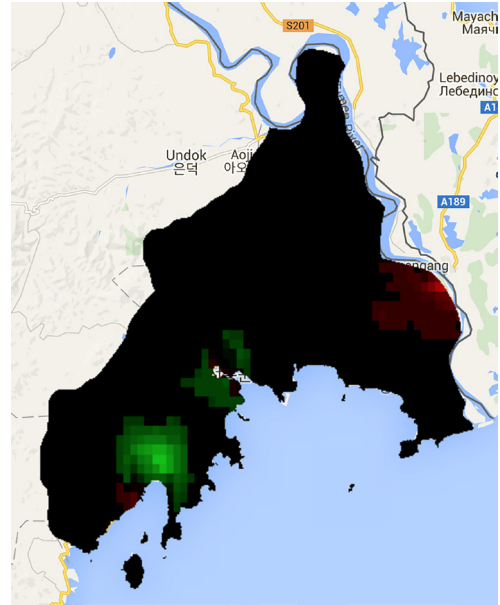
Figure 5 – Forest Cover and Loss in Rason, 2000 -2014
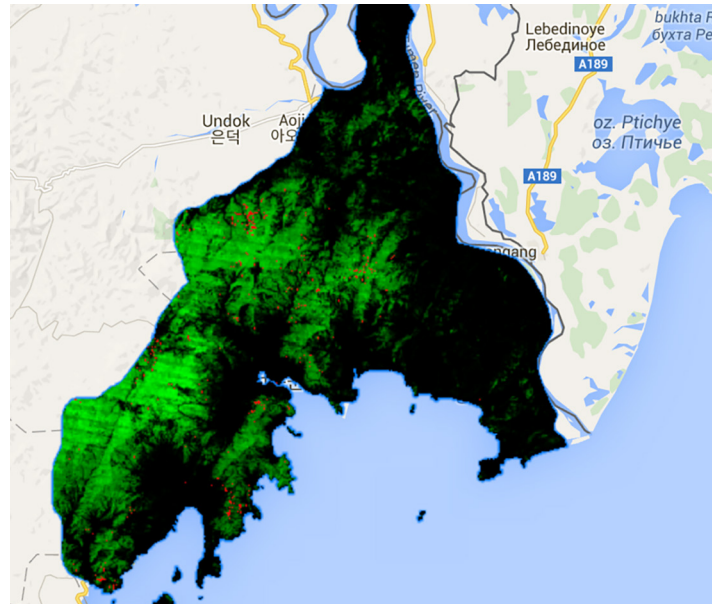
Figure 3 Annual Average Nighttime Illumination in Kaesong and Rason, 1993-2012

(Calculated using the NOAA DMSP-OLS Nighttime Lights dataset in Google Earth Engine)

Average Nightime Illumination in Kaesong, 1993 - 2012

Average Nightime Illumination in Rason Province, 1993 - 2012
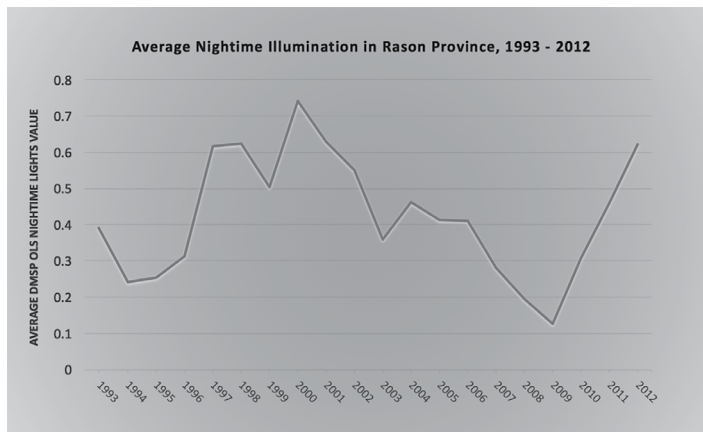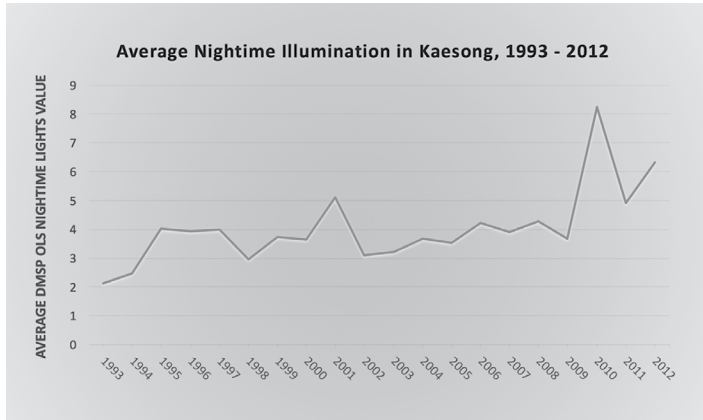
Figure 6 - Total Annual Area of Deforestation, 2002 - 2012

Annual Area of Deforestation in Kaesong, 2002 - 2012

Annual Area of Deforestation in Rason, 2002 - 2012
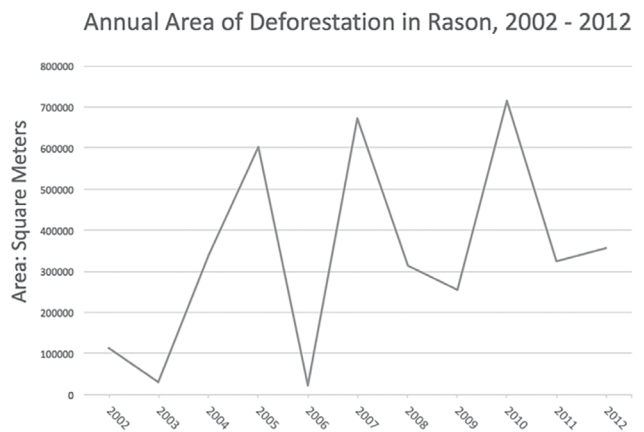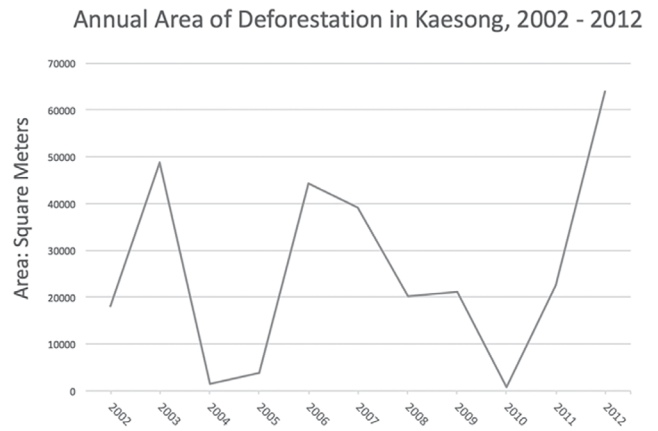
Table 1 – Built-up Area Classifier Error Matrix

Kaesong Model:

Overall validity: 98.83%			
	# Points	Buildup	Not built up
■ Buildup	8263	96.82%	3.18%
■ Not built up	35606	0.7%	99.3%

Rason Model:

Overall validity: 96.96%			
	# Points	Built Up	Not Built Up
■ Built Up	10007	94.8%	5.2%
■ Not Built Up	24234	2.15%	97.85%

Map 1a – The Kaesong Industrial Region as seen on 2002
(image obtained from Google Earth)

Map 2a – Growth in Built-up Areas, 2000-2014, Kaesong
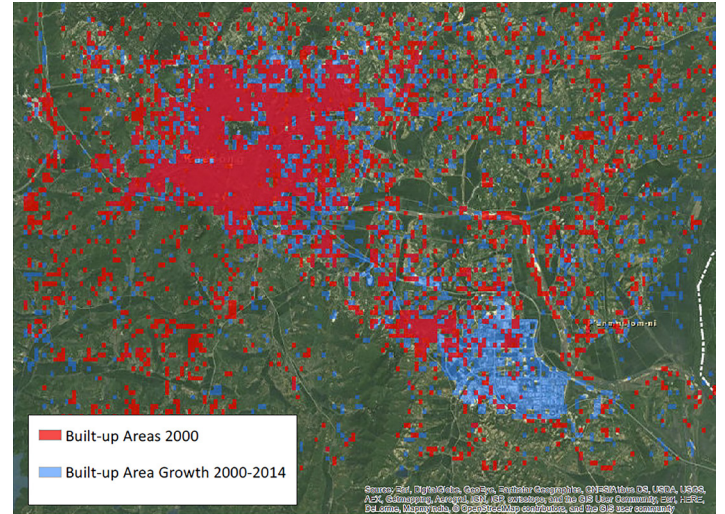
Map 1b – The Kaesong Industrial Region as seen in 2015
(image obtained from Google Earth)
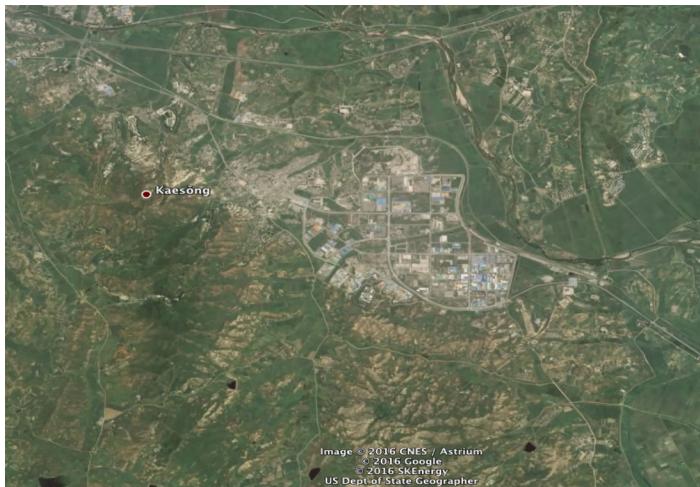
Map 2b – Growth in Built-up Areas, 2000-2014, Rajin Port(Rason)
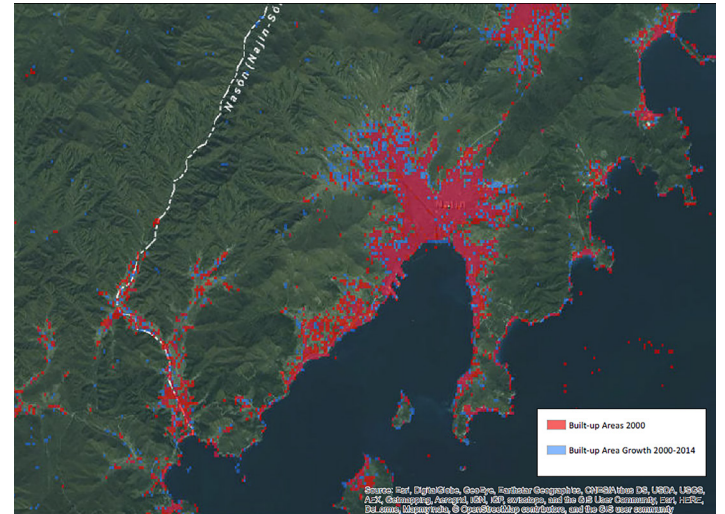
Map 1c – Rajin Port (Rason) as seen in 2015 *(image obtained from Google Earth)*

Map 3a – Deforestation in the Kaesong Industrial Region, 2000-2015

Map 3b – Deforestation in the Rason Special Economic Zone, 2000-2015

NOTES

1   The Korean terms for Rason (라선) and Rajin (라진) may be alternately Romanized as "Nason" and "Najin."

2   Illumination values are measured by 500m x 500m pixel on a scale of 0 to 63, with 63 being the brightest. Since there are relatively few illuminated nighttime pixels in North Korea, taking a province-wide average, while useful for tracking change over time, results in extremely low values.

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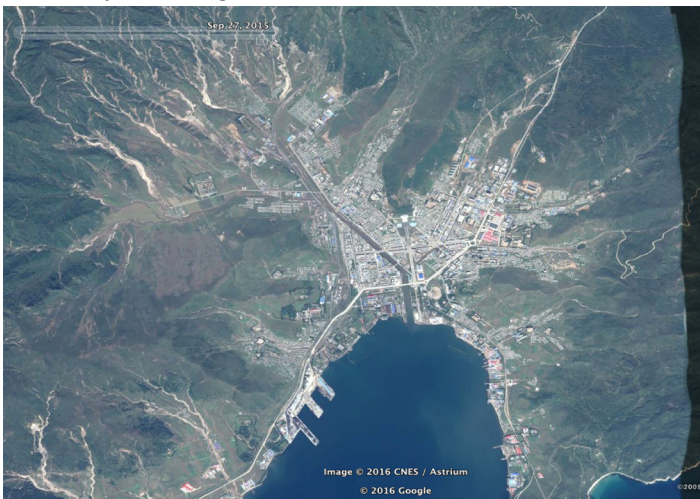
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FISHING FOR SUSTAINABILITY

Measuring the Power of the "Market Instrument" for Compliance Promotion in the Global Fishing Industry

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Edited by Dickson Su

The European Union (EU) and the United States (US) have placed sanctions against countries whose fishing vessels have committed serious illegal fishing activities (IUU activities) by publicly identifying such countries as "IUU fishing nations". This paper evaluates the sanction policy's impact size on seafood export value of sanctioned IUU countries and its trend using fixed effects and two control variables, hypothesizing that sanction policy reduces seafood export value from IUU countries through reputational loss in increasingly environmentally-aware global markets. The study reveals that information disclosure sanction significantly reduces raw seafood export value from sanctioned countries to the world by approximately 10-20% on average, having controlled for their export value of other foods (e.g. meat, rice, sugar) and other regular time trends. However, the significant impact does not seem to occur in individual markets (EU15, US, other countries). Further, the impact is weaker and less significant on processed products than on raw seafood. These findings offer new empirical evidence which supports the effectiveness of non-compliance information disclosure as a "market instrument", which could eliminate or reduce the sales of seafood products from non-compliant sources, under some limitations. It is expected that the findings of this study would contribute to better informed decisions of global fisheries and environment managers on how to best promote environmental compliance.

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INTRODUCTION

Sustainability in production has become one of the central themes in the marketing of seafood products. As the largest and most influential global private certification body of sustainable seafood products, the Marine Stewardship Council (MSC) has certified "close to 10% of the annual global harvest of wild capture fisheries (Council, 2017)" and placed them with its eco-label that certifies raw fish which has been caught in an environmentally friendly manner. As more global retail giants such as Walmart and Tesco claim to procure seafood only from MSC-certified sources or those which have been documented as sustainable, retailers are more likely to avoid seafood from sources with negative or untrustworthy sustainability record.

Based on this expectation, the paper examines the economic impact size of sanction policy by the US and EU on illegal, unreported and unregulated fishing countries (IUU countries). Since 2009 and 2012, the US and EU respectively have

identified several IUU countries as "IUU fishing nations". By publicly exposing information on serious IUU fishing activities committed by fishing vessels of sanctioned flag state, the US and EU show certain flag states which have not effectively managed the IUU activities of their fishing vessels in a responsible manner[1]. The stated objectives are to urge the nations to take stronger action against IUU activities and warn against further action (e.g. import ban) if violation of fishing activities persist. The sanction will be lifted if the EU or US acknowledges the IUU country's effort, after several years from initial sanction enforcement (e.g. South Korea). This policy does not directly restrict seafood trade with IUU countries. However, based on the market trend toward "green seafood" on a global scale, this study expects that seafood export from sanctioned flag states will decrease, as they face international reputational loss due to publicly exposed negative information on its sustainability source.

In the area of promoting environmental compliance, disclosure of non-compliance information has increasingly gained attention as one of the most promising "market instruments" which can effectively and efficiently urge firms to comply with environmentally friendly production process (OECD, 2004). Therefore, the sanction policy of information disclosure by the EU and the US is expected to create reputational damage and economic incentives for the flag state to take stronger measure against IUU activities of their fishing vessels. In evaluating the effectiveness of the policy as a "market instrument" to promote sustainable fisheries, it is crucial to understand the size and trend of economic impact in which the current sanction policy has exerted on the IUU countries. With the launch of the Presidential Task Force on Combating IUU Fishing and Seafood Fraud initiated by the White House in 2014, a study that considers illegal fishing is more important than ever (NOC, 2014). However, at present there is no existing study which quantitatively and empirically evaluates the economic impact size of negative information disclosure policy in the area of fisheries management, although there are some existing studies on broader macroeconomic scale sanctions such as the study by Caruso (2003)[5].

Based on awareness of the issue, this study evaluates the EU/US disclosure policy's impact size on seafood export value of each sanctioned IUU countries and its trend, hypothesizing that the disclosure policy reduces seafood export value of IUU countries through reputational loss. This study expects that markets in the EU15[2] and the US will most acutely react to information disclosure for three reasons: (a) they are sanctioning parties; (b) the amount of personal contribution to Greenpeace (one of the most influential environmental NGOs), based on the assumption that consumers who make higher contributions are more environmentally aware than those of other regions (Greenpeace, 2015), and (c) these regions are one of the biggest and influential seafood markets in the world. This study plans to use a retrospective identification strategy including an analysis of difference in differences (DID) and staggered entry. In order to cover the small number of sanctioned IUU countries currently available, this study first assumes that sanction enforced by EU and the US are identical to each other in their effect size and pattern, so that more IUU countries can be included in a single estimation. This assumption is later examined by separating IUU countries according to the EU and US. The study also looks into the treatment effect of the IUU country's trade value of processed seafood (e.g. canned tuna) and meat, through the hypothesis that export value of processed seafood does not decrease after sanctions, and might even increase as it is easier to disguise its source than the case of raw seafood products.

DATA

The research makes use of country and monthly export data from the International Trade Statistics of the International Trade Centre. As the dependent variable of interest, this study uses international trade data of unprocessed seafood (hereinafter referred to as "raw seafood") and processed seafood/meat (hereinafter referred to as processed seafood/meat) of 15 sanctioned IUU countries and other non-sanctioned countries whose trade data is well established and available. Export data of raw seafood and processed seafood/meat will be treated separately, but it is hereinafter referred to as "seafood" collectively.

To provide a counterfactual comparison, the study uses two types of datasets: 1) international trade data of all non-fish food sectors (all HS codes 1-2, 4-15 and 17-24 combined, this sector category is hereinafter referred to as "other foods") of the 15 sanctioned IUU countries, and 2) seafood export value from non-sanctioned countries. As for the latter, export data of each single non-sanctioned countries to EU15 on the aggregate level was not available. In order to look at how the sanction affects the overall global seafood export of non-sanctioned countries, the total export value of unprocessed seafood (HS code: 03) and processed seafood/meat (HS code: 16) of those countries which has never been sanctioned as a IUU country, is also used. This dataset uses single time series trade data (single string of total value of non-sanctioned countries, not separated by country by country) to cover every single sanction against each sanctioned country. Each trade dataset is divided into four components, based on importers: world total, EU15, the US and the rest of the world. The detailed structure of the datasets and analysis are shown in Table 1 and Table 2.

The data on sanctions by the EU and the US makes up our independent variable of interest (policy variable). The source of this data is obtained from official press release from the European Commission and reports to Congress published by the National Oceanic and Atmospheric Administration (NOAA) of the US. Each IUU country has been sanctioned by either EU or the US. The information is summarized in Table 3. The data takes the form of a binary dummy variable which is equal to 1 on and after the sanction is put in place, and otherwise zero. Although several countries have been sanctioned several times, this study looks at the treatment effect of only first sanction of each IUU country.

As a secondary binary independent variable, the sector variable is equal to 1 if trade value is of "seafood (03)" or processed seafood/meat (16)" and 0 if trade value is of other foods. Subsequently, in analysis (iii) as shown in Table 1 and Table 2, the binary independent variable will be replaced by another one which shows country group; equal to 1 if the trade value is of sanctioned country and 0 if it is of non-sanctioned countries.

METHODOLOGY

The following analysis consists of three major parts detailed below and in Table 1 and Table 2.

Analysis(i) EU-US sanctioned groups combined

(i)-a. DID estimation (Control DV: export value of other foods, of the sanctioned countries)

The study first estimates the effect size of the sanction policy on the IUU country's monthly seafood trade value with a DID estimator, using export data of other foods of those countries as a control group dependent variable. Each sanctioned country is treated as a unit of observation. In performing the DID analysis, the assumption made is that there is no heterogeneity in its effect between sanctions imposed by EU and the US, hence the two sanctions are treated equally as if there is only one international sanctioning authority. This assumption enables us to include greater number of sanctioned countries into a single regression, in order to cover the small number of IUU countries available. However, results of the analysis based on the assumption would be different from the reality since heterogeneity is likely to be present in the treatment itself and those who receive the treatment. Subsequently, we examine the assumption in analysis (iii) below.

The DID analysis makes use of fixed effects for country-sector, year, country-month, so that any variation unrelated to sanction enforcement in the dependent variable is captured and the treatment effect is estimated in a more robust manner. Because the monthly trade data of each country and sector (seafood or other foods) exhibits its own unique seasonality and annual trend, it is advisable to include multiple fixed effects into the regression model as Equation (1) below.

Using export data of other foods of those countries as a control group dependent variable enables us to estimate the effect size relative to other foods sector. The latter is expected to move in the same trend as seafood, as export value of other foods are subjected to the same macroeconomic trends such as foreign exchange rate and momentum of domestic food demand. However, the disadvantage of this approach is that the estimated coefficient could be biased if the sanction affects the export value of other foods (control group) as well. This concern is examined in analysis (i)-b and (i)-c below.

As part of robustness check, the parallel trend assumption for pre- and post-treatment is tested with an estimating equation of first difference in Equation (2).

$$Y_{iTym} = \alpha_{iT} + \theta_y + \delta_{im} + \beta_1 * \theta_T + \beta_2 * SA + \gamma_{TE} * (\theta_T * SA_{iTym}) + u_{iTym} \quad (1)$$

$$Y_{iTym} - Y_{iTym-1} = \beta_3 * \theta_T + \mu_{iTym} \quad (2)$$

Y_{iTym} = natural logarithm of export value of group T, country i, at year y and month m;

i = each IUU fishing country (exporter);

y = year;

m = month ($1 \leq$ month ≤ 12);

T = sector which is either seafood (HS 03/16) or other foods;

α_{iT} = country specific permanent fixed effect for difference between sectors;

θ_y = year specific fixed effect (overall annual trend);

δ_{im} = country-month specific fixed effect (country specific seasonality);

θ_T = A binary variable for sector group which is:

   =1 if treatment group: "raw seafood (03)" or "processed seafood/meat (16)",

   =0 if control group: other foods;

SA_{iTym} = sanction binary dummy variable (=1 if being sanctioned by either EU or the US);

γ_{TE} = treatment effect of sanction;

ϑ_T = coefficient to test parallel trend assumption in pre-sanction period &

u_{iTym} = error term

(i)-b. Changes around the time of entry (Nominal export value of seafood and other foods from sanctioned countries)

Changes around the time of entry is used to look at the nominal change of export value of seafood and other foods in a uncontrolled environment and whether an Ashenfelter's dip exists in the DID analysis, as part of the robustness check. The weakness of this approach is that changes shown in the graph is not controlled for other variables. Therefore, other robustness checks using fixed effects or control independent variable is required to strengthen the analysis.

(i)-c. Staggered entry with fixed effects (DV: Nominal export value of seafood and other foods from sanctioned countries. No control DV)

In order to see the period-specific treatment effect of sanction without being affected by the trend of control group variable (other foods), each dataset of raw seafood, processed seafood and meat, and other foods of sanctioned countries is independently analyzed with estimating Equation (3) below. The weakness of this approach is that because there is only a single export trade dataset without control dependent variable for each regression, its statistical power to detect sig-

nificant treatment effect might be weaker than the analysis using a control DV. Also, as export data for each month after sanction is observed only once per country, there is smaller degree of freedom in estimating the period (month) specific shocks (γ_k in the equation below).

$$Y_{iym} = \alpha_i + \theta_y + \delta_{im} + \sum_{k=0}^{6} \gamma_k * T_{iym+k} + u_{iym} \qquad (3)$$

Y_{iym} = log of export value of country i, at year y and month m;

α_i = country specific permanent fixed effect;

θ_y = year specific fixed effect (overall annual trend);

δ_{im} = country-month specific fixed effect (country specific seasonality);

$i/$ = each IUU fishing country (exporter);

y = year;

m = month ($1 \le$ month ≤ 12);

γ_k = period specific shock in tau=k;

T_{iym+k} = dummy variable indicating tau=k in country i &

u_{iym} = error term

(i)-d. Regression using seafood export value of non-sanctioned countries as control variable (DV: only seafood of sanctioned and non-sanctioned countries)

To consider the effect size in a multi-sided manner, we use the export value of non-sanctioned countries as a control variable and fixed effects, as described in Equation (4) below. However, due to limitations with STATA/IC, we were unable to perform the regression with country-month specific fixed effect (for country specific seasonality).

$$Y_{iym} = \alpha_i + \theta_y + \delta_m + \gamma_{TE} * T_{iym} + u_{iym} \qquad (4)$$

Y_{iym} = log of export value of country i, at year y and month m;

α_i = country specific permanent fixed effect;

θ_y = year specific fixed effect (overall annual trend);

δ_m = month specific fixed effect (overall seasonality);

i = each IUU fishing country (exporter);

y = year;

m = month ($1 \le$ month ≤ 12);

γ_{TE} = average treatment effect;

SA_{iym} = sanction binary dummy variable (=1 if being sanctioned by either EU or the US) &

u_{iym} = error term

The strength of this approach is that each regression incorporates additional observations from over 100 non-sanctioned countries, which strengthens the statistical power. The weakness is that the estimated coefficient could be biased if seafood export of non-sanctioned countries as a control is affected by sanction too. This concern is examined in analysis (ii).

Analysis(ii). EU-US sanctioned groups combined: Potential effects of sanction on seafood export from non-sanctioned countries

As a robustness check for the analysis in (i)-d, this study also analyzed the sanction effect on non-sanctioned countries, using total seafood export value of non-sanctioned countries.

The numbers of non-sanctioned countries (over 100) and sanctioned countries (only 15) are imbalanced in our study and it is for the reason that we do not use country-by-country export value of non-sanctioned countries as the dependent variable, which would open up the potential for arbitrary pair selection. Choosing a "best matching" pair for each IUU country from the pool of non-sanctioned countries would be difficult as there are numerous latent factors (e.g. export value, region, distance from trade partner, etc) that may affect the eligibility of each pair, and the result of the analysis would be heavily dependent on the arbitrary choice of the pair for each IUU country. The approach might work if the sanction against an IUU country affects only the paired non-sanctioned country, but this is not the case in reality. Using the sum of non-sanctioned countries enables us to capture not only an overall trend of non-sanctioned countries on a global scale, but also the impact of every single sanction enforcement against each IUU countries on overall non-sanctioned countries. The disadvantages of this approach would be that it reduces the degree of freedom of analysis and it would be debatable if the total export value of all non-sanctioned countries can be paired up with each single sanctioned country.

(ii)-a. Changes around the time of entry (Nominal total export value of seafood from all non-sanctioned countries)

In order to look at the nominal change of total export value from non-sanctioned countries around sanction enforcement against each IUU country, charting changes around the-time of entry would be a useful tool. It should be noted that this change is not controlled for other variables.

(ii)-b. Staggered Entry Analysis with Fixed Effects (DV: natural logarithm of total export value of seafood from all non-sanctioned countries)

The same analysis as (i)-c is performed using total export value of seafood from all non-sanctioned countries as a dependent variable. As there is only one string of time series total trade data for each sanction enforcement, we are limited by the degree of freedom in this analysis. However, we consider that this estimation, in combination with (ii)-a, is the best way available to measure the sanction effect on non-sanctioned countries overall.

Analysis (iii). EU/US sanctioned group are separated out: examining the heterogeneity of sanction effect

In order to examine the heterogeneity effect on sanction and its trend, the same analysis as (i)-a and (i)-c is conducted, separating out the two groups of IUU countries: those sanctioned by EU and those sanctioned by the US (hereinafter referred to as "analysis (iii)-a" and "analysis (iii)-b").

RESULTS

1. US/EU sanctioned groups combined (Overall Average)

The result of analysis (i)-a as shown in the Table 4, suggests that on a worldwide level, information disclosure does significantly reduce the export value of raw seafood by approximately 10-20% on average in the short run. This is upon controlling for time variant and invariant fixed effects and the export value of other foods. However, in the longer run (>3 months) this treatment effect is weakened by the passage of time, although the statistical significance continues for at least until 10 months after the sanction. In the case of processed seafood/meat, the export value significantly decreased over several months, but the impact size is weaker and goes away more quickly than raw seafood. Also, looking at each market individually, there is almost no significant treatment effect observed. In this analysis, the result of pre-treatment parallel trend shows that there is no violation of parallel trend assumption between seafood and other foods, which makes the findings robust to a certain extent.

Looking at the result of analysis (i)-b as shown in Figure (i)[8], significant jumps are observed around the sanction enforcement in an uncontrolled environment. Based on the result for other foods, except for the case of the US (figure (i) -3-OT), minor dips around the sanction enforcement are observed. This suggests that the sanction potentially might be affecting the export value of other foods (control group variable in analysis (i)-a) as well.

In order to check if the minor dip in other food is significant, the result of analysis (i)-c is shown in Table 5. Although some coefficients for other foods just after sanction enforcement show a statistically significant decease even after control for

time variant and invariant fixed effects, the way they appear is sporadic and non-repeated, rather than consecutively repeated in each variable. It could then be safely said that the sanction effect on other foods is limited, at least not so severe as to strongly bias the result in analysis (i)-a. Also, there are limited coefficients which show significant drop among seafood. Moreover, the significance is weak. Although the non-significant result is affected by the limited degree of freedom from not using control variables and the capture of variance by fixed effects, the result suggests that within a single export trade value dataset, the treatment effect does not appear on a month-by-month basis. It further suggests that the impact of sanction should be considered as a relative one to other food sectors, not an absolute one.

The result of analysis (i)-d is shown in Table 6. Although limitations with data for EU15 has weakened the validity of "other importing countries", no significant decrease was observed, having controlled for fixed effects and seafood export value of non-sanctioned countries (country-by-country-basis value). As mentioned before, this result could be biased if the control variable (seafood export of non-sanctioned countries) is affected by the sanction enforcement against sanctioned countries.

In order to examine this potential concern, we look at the result of analysis (ii)-a as shown in Figure (ii)[8]. With an exception at Figure (ii)-3-16, it seems that sanction against IUU countries negatively affects the total export value from all non-sanctioned countries for a few months after the enforcement, in each market.

Because these figures show changes from treatment uncontrolled for other variables, it should be further examined using more robust estimation method with fixed effects. The result of the estimation for analysis (ii)-b is shown in Table 7. Compared to the period specific shock toward seafood export from sanctioned countries (already estimated in Table 5, but re-listed in Table 6 to make comparison easier), the negative impact on total seafood export from non-sanctioned countries are much more significant and consecutively repeated in raw seafood export to "world total", "EU15" and "other countries." The results of non-sanctioned countries in Table 7 might be less reliable due to the smaller degree of freedom originating from the single time-series dataset of total (aggregated) export value from non-sanctioned countries. However, the consecutively repeated significant negative coefficients in Table 7, combined with the distinct drop on sanction in figure (ii), cast doubts on the validity of seafood from non-sanctioned countries as a control in analysis (i)-d (table 6). This raises a potential concern that the estimated impact size against raw seafood export from sanctioned countries to these two markets in Table 6 is potentially underestimated and should have been more statisti-

cally significant if this control was unaffected by sanction. It could be inferred that the impact size on raw seafood export from sanctioned countries which were estimated in Table 4 are now more robust than that in Table 6. As for the export of processed seafood/meat to "world total" and US importing market in Table 7, there is almost no consecutively repeated significant drop, which suggests that the concern with underestimation is weaker in Table 6. Taking this into account, results of both analyses (i)-a (Table 4) and (i)-d (Table 6) support the significant negative impact not observed in the US market. The results of processed seafood/meat in "world total" market in (Table 4) and (i)-d (Table 6) compete with each other (significant drops are observed in table 4 but it is not the case in Table 6). Therefore, the significant drops of processed seafood/meat in "world total" market observed in Table 4 would be less robust.

2. US/EU sanctioned groups separated

The result of analysis (iii)-b for non-controlled values of export, as shown in Figure (iii) suggest that the trend of change around the sanction enforcement is different between IUU countries sanctioned by EU and those sanctioned by the US[3].

Are these changes significant? In order to answer the question, we refer to the result of analysis (iii)-a as shown in Table 8. They suggest that having controlled for fixed effects and export value of other foods, the US sanction seems to have more significant impact on both raw seafood and processed seafood/meat in the market all over the world, although significant negative impact of EU sanction is observed on raw seafood in the same market. In case of "other importing countries," significant negative impacts are observed in both EU-sanctioned countries and US-sanctioned countries. In the case of "world total," it seems that the market responds more quickly to US sanction than to EU sanction. However, it would be difficult to judge based on analysis of this study, that whether the differences in impact between these two groups are attributable to heterogeneity in treatment (sanction itself) or in sanctioned countries or the market. Further, the EU market appears to react acutely to the US sanction especially in the case of raw seafood, but not so toward the EU's own sanction. Similarly, the US market is sensitive to sanction by EU on importing raw seafood but it is not the case for US sanction. Looking back at Table 3, only two countries are listed in both EU-sanctioned countries and US-sanctioned countries in the first place, even though both the EU and the US outwardly claim that they monitor IUU fishing worldwide and imposing sanction against serious violators. These interesting facts evoke a concern for potential reverse causality; the EU and the US might have deliberately chosen their sanction target from those countries whose seafood export is less likely to significantly affect its domestic market.

In order to examine this hypothesis, Table 9 summarizes the difference between the two markets in mean export values during 5 years (60 months) up to sanction enforcement in each target country for both EU-sanctioned countries and US-sanctioned countries. The table shows that for raw seafood, in both EU and US sanctions, the mean export value of sanctioned countries to the sanctioning country's domestic market is significantly lower than that destined for the other one, and the difference is especially large in the case of US sanction. For processed seafood/meat, no significant difference between the two markets is observed from EU sanction, but the large significant difference is observed from US sanction. Although the examination here does not offer full evidence on the validity of the hypothesis above, at the very least, it has failed to reject the hypothesis. Especially in the case of US, it seems more obvious that it has picked up target countries of its sanction from those countries with smaller seafood export value to US market, so that significant impact by sanction on its domestic market does not occur. Further study would be required to examine this concern with higher degree of confidence.

POLICY RECOMMENDATIONS

These findings offer new empirical evidence which supports the effectiveness of non-compliance information disclosure as a "market instrument" which could be used to eliminate or reduce the sales of seafood products from non-compliant sources, with some limitations. Through the above discussion of results, the study aims to contribute to better informed decisions of global fisheries and environment managers on how to best promote environmental compliance. From this viewpoint, the study identifies two policy recommendations in fisheries management based on major findings of the study.

1. Revision of yellow-card sanction trigger requirements (To: European Commission and the US government)

The study pointed out the concern that EU and the US may potentially have refrained from imposing sanctions against some of their major fish exporting countries, derailing from the outwardly stated requirement (serious IUU fishing activities). To maximize the impact size of yellow-card sanction policy as a "market instrument" and achieving the stated objective more effectively, this study recommends that the European Commission and US government eliminate the potential "hidden filter" from their target-choosing process. Looking at Table 8 and Table 9, the yellow-card sanction is more likely to have significant impact when seafood export value from the sanctioned country is higher. Taking this into account, it does not conform with the stated objective of

yellow-card sanction policy to identify IUU fishing nations with higher fish export.

2. Publication of each country's compliance situation by Regional Fisheries Management Organizations (RFMOs) (To: each RFMOs (e.g. The International Commission for the Conservation of Atlantic Tunas (ICCAT)))

Due to its broad international coverage, RFMOs face a collective action problem where effective non-compliance deterrence tends to be undersupplied (Olson, 1965; Koehler, 2013). Therefore, it would be useful to provide information that incentivizes better compliance with regulations. Taking into account that seafood export is one of the major fishing incentive among contracting parties, adopting a system similar to the yellow-card sanction of EU and the US would be an effective deterrence against non-compliance by each contracting party. For instance, it may be worth considering a scoring mechanism of compliance status that visualizes how each contracting country implements conservation and management measure adopted by the RFMOs. If one contracting country receives a compliance score which is significantly lower than other member countries, such negative compliance information could have a similar impact to the yellow-card sanction, on that country's seafood export. Such an impact would function as a "market instrument" which urges the non-compliant countries to sincerely implement conservation and management measures adopted by the RFMO.

CONCLUSION

This study estimated the impact size of disclosure sanction policy of the EU and the US on seafood export value using two different control variables: the export value of other foods of sanctioned countries and the seafood export value of non-sanctioned countries. The two types of analysis provided mixed results: the former showed a significant decrease in seafood export from sanctioned countries but the latter did not. At the very least, in one of the two estimations, this study has revealed that information disclosure sanction does significantly reduce the raw seafood export value from sanctioned countries to the world by approximately 10-20% on average, having controlled for the export value of other foods (e.g. meat, rice, sugar) and fixed effects. Although the significant negative impact was not observed in the other estimation using seafood export value from non-sanctioned countries as a control variable, it is at least partially attributable to the finding that the control variable also significantly decreased just after sanction enforcement. This suggests that the estimated negative coefficients of the original regression

as shown in Table 6 may be underestimated. Therefore, the result of significant negative impact that was not observed does not necessarily lead to immediate rejection of the study's original hypothesis that the sanction will have a negative impact on seafood export. Considering that the significantly negative impact was not observed in export of other foods from sanctioned countries, the DID estimation outcome using it as control variable should be more robust and reliable than another regression outcome using negatively affected control variable (seafood export from non-sanctioned countries). It should, therefore, be noted that the finding that seafood export from non-sanctioned countries significantly decreases after sanction against an illegal fishing country could be less robust due to its uncommon methodology: using only single time-series dataset of total seafood export value all non-sanctioned countries. At the very least, as mentioned earlier, the sanction does work to inflict economic damage against seafood export from sanctioned countries, according to one of the two analyses in the paper.

The significant impact of the sanction does not appear when looking at each market (EU15, US, other countries) individually. The impact was weaker and less significant on processed products than on raw seafood. Furthermore, that meaningful negative impact was not observed in the staggered entry analysis without any control variable suggests that the negative impact of disclosure sanction is relative, rather than absolute.

Findings from analysis (ii)-b using seafood export from non-sanctioned countries also suggest that the sanction against IUU countries could have a significant negative impact on raw seafood export from non-sanctioned countries, and that the negative impact is absolute, not relative to the control. As mentioned above, it should be noted that the analysis itself is less robust due to the limited number of observations (using only aggregated export value of non-sanctioned countries, not individual basis). However, it might be likely that sanction enforcement to a particular IUU country causes a "credit crunch" of seafood in general on a global scale, or it might be attributable to fishing vessels flagged as IUU countries that offload their catch in non-sanctioned third-party countries. Further careful examination would be required to obtain more robust finding on this point.

In the analysis separating the two groups of countries (EU-sanctioned countries group and US-sanctioned countries group), three notable outcomes were produced. First, it was revealed that both US and EU sanctions have significantly negative impact on raw seafood export of sanctioned countries, having controlled for the export of other foods and fixed effects. However, the world market reacts more quickly to US than to EU sanction. Moreover, US sanctions correspond with a negative impact on processed products as well,

although the duration is shorter (for a couple of months). This study finds it difficult to judge to what extent all of these different trend of results between the two groups is attributable to heterogeneity of sanction (treatment) itself, or to that of sanctioned countries or the market. Secondly, this study found that the EU15 market does not react to EU sanction and neither does the US market to US sanction, although both of them react to sanctions enforced by the opposite sanctioning country. This study failed to reject the hypothesis that EU and the US have deliberately chosen their sanction target from those countries with smaller seafood export to their domestic markets. The potential concern of reverse causality is especially strong in US sanction, as there is a huge and significant gap in the mean seafood export values between to US market and EU15 market. Thirdly, the market of "other importing countries" also reacts to the US sanction, although its reaction to EU sanction is less substantial. This suggests that there are some environmentally aware markets which at least care about the US sanction and the disclosed negative compliance information, other than the EU15 and US. The market power to eliminate non-compliant seafood exists at least in some countries or regions in the world, other than the two most developed Western markets. This is one of the major findings which is beyond the initial expectation of this study.

APPENDIX

Table 1. Summary of analysis structure

Analysis #		Importing Country	Product types of dependent variable of interests	Primary Variable for analysis	
				Dependent Variable of Interests	Control Dependent Variable
(i)-a	1	World total	Raw Seafood (HS:03)	Export value of the products in the left side from 15 **sanctioned** countries (US-sanctioned group and EU-sanctioned group are treated **together**)	Export value of **other foods** from 15 **sanctioned** countries (US-sanctioned group and EU-sanctioned group are treated **together**)
			Processed Seafood & Meat (HS:16)		
	2	EU15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
(i)-b	1	World total	Raw Seafood (HS:03)		None
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	2	EU15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	4	Other importing countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
(i)-c	1	World total	Raw Seafood (HS:03)		None
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	2	EU15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
(i)-d	1	World total	Raw Seafood (HS:03)		Export value of the products in the left side from **Non-sanctioned countries**
			Processed Seafood & Meat (HS:16)		
	2	EU15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		

Table 2. Summary of analysis structure (Cont.)

Analysis #		Importing Country	Product types of dependent variable of interests	Primary Variable for analysis	
				Dependent Variable of Interests	Control Dependent Variable
(ii)-a	1	World total	Raw Seafood (HS:03)	Total export value of products in the left side from **non-sanctioned** countries	-
			Processed Seafood & Meat (HS:16)		
	2	EU 15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
(ii)-b	1	World total	Raw Seafood (HS:03)		-
			Processed Seafood & Meat (HS:16)		
	2	EU 15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
(iii)-a	1	World total	Raw Seafood (HS:03)	Export value of the products in the left side from **15 sanctioned** countries (US-sanctioned group and EU-sanctioned group are treated **separately**)	Export value of **other foods** from 15 **sanctioned** countries (US-sanctioned group and EU-sanctioned group are treated **together**)
			Processed Seafood & Meat (HS:16)		
	2	EU 15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
(iii)-b	1	World total	Raw Seafood (HS:03)		None
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	2	EU 15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	4	Other importing countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
(iii)-c	1	World total	Raw Seafood (HS:03)		None
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	2	EU 15	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	3	US	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		
	4	Other countries	Raw Seafood (HS:03)		
			Processed Seafood & Meat (HS:16)		
			Other Foods (HS:01-02,04-15,17-24)		

Table 3. Summary of data of sanctioned countries

Sanctioned countries	Sanction enforcement		Sanctioning party	Monthly trade data available	Trade Data coverage
	Year	Month			
Belize	2012	11	EU	○	2008.01-
Cambodia	2012	11			
Fiji	2012	11		○	2008.01-
Guinea	2012	11			
Panama	2012	11			
Sri Lanka	2012	11			
Togo	2012	11			
Vanuatu	2012	11			
Republic of Korea	2013	11		○	2008.01-
Ghana	2013	11			
Curaçao	2013	11			
Philippines	2014	6		○	2007.01-
PNG	2014	6			
Saint Vincent and the Grenadines	2014	12			
Tuvalu	2014	12			
Saint Kitts and Nevis	2014	12			
Solomon Islands	2014	12			
Thailand	2015	4		○	2007.01-
Comoros	2015	10			
Taiwan	2015	10		○	2004.01-
France	2009	1	US	○	2004.01-
Italy	2009	1		○	2004.01-
Libya	2009	1			
Panama	2009	1			
China	2009	1		○	2005.01-
Tunisia	2009	1			
Colombia,	2011	1		○	2005.01-
Ecuador,	2011	1		○	2005.01-
Portugal,	2011	1		○	2004.01-
Venezuela	2011	1			
Ghana	2013	1			
Mexico	2013	1		○	2005.01-
Republic of Korea	2013	1		○	2008.01-
Spain	2013	1		○	2004.01-
Tanzania	2013	1			
Nicaragua	2015	1		○	2004.01-
Nigeria	2015	1			

*1: Republic of Korea (ROK) was treated as both one of the sanctioned-by-EU group and sanctioned-by-US group. When both groups are treated together (analysis (i)), EU sanction against ROK was dismissed as it was enforced right after US sanction and it could affect the estimation)

*2: Several countries are sanctioned repeatedly. Second sanction and thereafter are dismissed.

Table 4. Summary of regression results of analysis (i)-a

DID Regression (Seafood vs Other foods): Within Sanctioned Countries (US/EU sanctioned groups are treated together)

#	Importing Country	Product type		Dif-in-Dif Regression with Fixed Effects				Pre-Sanction Parallel trend check
				Window Length of Post-Sanction period				
			# of months	2	4	7	10	-
			tau	≤ 1	≤ 3	≤ 6	≤ 9	≤ -1
1	World total	Raw Seafood (HS:03)	Coef.	-0.195***	-0.183***	-0.172***	-0.117***	-0.002
			(Robust Std. Err.)	(0.063)	(0.047)	(0.037)	(0.032)	(0.010)
			# of Obs.	2,494	2,550	2,634	2,698	2,384
			R-squared	0.984	0.984	0.984	0.984	0.000
		Processed Seafood & Meat (HS:16)	Coef.	-0.132*	-0.118**	-0.0529	-0.0103	0.001
			Robust Std. Err.	(0.074)	(0.057)	(0.046)	(0.039)	(0.013)
			# of Obs.	2,402	2,456	2,537	2,618	2,299
			R-squared	0.989	0.989	0.989	0.988	0.000
2	EU 15	Raw Seafood (HS:03)	Coef.	-0.136	-0.111	-0.101	0.0238	-0.013
			(Robust Std. Err.)	(0.193)	(0.154)	(0.113)	(0.097)	(0.028)
			# of Obs.	2,452	2,508	2,591	2,674	2,350
			R-squared	0.941	0.94	0.94	0.939	0.001
		Processed Seafood & Meat (HS:16)	Coef.	-0.128	-0.131	-0.142	-0.148**	0.004
			(Robust Std. Err.)	(0.182)	(0.119)	(0.089)	(0.072)	0.027
			# of Obs.	2,195	2,244	2,320	2,395	2,085
			R-squared	0.963	0.963	0.963	0.964	0.874
3	US	Raw Seafood (HS:03)	Coef.	-0.173	-0.152	-0.0978	-0.0475	-0.003
			(Robust Std. Err.)	(0.122)	(0.095)	(0.068)	(0.056)	(0.019)
			# of Obs.	2,474	2,530	2,614	2,698	2,384
			R-squared	0.97	0.969	0.969	0.969	0.879
		Processed Seafood & Meat (HS:16)	Coef.	0.181	0.172	0.251**	0.316***	-0.008
			(Robust Std. Err.)	(0.188)	(0.127)	(0.098)	(0.085)	(0.022)
			# of Obs.	2,274	2,327	2,407	2,487	2,170
			R-squared	0.962	0.961	0.96	0.959	0.733
4	Other importing countries	Raw Seafood (HS:03)	Coef.	-0.0515	-0.0627	-0.0388	-0.00315	-0.001
			(Robust Std. Err.)	(0.089)	(0.062)	(0.053)	(0.046)	(0.013)
			# of Obs.	2,474	2,530	2,614	2,698	2,384
			R-squared	0.979	0.979	0.979	0.978	0.000
		Processed Seafood & Meat (HS:16)	Coef.	-0.108	-0.135**	-0.0735	-0.065	-0.002
			(Robust Std. Err.)	(0.082)	(0.067)	(0.053)	(0.045)	(0.026)
			# of Obs.	2,395	2,449	2,530	2,611	2,288
			R-squared	0.97	0.971	0.971	0.972	0.933

Table 5. Summary of regression results of analysis (i)-c

Staggered Entry with Fixed Effects: Within Sanctioned Countries (US/EU sanctioned groups are treated together)

Importing Country	Product type	Coefficient (period-specific shock) for each tau							# of Obs	R-squared
		$\tau=0$	$\tau=1$	$\tau=2$	$\tau=3$	$\tau=4$	$\tau=5$	$\tau=6$		
World total	Raw Seafood (HS:03)	0.0161 (0.077)	-0.0642 (0.068)	0.0388 (0.084)	0.00668 (0.090)	-0.0435 (0.091)	-0.098 (0.080)	0.0263 (0.080)	1,349	0.972
	Processed Seafood & Meat(HS:16)	-0.115 (0.088)	-0.013 (0.091)	-0.0721 (0.087)	0.0658 (0.161)	-0.0188 (0.151)	0.0205 (0.138)	-0.0531 (0.082)	1,349	0.981
	Other foods	-0.0542 (0.042)	-0.088 (0.063)	-0.113** (0.056)	-0.0338 (0.035)	-0.0683 (0.052)	-0.00141 (0.053)	-0.0489 (0.063)	1,269	0.990
EU15	Raw Seafood (HS:03)	0.205 (0.275)	0.263 (0.205)	0.388* (0.198)	-0.205 (0.392)	0.211 (0.179)	-0.499* (0.278)	-0.0512 (0.251)	1,325	0.914
	Processed Seafood & Meat(HS:16)	-0.0961 (0.220)	-0.043 (0.221)	-0.254* (0.136)	-0.0283 (0.133)	-0.19 (0.145)	-0.436* (0.240)	-0.0565 (0.116)	1,046	0.952
	Other foods	-0.216 (0.191)	0.0809 (0.138)	-0.179 (0.209)	0.0293 (0.106)	-0.0444 (0.182)	0.0704 (0.127)	-0.04 (0.128)	1,349	0.964
US	Raw Seafood (HS:03)	-0.111 (-0.155)	0.22 (-0.135)	0.244** (-0.115)	-0.0484 (-0.242)	0.225 (-0.155)	0.122 (-0.113)	0.0629 (-0.175)	1,349	0.951
	Processed Seafood & Meat(HS:16)	-0.202 (0.162)	0.0954 (0.220)	0.0325 (0.210)	0.196 (0.214)	0.397 (0.277)	0.44 (0.314)	0.331 (0.277)	1,138	0.909
	Other foods	-0.00948 (0.062)	-0.156 (0.114)	-0.042 (0.054)	0.0227 (0.051)	-0.0817* (0.046)	-0.022 (0.063)	-0.0615 (0.074)	1,349	0.977
Other importing countries	Raw Seafood (HS:03)	-0.00457 (0.125)	-0.0611 (0.116)	0.0501 (0.119)	-0.0365 (0.120)	0.00574 (0.153)	-0.002 (0.146)	0.0564 (0.152)	1,349	0.952
	Processed Seafood & Meat(HS:16)	0.0704 (0.142)	-0.0236 (0.132)	-0.0449 (0.156)	0.0411 (0.179)	-0.089 (0.131)	0.0627 (0.158)	-0.0391 (0.152)	1,262	0.943
	Other foods	0.0522 (0.077)	-0.0820* (0.045)	-0.0528 (0.044)	-0.0798** (0.040)	-0.0336 (0.058)	-0.0178 (0.050)	-0.062 (0.049)	1,349	0.991

Table 6. Summary of regression results of analysis (i)-d

Regression with Fixed Effects (Sanctioned Countries vs Non-sanctioned countries) (US/EU sanctioned groups are treated together)

Importing Country	Product type		Regression with FEs			
			Window Length of Post-Sanction period			
		# of months	2	4	7	10
		tau	≤ 1	≤ 3	≤ 6	≤ 9
1 World total	Raw Seafood (HS:03)	Coef.	-0.0189	-0.0392	-0.0321	-0.0536
		(Robust Std. Err.)	(0.031)	(0.036)	(0.040)	(0.054)
		# of Obs.	11,999	11,957	11,915	11,887
		R-squared	0.936	0.935	0.935	0.935
	Processed Seafood & Meat (HS:16)	Coef.	-0.00636	-0.0134	0.021	0.0415
		Robust Std. Err.	(0.083)	(0.058)	(0.046)	(0.041)
		# of Obs.	10,991	11,017	11,056	11,095
		R-squared	0.941	0.941	0.942	0.942
3 US	Raw Seafood (HS:03)	Coef.	-0.0302	0.0447	0.0813	0.117**
		(Robust Std. Err.)	(0.109)	(0.089)	(0.064)	(0.054)
		# of Obs.	12,494	12,522	12,564	12,606
		R-squared	0.888	0.888	0.888	0.889
	Processed Seafood & Meat (HS:16)	Coef.	0.321*	0.373***	0.441***	0.502***
		(Robust Std. Err.)	(0.193)	(0.131)	(0.099)	(0.086)
		# of Obs.	7,152	7,177	7,215	7,252
		R-squared	0.852	0.852	0.852	0.852
4 Other countries (including EU 15)	Raw Seafood (HS:03)	Coef.	0.0067	0.0168	0.0165	0.0375
		(Robust Std. Err.)	(0.061)	(0.043)	(0.043)	(0.038)
		# of Obs.	9,913	9,941	9,983	10,023
		R-squared	0.946	0.946	0.946	0.946
	Processed Seafood & Meat (HS:16)	Coef.	-0.0985	-0.0949	-0.0422	-0.0434
		(Robust Std. Err.)	(0.085)	(0.062)	(0.046)	(0.042)
		# of Obs.	8,066	8,092	8,131	8,169
		R-squared	0.923	0.923	0.923	0.924

Table 7. Summary of regression results of analysis (ii)-c

Staggered Entry with Fixed Effects: Total of Non-sanctioned countries (Coefficients for sanctioned countries are reused to make comparison easier) (US/EU sanctioned groups are treated together)

Importing Country	Product type	Country group	Coefficient (period-specific shock) for each tau							# of Obs	R-squared
			τ=0	τ=1	τ=2	τ=3	τ=4	τ=5	τ=6		
World total	Raw Seafood (HS:03)	Sanctioned Average	0.0179 (0.077)	-0.0624 (0.068)	0.0407 (0.084)	0.00861 (0.090)	-0.0416 (0.091)	-0.101 (0.080)	0.0211 (0.080)	1,349	0.972
		Non-sanctioned Total	0.00734 (0.013)	-0.0376** (0.017)	-0.0450*** (0.016)	-0.0420** (0.017)	-0.0213** (0.010)	-0.0451*** (0.009)	-0.0187 (0.012)	1,297	0.952
	Processed Seafood & Meat (HS:16)	Sanctioned Average	-0.115 (0.088)	-0.013 (0.091)	-0.0721 (0.087)	0.0658 (0.161)	-0.0188 (0.151)	0.0205 (0.138)	-0.0531 (0.082)	1,268	0.981
		Non-sanctioned Total	0.0392** (0.019)	-0.0059 (0.019)	0.0218** (0.009)	-0.00876 (0.019)	-0.00384 (0.008)	-0.0167* (0.009)	-0.00607 (0.010)	1,297	0.958
EU15	Raw Seafood (HS:03)	Sanctioned Average	0.0161 (0.077)	-0.0642 (0.068)	0.0388 (0.084)	0.00668 (0.090)	-0.0435 (0.091)	-0.098 (0.080)	0.0263 (0.080)	1,349	0.972
		Non-sanctioned Total	0.00592 (0.016)	0.0111 (0.014)	-0.0277 (0.017)	-0.0377** (0.018)	-0.0287** (0.015)	-0.0244** (0.011)	-0.00526 (0.011)	1,296	0.793
	Processed Seafood & Meat (HS:16)	Sanctioned Average	-0.115 (0.088)	-0.013 (0.091)	-0.0721 (0.087)	0.0658 (0.161)	-0.0188 (0.151)	0.0205 (0.138)	-0.0531 (0.082)	1,349	0.981
		Non-sanctioned Total	0.0132 (0.011)	-0.0193 (0.012)	0.00261 (0.016)	-0.00242 (0.013)	0.0203 (0.019)	0.00321 (0.012)	-0.012 (0.008)	1,296	0.892
US	Raw Seafood (HS:03)	Sanctioned Average	0.0161 (0.077)	-0.0642 (0.068)	0.0388 (0.084)	0.00668 (0.090)	-0.0435 (0.091)	-0.098 (0.080)	0.0263 (0.080)	1,349	0.972
		Non-sanctioned Total	-0.0256 (0.019)	-0.00709 (0.029)	-0.0309 (0.025)	-0.0391 (0.034)	0.0466* (0.028)	-0.0483* (0.026)	-0.00712 (0.025)	1,296	0.848
	Processed Seafood & Meat (HS:16)	Sanctioned Average	-0.115 (0.088)	-0.013 (0.091)	-0.0721 (0.087)	0.0658 (0.161)	-0.0188 (0.151)	0.0205 (0.138)	-0.0531 (0.082)	1,349	0.981
		Non-sanctioned Total	-0.0922** (0.037)	0.102 (0.067)	-0.102*** (0.040)	-0.0415 (0.036)	-0.0361 (0.049)	0.0478* (0.027)	0.0213 (0.036)	1,296	0.802
Other importing countries	Raw Seafood (HS:03)	Sanctioned Average	0.0161 (0.077)	-0.0642 (0.068)	0.0388 (0.084)	0.00668 (0.090)	-0.0435 (0.091)	-0.098 (0.080)	0.0263 (0.080)	1,349	0.972
		Non-sanctioned Total	0.139*** (0.049)	-0.146*** (0.045)	-0.120*** (0.037)	-0.0795*** (0.028)	-0.0118 (0.029)	-0.0963*** (0.027)	-0.120*** (0.039)	1,197	0.917
	Processed Seafood & Meat (HS:16)	Sanctioned Average	-0.115 (0.088)	-0.013 (0.091)	-0.0721 (0.087)	0.0658 (0.161)	-0.0188 (0.151)	0.0205 (0.138)	-0.0531 (0.082)	1,349	0.981
		Non-sanctioned Total	0.132*** (0.041)	0.0287 (0.040)	0.0359 (0.023)	-0.0292 (0.031)	-0.0434*** (0.015)	-0.0561*** (0.015)	-0.00478 (0.018)	1,297	0.942

Table 8-EU. Summary of regression results of analysis (iii)-a

DID Regression: Within Sanctioned Countries (EU-sanctioned countries ONLY)

Importing Country	Product type		Dif-in-Dif Regression with FEs				Pre-Sanction Parallel trend check
			Window Length of Post-Sanction period				-
		# of months	2	4	7	10	-
		tau	≤ 1	≤ 3	≤ 6	≤ 9	≤ -1
World total	Raw Seafood (HS:03)	Coef.	-0.156	-0.157*	-0.232***	-0.191***	-0.004
		(Robust Std.Err.)	(0.120)	(0.090)	(0.067)	(0.058)	(0.018)
		# of Obs.	996	1016	1046	1076	960
		R-squared	0.378	0.378	0.378	0.378	0.000
	Processed Seafood & Meat (HS:16)	Coef.	0.0285	0.00836	0.0139	0.0212	-0.004
		(Robust Std.Err.)	(0.122)	(0.094)	(0.082)	(0.068)	(0.022)
		# of Obs.	958	976	1003	1028	923
		R-squared	0.383	0.383	0.383	0.383	0.000
EU 15	Raw Seafood (HS:03)	Coef.	0.205	0.224	0.0826	0.245	-0.032
		(Robust Std.Err.)	(0.425)	(0.361)	(0.271)	(0.240)	(0.059)
		# of Obs.	1000	1020	1049	1076	958
		R-squared	0.384	0.381	0.381	0.376	0.001
	Processed Seafood & Meat (HS:16)	Coef.	-0.0992	-0.0864	-0.138	-0.167	0.005
		(Robust Std.Err.)	(0.245)	(0.192)	(0.146)	(0.116)	(0.045)
		# of Obs.	896	912	936	958	866
		R-squared	0.328	0.327	0.326	0.326	0.000
US	Raw Seafood (HS:03)	Coef.	-0.283	-0.329***	-0.351***	-0.285***	-0.005
		(Robust Std.Err.)	(0.177)	(0.122)	(0.086)	(0.075)	(0.026)
		# of Obs.	1016	1036	1066	1094	980
		R-squared	0.345	0.345	0.346	0.346	0.000
	Processed Seafood & Meat (HS:16)	Coef.	0.473	0.388	0.374*	0.385**	-0.039
		(Robust Std.Err.)	(0.375)	(0.267)	(0.214)	(0.191)	(0.030)
		# of Obs.	921	939	966	991	877
		R-squared	0.332	0.331	0.329	0.327	0.006
Other importing countries	Raw Seafood (HS:03)	Coef.	0.0427	-0.0419	-0.126**	-0.115**	-0.013
		(Robust Std.Err.)	(0.101)	(0.074)	(0.054)	(0.055)	(0.019)
		# of Obs.	981	1001	1031	1059	945
		R-squared	0.388	0.388	0.388	0.388	0.001
	Processed Seafood & Meat (HS:16)	Coef.	0.0759	-0.0897	-0.0176	0.015	-0.003
		(Robust Std.Err.)	(0.078)	(0.102)	(0.074)	(0.064)	(0.026)
		# of Obs.	935	953	980	1005	900
		R-squared	0.389	0.389	0.389	0.389	0.000

Table 8-US. Summary of regression results of analysis (iii)-a

DID Regression: Within Sanctioned Countries (US-sanctioned countries ONLY)

Importing Country	Product type	# of months / tau	Dif-in-Dif Regression with FEs — Window Length of Post-Sanction period				Pre-Sanction Pallarel trend check
		# of months	2	4	7	10	-
		tau	≤ 1	≤ 3	≤ 6	≤ 9	≤ -1
World total	Raw Seafood (HS:03)	Coef.	-0.208***	-0.198***	-0.144***	-0.0873***	-0.001
		(Robust Std.Err.)	(0.056)	(0.043)	(0.035)	(0.031)	(0.011)
		# of Obs.	1,502	1,542	1,702	1,762	1,542
		R-squared	0.987	0.987	0.987	0.987	0.000
	Processed Seafood & Meat (HS:16)	Coef.	-0.229***	-0.183***	-0.0792*	-0.0112	0.004
		Robust Std.Err.	(0.078)	(0.060)	(0.047)	(0.041)	(0.017)
		# of Obs.	1,464	1,500	1,554	1,508	1,396
		R-squared	0.992	0.992	0.992	0.991	0.000
EU 15	Raw Seafood (HS:03)	Coef.	-0.398***	-0.306***	-0.189***	-0.0661	0.000
		(Robust Std.Err.)	(0.118)	(0.094)	(0.072)	(0.066)	(0.024)
		# of Obs.	1,472	1,508	1,562	1,616	1,412
		R-squared	0.959	0.959	0.959	0.958	0.000
	Processed Seafood & Meat (HS:16)	Coef.	-0.227	-0.221*	-0.200**	-0.198***	0.003
		(Robust Std.Err.)	(0.201)	(0.118)	(0.088)	(0.073)	(0.031)
		# of Obs.	1,443	1,480	1,538	1,595	1,357
		R-squared	0.976	0.976	0.976	0.976	0.000
US	Raw Seafood (HS:03)	Coef.	-0.0895	-0.0635	0.0363	0.0867	-0.001
		(Robust Std.Err.)	(0.160)	(0.128)	(0.091)	(0.073)	(0.026)
		# of Obs.	1,478	1,514	1,568	1,622	1,424
		R-squared	0.977	0.976	0.976	0.976	0.000
	Processed Seafood & Meat (HS:16)	Coef.	0.0495	0.0996	0.207**	0.321***	0.011
		(Robust Std.Err.)	(0.167)	(0.113)	(0.087)	(0.077)	(0.028)
		# of Obs.	1,497	1,536	1,595	1,554	1,431
		R-squared	0.974	0.974	0.974	0.973	0.001
Other importing countries	Raw Seafood (HS:03)	Coef.	-0.185*	-0.245***	-0.159**	-0.176***	-0.013
		(Robust Std.Err.)	(0.111)	(0.076)	(0.070)	(0.060)	(0.020)
		# of Obs.	1,446	1,486	1,546	1,606	1,386
		R-squared	0.982	0.982	0.981	0.981	0.001
	Processed Seafood & Meat (HS:16)	Coef.	0.0628	-0.00531	0.015	-0.00602	-0.014
		(Robust Std.Err.)	(0.113)	(0.083)	(0.065)	(0.055)	(0.038)
		# of Obs.	1,533	1,573	1,533	1,593	1,455
		R-squared	0.974	0.974	0.974	0.975	0.000

Table 9. Comparison of Mean Export Value during 5 years up to Sanction Enforcement by EU and the US between Two Markets

| Product	Importer	Parameter	Sanctioning Party		Difference (=A-B)		
			EU (=A)	US (=B)	Mean	tStat	P(T<=t) one-tail
Raw Seafood (HS:03)	EU15 (=a)	Mean	7,038	46,398	-39,360	-17.86	0.000
		StdDev	11,346	51,405	-	-	-
		#ofObs	356	588	-	-	-
	US (=b)	Mean	13,222	15,456	-2,234	-1.57	0.059
		StdDev	19,467	23,831	-	-	-
		#ofObs	356	588	-	-	-
	Difference (=a-b)	Mean	-6,184	30,942	-	-	-
		tStat	-16.09	13.24	-	-	-
		P(T<=t) one-tail	0.000	0.000	-	-	-
Processed Seafood & Meat (HS:16)	EU15 (=a)	Mean	22,748	27,869	-5,121	-1.87	0.031
		StdDev	44,756	32,854	-	-	-
		#ofObs	356	588	-	-	-
	US (=b)	Mean	21,133	7,659	13,474	5.62	0.000
		StdDev	42,073	21,249	-	-	-
		#ofObs	356	588	-	-	-
	Difference (=a-b)	Mean	1,615	20,209	-	-	-
		tStat	0.50	12.52	-	-	-
		P(T<=t) one-tail	0.310	0.000	-	-	-
Other foods	EU15 (=a)	Mean	37,981	805,871	-767,891	-16.33	0.000
		StdDev	49,118	1,138,667	-	-	-
		#ofObs	356	588	-	-	-
	US (=b)	Mean	50,479	225,445	-174,965	-12.39	0.000
		StdDev	53,269	335,459	-	-	-
		#ofObs	356	588	-	-	-
	Difference (=a-b)	Mean	-12,499	580,427	-	-	-
		tStat	-3.25	11.86	-	-	-
		P(T<=t) one-tail	0.001	0.000	-	-	-

Figure (i)-1-03. Changes of nominal export value of raw seafood (HS code: 03) around sanction enforcement (Exporter: 15 IUU countries sanctioned by either US or EU, Importer: world total)
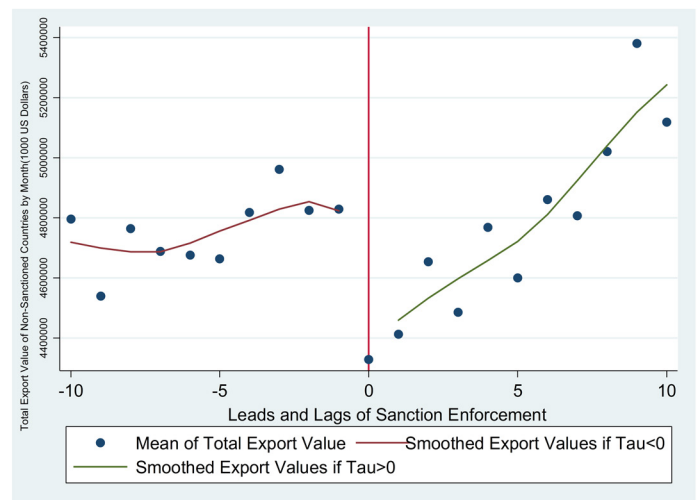

Figure (i)-1-OT. Changes of nominal export value of other foods (HS code: 01-02, 04-15, 17-24) around sanction enforcement (Exporter: 15 IUU countries sanctioned by either US or EU, Importer: world total)

Figure (i)-1-16. Changes of nominal export value of processed seafood and meat (HS code: 16) around sanction enforcement (Exporter: 15 IUU countries sanctioned by either US or EU, Importer: world total)
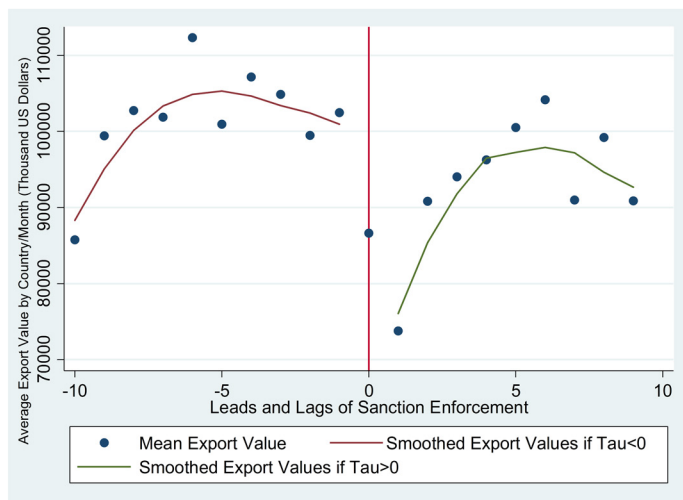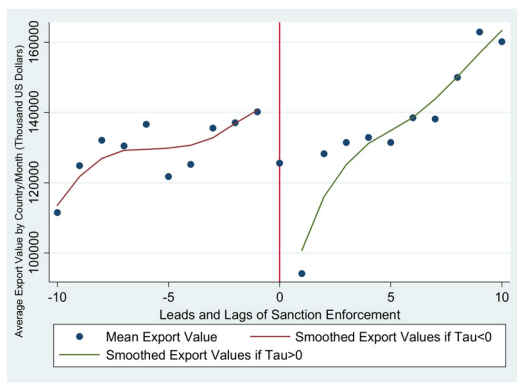

Figure (ii)-1-03. Changes of nominal export value raw seafood (HS code: 03) around sanction enforcement (Exporter: All non-sanctioned countries combined, Importer: world total)

Figure (ii)-1-16. Changes of nominal export value processed seafood and meat (HS code: 16) around sanction enforcement (Exporter: All non-sanctioned countries combined, Importer: world total)

Figure (iii)-1-03-EU. EU sanctioned group only: Changes of nominal export value of raw seafood (HS code: 03) around sanction enforcement (Exporter: IUU countries sanctioned by EU, Importer: World total)

Figure (iii)-1-03-US. US sanctioned group only: Changes of nominal export value of raw seafood (HS code: 03) around sanction enforcement (Exporter: IUU countries sanctioned by US, Importer: World total)
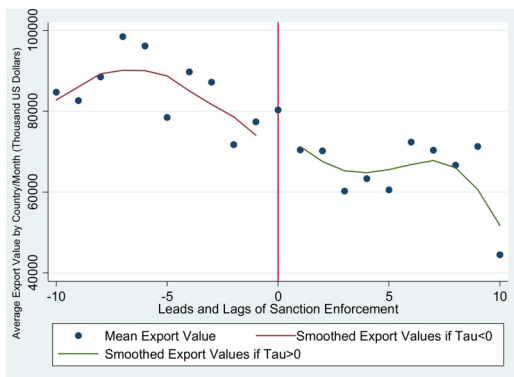
NOTES

1   The European Commission issues press release and Official Journal of the European Union on the IUU identification and sanction. In the US, the National Oceanic and Atmospheric Administration (NOAA) identifies IUU countries in its report to the Congress and publish the report. For more detailed information, please visit their official websites:

http://ec.europa.eu/fisheries/cfp/illegal_fishing/info/index_en.htm

http://www.nmfs.noaa.gov/ia/iuu/msra_page/msra.html

2   Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

3   In this version of paper, most of the figures were dropped due to limitation on number of pages.

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A DOUBLE-EDGED SWORD

The Importance of the Media in Creating and Dismantling Terrorist Networks in the Philippines

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The expansion of terrorism has become increasingly dependent on technological means by using the internet and social media to target and recruit disaffected members of impoverished communities. This has occurred in the southern islands of the Philippines where a terrorist organization known as Abu Sayyaf (ASG) has emerged with the help of its media propaganda tactics. The lack of an objective public media outlet is one of the main reasons that this organization remains powerful today. The paper discusses the historical background of this terrorist group and uses two analytical frameworks to propose policies that can diminish the power of ASG in the southern Philippines. These policy recommendations include three mechanisms the government of the Philippines can utilize to counteract the power of ASG, including the reformulation of the reporting on terrorism propagated by the media, the improvement of intelligence gathering at the grassroots level and the cooperation between the Philippines and neighboring countries to improve multilateral counter-terrorism approaches.

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INTRODUCTION

Throughout the early 1990s, the spread of global terrorist networks captured the attention of the global community as terrorist organizations like Al-Qaeda expanded, while other terrorist organizations, such as the Abu Sayyaf Group (ASG) received relatively little media attention. The latter group, formerly funded by Al-Qaeda and recently announcing affiliation with the Islamic State of Iraq and the Levant (ISIL), is situated in the southern island of the Philippines, Mindanao, and the Sulu Archipelago. As it expanded in the aftermath of failed peace negotiations between the Moro National Liberation Front (MNLF) and the Philippine government, members of the ASG have been directly associated with over 100 terrorist activities (Stanford University). These activities include mass killings, kidnappings, and orchestrated bombings, most notably the recent Davao City bombings on September 2, 2016 that claimed 15 lives and injured over 70 people (Tesiorna).

In 2016, the newly-elected President, Rodrigo Duterte, announced plans to target all ASG networks to eliminate them from the national scene. Yet, poverty-stricken communities, particularly those in Mindanao, are skeptical about the use of strong government and military forces to eradicate the emergence of radicalization. Central to this issue is the government's reluctance to improve regional media coverage of social conditions in ASG-impacted areas. The ASG continues to be an influential and strategic terrorist network in Southeast Asia with close ties to ISIS and Jemaah Islamiyah in Indonesia. The group remains active, continuing its objective of expanding in regions with high levels of poverty using media propaganda as a recruitment tactic. In this vein, the ASG has taken advantage of the lack of public broadcasting and used biased media sources to expand its support base.

This paper will recommend three policies: first, per Stephen Corman's 'Pragmatic Complexity Model,' the Philippine government must provide and promote unbiased regional and global media coverage of ASG's violence and the Moro people's social conditions. Second, the government should increase intelligence gathering at a grassroots level by referring to the framework proposed in "Fixing Intel: A blueprint for making intelligence relevant in Afghanistan" by Major General Michael T. Flynn, USA; Captain Matt Pottinger, USMC; and Paul D. Batchelor, DIA. Finally, the Philippines should consider multilateral cooperation with countries like Malay-

sia and Indonesia that can offer increased military support to combat terrorism. Using these policy recommendations, the Philippine-U.S. coalition can collaborate on limiting ASG's influence in Southern Mindanao by using the media to develop stronger relations with the local population.

History of Muslim Separatism in Mindanao

The turbulent history between the Muslim minority population situated in Southern Mindanao and the Christian-dominated ruling government of the Philippines has roots spanning about 300 years before the arrival of the Spanish Empire. During the 7th century, the Srivijaya Empire emerged in present-day Indonesia, and spread its cultural and political influence as far as Formosa (present-day Taiwan), Ceylon, and also the Southern islands of the Philippines. The decline of the Srvijaya Empire led to the rise of the Majapahit Empire within the 14th century (Wood, 2011). It was a Hindu-dominated empire, with Muslim alliances and influences, that relied on commercial trades with regions like the Sulu archipelago, which consists of the Basilan, Sulu, and Tawi-Tawi provinces of the Southern Philippines that are now the ASG's main strongholds (McAmis, 2002). The period of Majapahit rule expanded Indian Hindu beliefs and Islamic influence to the Sulu archipelago as merchants expanded their trading activities. As Islam spread to the east, Islamic kingdoms within the archipelago surfaced around Java, in small yet powerful coastal sultanates.

After Islam spread to the Southern island of Mindanao, the arrival of Spanish Jesuits in the 16th century ignited conflicts between Christians and Muslims that culminated in violence experienced today (Shay, 2009). Despite their attempts, the Spanish were unable to overthrow and resolve Islamic insurgence in the Southern Philippines. American imperialists during U.S. occupation of the country in the 19th century were met with more resistance and insurgency, laying the foundation for a radically violent and destructive conflict that would lead to the formation of the ASG. The ASG has since grown and captured the support of 2 million separatists known as Muslim "moros" that have been involved in attacks leading to over 100,000 deaths (Bale). Despite these figures, ASG violence has not garnered the same media coverage and international spotlight as other terrorist organizations.

The Rise of ASG

Around early 1990, the Abu Sayyaf group, meaning "sword bearer" in Arabic, was first established by Abdurajik Abubakar Janjalani, who became deeply involved and associated with a Muslim movement known as Al Islamic Tabligh (Niksch, 2002). As a member of this movement - which

was partly backed by Saudi Arabia – Abubaker Janjalani went abroad to study in Saudi Arabia and Libya, which led to his exposure to Islamic extremist views and radicalization (Niksch, 2002). The ASG's initial objective was to create an independent Islamic state in Southern Mindanao. However, some members later began to behave more like a structured gang than an independent political organization (Shay, 2009).

After the death of ASG's leader Abubakar Janjalani in 1998, his younger brother, Khadaffy Janjalani, took over as ASG's leader. For a period after 1998, the group halted its bombing attacks and focused more on kidnapping for ransom money, targeting wealthy foreigners and public officials (Elegant, 2004). This shift was mainly due to the organization's need for operation funds and more support from local communities struggling with high levels of poverty and unemployment. In 2000, the group was responsible for the kidnapping of 21 people in Sabah, Malaysia, in which 19 were foreigners. Around this time, the ASG also kidnapped 50 students and teachers from schools located on the island of Basilan, and 15 journalists were held for ransom (Elegant, 2004). Philippine and American intelligence officials have noted that ASG also receives funding from the Indonesian/Southeast Asian-based terrorist group, Jemaah Islamiyah (Bayron).

The ASG is now led by Isnilon Totoni Hapilon who has pledged his organization's allegiance to ISIL (Moore, 2016). Today, the ASG remains an imminent threat in the Southern Philippines and Southeast Asia as a whole. Recently, members affiliated with the ASG and linked to the ASG-funded Maute Group orchestrated the Davao bombings in Mindanao on September 2, 2016 which resulted in 15 casualties. (Elegant, 2004). This bombing came just months after newly-elected President Duterte assumed power in June 2016, and vowed to destroy ASG and all criminal organizations in the country. Since then Duterte has placed the Armed Forces of the Philippines (AFP) and the Philippine National Police (PNP) on national alert, indicating a need to eradicate any ASG links and associates (Lema & Petty).

Today, the territories controlled and dominated by Muslim populations are western Mindanao, Tawi-Tawi, Basilan, and the Sulu Archipelago. The Muslim-controlled southern portion of Mindanao is reported to contain 15 of Philippines' poorest territories and the lowest levels of life expectancy in the country (Dearn, 2009). One of the leading causes of an ever-increasing transnational terrorism is the lack of social development resources and high levels of poverty (Li & Schaub, 2004). Globalization has also contributed to radicalization, with extremist groups like ASG using social media and other internet resources that are more difficult to monitor and detect by intelligence forces to communicate with and recruit members.

Currently, media in the Philippines suffers from an overrep-

resentation of stories of violence, and a lack of coverage of efforts to ameliorate the development and economic woes of communities. Duterte is known to be a hard-power focused leader, who places more emphasis on military methods of eradicating terrorism rather than rehabilitation of impoverished communities. His new administration has allocated more power to the military and police forces, leading critics to fear abuse of power and corruption issues (Lema & Petty).

Environments with poor economic development and lack of government assistance are strong breeding grounds for terrorist recruitment and training. Heavily affected populations suffering from poverty and government neglect desperately rely on transnational terrorist agendas as a means to resolve their social conditions (Manalo, 2004). In Mindanao, where the population relies on agriculture and fishing for their livelihood, people have been disenfranchised by low levels of productivity, high rates of illiteracy and an increase in unemployment. With a poverty level higher than the national average, the ASG has thrived in such environment, using the media to spread its propaganda to recruit young, uneducated, and disenfranchised members of the community (Sieb et. al., 2010).

An ongoing challenge in the Philippine government's fight against the ASG is the growing lack of trust between the people of Mindanao and the national government. Much of the population views the government as inadequate in providing assistance and aid programs to improve the social stability of disaffected communities (Adriano & Parks, 2013). Rampant acts of corruption and bribery have caused negative sentiments towards the government. Furthermore, the local population often views the government's efforts to eradicate terrorism in the region as a method of systematically dividing the Moro population (Adriano & Parks, 2013). Though the Philippine government and other international aid agencies have expressed a commitment to improving the social conditions in Mindanao, the distribution of aid has been slowed down by a lack of coordination between domestic, national, and international actors. This may have led to more recruitment by the ASG within the local disaffected population (Sieb et. al., 2010).

In 2015, with widespread coverage of conflicts in the Middle East and the rise of ISIL, as well as large-scale terrorist activities such as the Paris attacks, the emergence of the ASG in Mindanao went largely underreported to the global community (Sales, 2006). According to experts, the causes of terrorism in the Philippines can be linked to the failure of the government to determine innovative solutions to tackling the roots of radicalization in the Autonomous Region in Muslim Mindanao (ARMM).[1] The cycle of disorganized police interests, quick and irrelevant arrests, and government manipula-

tion of information has prevented any further progress in the war against the ASG.

ANALYSIS

Stephen Corman's Pragmatic Complexity Model

In Stephen Corman's Pragmatic Complexity Model, he highlights the need to deemphasize or minimize the control of media and social resources propagated solely in the government sector, and to distribute equal use of these resources to the masses. The model also emphasizes the acceptance of the systemic complexity of terrorist issues by the media. Or, the importance of highlighting the social roots of terrorism when reporting about terrorist groups. This approach views successful counterterrorism efforts to be grounded in measures to enhance social equality and economic stability rather than the use of military force. Following the tenets of this model, the Philippine government, media, and civil society must deemphasize control of media messages and embrace the root causes of the conflict, such as poverty and a lack of social development in affected communities in their counterterrorism approach against the ASG.

Another aspect of Corman's Model is the eradication of repetitive cycles of messages that seem to highlight and intensify terrorist acts in an affected area. For instance, continuously broadcasting military force and dead bodies of terrorists, rather than displaying community relations and social improvement within the community. This may have the effect of increasing the repetitive cycle of violence by promoting the retaliation of terrorist groups. Instead, the media might replace negative repetitive messages of "one-sided military victory" with developmental improvements in Moro society.

Corman's framework also supports the use of alternative methods by the government to counter radicalization, such as rehabilitation and de-radicalization programs for former ASG members. Anti-radicalization through inter-faith conferences, disengagement mechanisms, and rehabilitation programs may also improve the interaction between intelligence officials and informants and improve intelligence gathering from former terrorists.

The last major point in Corman's model is to be prepared for failure of certain plans and adapting alternative approaches following unsuccessful strategies. For long-term stability in the Philippines, the government must make contingency plans for failure and portray them in the media in an unbiased and transparent manner in order to bring ARMM leaders and government officials to the negotiating table and increase dialogue of sustainable and effective solutions.

Major General Michael T. Fynn's Fixing Intel Blueprint

Major General Flynn's Fixing Intel Model supports the establishment of a team of analysts of military and media officials who will interact at the grassroots level, communicate with intelligence collectors, and share feedback with command posts. In a greater sense, information and media outlets will not just be focused on military operations to eradicate the enemy, but will also play a vital role in assisting in the development and growth of affected communities. The main purpose of Fixing Intel is to limit the reliance on hard power approaches in favor of an increased emphasis on community-level development and interactive approaches.

This framework evaluated the systematic failures of intelligence-gathering activities against the Taliban. The analysis highlighted the following issues: first, much of the information transferred up the chain of command was labeled as irrelevant in the search for specific targets; second, much of the information gathered at the grassroots level never made it up the chain of command at all; and third, only a small amount of the information that reached high command was disseminated to personnel in the field as adequate intelligence (Flynn, 2010). These issues were caused by decision-makers' overreliance on the media for information. The intelligence community was also too focused on collecting detailed data on insurgents, thereby failing to gather critical information on the communities in which the Taliban operated. Many of these intelligence failures are currently apparent in the Philippines as well.

The model also emphasizes the collection of geographic, social, cultural, economic, and political data about a particular region so that officials have background and data about the areas and communities most-affected by terrorism. Military forces should have interactive roles with the local community, meeting with local leaders to establish partnerships. Military and political officials working in the area should develop comprehensive and, if possible, unclassified evaluations of the governance, economy, and stability of the region. The model points out that such actions are more sustainable than concentrating on military hard power, which promotes more retaliatory attacks and radicalization at the grassroots level.

A primary aspect of the model emphasized by Major General Flynn is the recruitment of personnel with backgrounds in history and journalism to participate in information gathering and communication with community leaders in targeted areas. These media-skilled individuals should join military and police units in patrolling and rebuilding troubled areas to further interact with the community and gain valuable intelligence. Census data and communication records from local radio talk shows could reveal important information for the National Philippine Police, Philippine Army, and U.S. Special Forces. The Fixing Intel Model is a grassroots approach to counter terrorism that focuses on shifting to community-oriented missions instead of the use of military force.

POLICY RECOMMENDATIONS

1. Increase the production and distribution of unbiased regional and global media coverage of ASG's violence

The Philippine government, mass media, and civil society must deemphasize the control of media messages. Instead, it should embrace the complexity of the root causes of the conflict, such as poverty and the lack of social development by engaging and accommodating Moro views in the discussion for establishing solutions. The mass media should also broadcast the root causes of the conflict in Southern Mindanao that have motivated civilians to join ASG (Rood, 2005). Revealing the systemic origins in the various media outlets can help the government reassess its strategies. Instead of striving for "victory" by targeting insurgent uprisings, the government should focus on developmental improvements in Moro society. An increase in media representation of ASG activities and the socio-economic conditions affecting locals would allow operations like interreligious conversations, organization of community planning, and general media advocacy to be more frequent than it has been in the past.

It is relevant to point out that most of the areas where the ASG operate have suffered a long history of abuse and oppression by the Philippine government and military. High levels of poverty, acts of neglect, and continuous abuse from government officials are all factors that motivate and fuel ASG's terrorist activities (Adams, 2008). U.S. officials collaborating with the Philippine government to combat ASG, have explained that a balanced effort of hard and soft power strategies need to be implemented in the counterterrorism plan. These are regions that have suffered from long-term insecurity and constant underdevelopment. A proper balance of hard and soft power tactics such as rehabilitating former terrorists, rebuilding communities in surrounding areas, and increasing the engagement of Muslim women in peace-building efforts are all programs that can help fight ASG at a grassroots level.

A highly-regarded and disputed solution to containing ASG's expansion is the Philippine government's continued efforts to cooperate closely with the Moro National Liberation Front (MNLF) and the Moro Islamic Liberation Front (MILF). These two organizations have condemned ASG's violent activities and created an expanded media coverage of the ARMM peace talks, particularly in Basilan and Jolo where the majority of ASG activities have occurred. However, in the ARMM, there is a problem of dealing with the lack of resources and funds to relay messages to impoverished Muslim

regions. In an interview conducted in December 2015 with Ed Lingao, news presenter for TV5 Manila, he indicated the drastic need to increase funding for a public broadcasting system in the Philippines, so that regions affected by poverty and terrorism will have affordable means for media representation and coverage. Due to the lack of media resources and high levels of poverty, regional governments should also consider the distribution of simple and affordable solar-powered hand-cranked radios, as outlined in Major Adam Potter's presentation on counterinsurgency strategies conducted in Afghanistan. The combination of both PBS networks and solar-powered hand crank radios would be an innovative approach to effectively improve regional media representation of the correlation between poverty and terrorist recruitment in various regions in Mindanao.

The distribution of over 20,000 solar-powered, hand-cranked radios across Afghanistan has enabled people in rural areas with high illiteracy rates to obtain important information on serious issues. Similarly, if applied in the Philippines, it could enable people in poor areas to make rational decisions on certain policies (Radio Free Europe Radio Liberty). Major Potter's strategies can help the regional government and military personnel control the narrative while cooperating closely with local leaders and groups like MNLF.

2. Increase intelligence at a grassroots level

To better comprehend the root causes of the ASG's activities and the socioeconomic conditions of the area, intelligence gathering at a "grassroots" level should be enforced. The systematic problems outlined by the Fixing Intel Model in intelligence-gathering activities to combat the Taliban, strongly resemble the issues unraveling in the Southern Philippines.

An effective solution to this issue is the use of indirect approaches that enable armed forces to develop close relations with the local population. This would help rebuild internal alliances and cooperation with various partners who are willing to provide the intelligence community with valuable information about ASG's activities. The indirect and diplomatic approach of creating grassroots operatives could also expand the government's legitimacy from a local perspective, which has been lacking. These local programs of cooperation will be able to persuade locals to distance themselves from ASG's recruitment networks, thereby isolating ASG from the community and weakening its influence in vulnerable areas.

Strengthening cooperation between local officials and informants is also necessary in the peace process. Peace conferences and town hall meetings would identify the social and economic conditions driving residents to the accommodation of ASG (Flynn). Also, intelligence collected from region-

al conferences and grassroots operatives will enable military officials to identify potential allies of ASG such as Jemaah Islamiyah, to further tackle ASG's various funding sources and help cut off ASG's strong ties with transnational terrorist organizations that supply ASG with sophisticated weapons and explosives (Initiatives for International Dialogue). This system of intelligence gathering is far from perfect. However, developing an understanding of the local community's political and cultural environment is a sufficient method to control the root causes of ASG's survival. Combat journalists and reporters accompanied by Special Forces, provide information that helps in obtaining accurate and reliable intelligence that is critically needed in the fight against ASG.

3. Form multilateral cooperation with neighboring countries such as Malaysia and Indonesia

The Philippine government should work multilaterally with other Southeast Asian nations like Malaysia and Indonesia to closely monitor and infiltrate the same radical terrorist activities that affect the local communities in those countries. Multilateral cooperation between the Philippines and its fellow ASEAN neighbors will contribute to the development of stronger military relations, further contributing to the gathering of valuable intelligence and the establishment of regional institutions necessary for successful counterterrorism operations that track terrorism through transnational approaches (Capie, 2004).

In the aftermath of 9/11, the U.S. urged the Philippines and its ASEAN counterparts to use collective counterterrorist strategies, especially against lesser known, but equally dangerous radical groups such as the ASG. Thus far, the global war on terrorism has provided a pathway for stronger multilateral dialogue and cooperation, despite doubts and skepticism from each respective government's willingness and commitment to take collective action (Capie, 2004). It is important to note that the term 'multilateral' in this context does not just apply to governmental and military operations, but also to media networks covering these terrorist networks. Using transnational media cooperation, military forces can utilize the information gathered from these sources to combat terrorist networks at a grassroots level. Southeast Asian governments in Thailand, Indonesia, and Malaysia have all dealt with Muslim insurgencies in their territories in the past. Therefore, by sharing media information between these governments and the Philippines, an efficient multilateral approach of gathering and sharing intelligence will be forged.

An increase in multilateral security cooperation between ASEAN members is a massive improvement compared to past operations that involved bilateral agreements between the Philippines and U.S. forces. Over the years, the Philip-

pines' approach to counterterrorism has been heavily criticized due to its unwillingness to increase multilateral operations with fellow ASEAN members, many of whom also face the same radicalization issues. However, the expansion of public broadcasting efforts and grass roots intelligence gathering by both media and military sources can enhance regional counterterrorism strategies. In order to fight the epidemic of terrorism, governments must cooperate multilaterally and collectively from a regional standpoint to tackle the roots of the problem, which include poverty and poor information resources.

CONCLUSION

The ongoing counterterrorism operation against ASG is a complex and delicate balance of political, economic, and social factors. A history of prejudice, alienation, and misrepresentation of the Moro people in Southern Mindanao has led to the emergence of radical terrorist groups like the ASG. The ASG takes advantage of these social conditions to recruit disaffected members of the Moro population. By closely analyzing the policy recommendations involved in this strategy, it is evident that the media plays a critical role in spreading awareness and gathering national support against ASG's networks. The media also has a responsibility in influencing the public opinion that can ultimately dismantle the existing terrorist networks. Moreover, establishing soft power approaches such as de-radicalization programs, participating in grassroots intelligence gathering, improving economic conditions, and forming multilateral counter-terrorism initiatives with other ASEAN members can help in limiting the influence of these terrorist organizations. Through these policy recommendations, the Philippine government can strengthen its ties with the Moro people and promote an enhanced sense of national and regional unity against terrorist networks like the ASG.

ACKNOWLEDGEMENTS

NOTES

1 For further analysis, I conducted an interview on December 2015 with Professor Octavio Dinampo from Mindanao State University, Sulu, a practicing Sunni Muslim and peace advocate within the region.

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MANAGING THE FALLOUT

An Analysis of Post-Fukushima International Response and Communication

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In the aftermath of the Fukushima Daiichi nuclear power plant accident – the largest release of radiation since Chernobyl – fears of radiation poisoning continue to plague the public. Uncertainty over the impact on public health looms over the Japanese, including the disaster's lingering legacy of mental stress. This paper presents a barriers analysis approach to this incident. It first seeks to identify key errors that inhibited international cooperation amidst the disaster, as well as the long-term consequences of these failures. This includes analysis of the role of U.S.-Japan disaster coordination processes that contributed to public confusion, distrust, and fear. The paper then articulates a theoretical framework for the public communication of scientific topics, as well as for governmental responses to these 'wicked problems,' as termed by Donald Kettl. The paper concludes by addressing potential options for bilateral cooperation between the U.S. and Japan in approaching these barriers, and suggests a role the International Atomic Energy Agency (IAEA) could serve in correcting international communication and coordination chasms in preparation for future nuclear disasters.

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INTRODUCTION

Disaster Discord

The magnitude 9.0 Great East Japan Earthquake – along with the massive tsunami it launched towards the mainland – forced the Fukushima Daiichi nuclear power plant meltdown. With the power grid decimated, plant operators would have ordinarily relied upon emergency diesel generators to pump water to cool the reactor cores. The tsunami, however, eliminated that possibility when it overwhelmed the plant's protective barrier and swamped the generators. The result was the only multi-unit accident in the history of nuclear power generation (Burns, 2012). This earned the Fukushima Daiichi accident a rating of '7' on the IAEA's logarithmic International Nuclear and Radiological Event Scale, a ranking which was previously achieved only by the Chernobyl disaster in 1986.

The emergency response at the nuclear plant therefore presented a logistical nightmare for all parties – local, federal, and international. Dr. Nobumasa Akiyama, leader of the working group for the Independent Commission on the Investigation of the Fukushima Nuclear Accident, argues that while a variety of issues presented challenges to U.S.-Japan cooperation, "The most critical challenge for the two allies was establishing a proper line of communication and information-sharing mechanism" the largest issue was establishing lines of communication and a proper information-sharing mechanism. (Akiyama, 2013, p. 1).

Several days after the tsunami, the Japanese government revised advisories to require local residents within 20-30 km (12.5-18 miles) of the power plant to stay within their houses (Akiyama, 2013), but, "since the United States recommended that its citizens within 50 miles of the accident site leave the zone, Japanese citizens became confused and concerned about their own government advisory" (Akiyama, 2013, p. 5). Indeed, most indications found, "the Japanese people's feelings of gratitude and trust toward the United States far surpassed those toward their own government" that the Japanese trusted and were more grateful towards the United

States' government than they were towards their own government. (Sato, 2012, p. 59). Concerned about risk of exposure to a possible radioactive plume, the U.S. aircraft carrier George Washington urgently departed from its port at Yokosuka Naval Base near Tokyo, an action which further exacerbated the Japanese public's fear (Lawrence, 2011).

Beyond their impact on public sentiment, wider evacuation zones greatly complicated the evacuations themselves, through a phenomenon termed 'shadow evacuations.' This is the idea that fear drives people to evacuate well beyond prescribed areas; causing "gridlock and delays, impeding the evacuations that are actually necessary" (Aldrich, 2012, p. 1). The United States should have already been aware of this possibility as a result of the Three Mile Island (TMI) nuclear power plant accident. During this incident, authorities advised only 3,500 people to leave, but then over 200,000 people in Pennsylvania fled the area, creating a shadow evacuation (Aldrich, 2012). These shadows only grow during a nuclear accident, since radiation's invisibility heightens public uncertainty and carries a widely-held stigma propagated by popular culture. In the Fukushima case, the U.S. decision bore even longer-lasting economic impacts, as even beyond a year after the incident, "about one-fifth of foreigners in Japan, many living as far as 180 miles away in Tokyo, have yet to return after the exodus" roughly 1/5 of foreigners in Japan had not yet returned to Fukushima. (Aldrich, 2012, p. 1). This only compounded the economic distress plaguing Fukushima Prefecture. Facing critique of its evacuation decision, the U.S. Nuclear Regulatory Commission (NRC) argued it was not an evacuation order of the type that would be issued during a domestic nuclear accident, but rather "a warning to U.S. citizens that the local conditions were uncertain, the government authorities may not be able to assure their safety, and that they should leave" a suggestion that U.S. citizens leave due to uncertainty on the ground. (Nuclear Regulatory Commission, 2014, p. 19503). The issue here is not that the NRC sought to protect American citizens, but rather the absence of foresight and consideration regarding what effect the warning would have on the Japanese populace. This precipitated a failure to coordinate this announcement with the Japanese government in a manner allowing for – at the bare minimum – the adoption of proactive mitigation strategies.

Mental Health Fallout

Despite their equal ranking on the International Nuclear and Radiological Event Scale, the direct physical impacts of the Fukushima disaster are less severe than those in the Chernobyl case. The World Health Organization (which Japan's environmental ministry formally argued overstated the risks) estimated that for infants from the most affected areas, the Fukushima radiation would increase their chance of de-

veloping cancer in their lives by 1% (McCurry, 2013, p. 791). Although increasing the risk of cancer is a negative outcome, the small relative impact pales in comparison to mental health issues. After the Chernobyl meltdown, 30 people died of radiation poisoning in the following few weeks (World Nuclear Association, 2016). Conversely, "it is unlikely to be able to attribute any health effects in the future among the general public and the vast majority of workers" the possibility of attributing any casual links between Fukushima Daiichi radiation and future health impacts on the general population is unlikely (World Nuclear News, 2013, p. 1). However, as mentioned above, public perceptions – and therefore the mental health harms they impact detailed below – do not track closely with provable harms of radiation in nuclear accidents.

All disasters affect a population's mental health, but "events involving radiation are particularly pernicious" radiation-related events are noticeably serious. (Bromet, 2014, p. 2). After the TMI accident, the President's Commission on the subject discovered mental health to be the largest public health problem (Bromet, 2014). Similarly, the Chernobyl Forum twenty years after the disaster concluded that mental health was the chief health issue from Soviet accident (International Atomic Energy Agency, 2006). It appears the same will be the case post-Fukushima, which was much less severe of a radiation release than Chernobyl. Lending credence to this prediction, the 2013 United Nations Scientific Committee on the Effects of Atomic Radiation Report warns of the impacts on "mental and social well-being" as the most important health effects of the Fukushima Daiichi crisis, and attributes these outcomes to both the disaster itself, as well as to the stigma and fear of the perceived risks from nuclear radiation exposure (United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 2013, p. 10).

The prevalence of public misperception then influences the way individuals evaluate their own health. Curious about this phenomenon, researchers of the TMI accident – which, like Fukushima, showed no verifiable radiation-related health impacts – decided to investigate. They asked mothers of young children (who, along with cleanup workers, compose the highest risk group) if they believed their health had been affected by the accident; 61% of these mothers answered 'yes' (Bromet, 2014). The most unfortunate component of this answer is that the perceived harm is enough to cause real health impacts; it is akin to a self-fulfilling prophecy, in which the individual unwittingly negatively impacts her own health when the radiation has had no physical effect. For the mothers in Pennsylvania and Kiev after their respective nuclear disasters, women who believed the accident had affected their health reported significantly higher anxiety, depression, and hostility scores (Bromet, 2014, p. 210). Furthermore, the mothers who believed the accident affected their health were

three times more likely to describe their health as 'fair' or 'poor' (Bromet, 2014, p. 210). Self-rated health is associated with a variety of physical health conditions, overuse of medical services, early mortality, and disability (Bromet, 2014). The lifetime prevalence of depression in women eleven years after Chernobyl also more than doubled, to 46.7% (Bromet, 2014). In another study, TMI cleanup workers experienced greater job tension, anger, extreme worry, demoralization, and somatic complaints than peers who had not been present at TMI (Bromet, 2014).

These types of mental health damages seem explicable. Individuals were unclear on the mechanism behind radiation's effects, but knew they lived in the area from which the U.S. government had instructed its citizens to leave. It is natural, in this situation, for a person to ascribe unrelated health issues to radiation. The full mental health impacts of Fukushima will not become readily apparent for several more decades, but Evelyn Bromet, a psychiatric epidemiologist analyzing surveys conducted at Fukushima Medical University, worries, "I've never seen PTSD questionnaires like this" remarked that she had never before seen PTSD responses like those from residents of Fukushima. She found respondents to be "utterly fearful and deeply angry. There's nobody that they trust any more for information" (Brumfiel, Fukushima's Doses Tallied, 2012, p. 424). While the nuclear fallout of the Fukushima Daiichi accident was significant, it appears the mental health fallout will pose greater long-term public health issues.

ANALYSIS

Challenges In Public Communication Of Science

Until recently, the most common framework used in the public communication of science was the Deficit Model. This approach views scientific knowledge-sharing as a one-way transfer into an empty vessel – the filling of a cup. It "attributes negative public attitudes towards science to a lack of scientific knowledge" (Kirby, 2008, p. 41). If only people would be more scientifically literate, this perspective holds, they would appreciate and respect those in the laboratory.

This understanding of the topic fell to significant criticism in the 1980s and 1990s (Bucchi, 2008). Along with criticism for the Deficit Model arrived critiques of the Diffusionist Model, a closely related framework which builds upon the foundations of the Deficit theory. Media, in the Diffusionist frame, plays a role as a 'middleman' between the scientific elite and the public. Scientists, however, are distrustful of that media presence, and see it as something which can only dilute the purer forms of knowledge revealed through science.

In contrast to the Diffusionist/Deficit theory stands the superior Continuity Model. This notion suggests public communication of science need not dichotomize the transfer of knowledge to only occur in one direction. Rather, it advocates for a continuum of public engagement, which includes "information provision, consultation (where publics are asked for feedback), involvement (where publics participate in the determination of appropriate solutions), and empowerment (where participation extends from defining the problem to determining the solution)" (Einsiedel, 2008, p. 175). The Continuity Model recognizes the existence of asymmetries, and thus recognizes that publics wield agency, opinions, and can participate actively. It additionally understands they "imbibe, select, reject and develop expertise out of necessity or interest; they also remain unaware, blissfully ignorant or simply disinterested, by choice or happenstance" (Einsiedel, 2008, p. 175).

Within a Continuity Model that explicitly recognizes the public's agency, trust is an important factor. Trust is an amalgam primarily of three independent variables: competence, integrity, and dependability (Borchelt, 2008). And while trust occurs on some level in any form of communication, it is of particular importance in science. This is because the proofs underlying most scientific claims and recommendations are often lengthy, esoteric, and therefore unintelligible to the vast majority of the population. Politicians can rely on citizens' firsthand experience of voting regulations and driving laws; moral philosophers can lean on intuitive conceptions of right and wrong sharpened since childhood; scientists, however, cannot prove the validity of expert advice, but can only make it plausible (Peters, 2008). There exists a variety of tools (like analogies, brief background explanations, and the clear articulation of assumptions) which scientists can use in dialogue with an audience in order to boost the reasonability of a claim, but the entire interaction is not without its social context of expertise. This not only means scientists must adapt their explanations to their audience's level of understanding, but also implies the credibility of a scientist – that is, whether or not the public can trust her – is a legitimate area of inquiry.

Bureaucracy's 'Wicked Problems'

It is within this environment that governments must coordinate an efficient and credible communication machine. Donald Kettl's notion of 'wicked problems' – issues which develop in unprecedented ways and at blistering paces – present sizeable challenges to the bureaucratic behemoths citizens expect to combat them. To describe such a reality, this paper articulates a framing for understanding how bureaucratic institutions (like governments) address such obstacles.

Three components define Kettl's 'wicked problem' formulation: "First, they allow little time to react. Second, failures anywhere can quickly become problems everywhere. Third, when failures occur, the costs can be very high and can quickly spread very far" (Kettl, 2009, p. 93). These are the complex sorts of problems which require rapid adaptation and flexibility in addressing their unprecedented symptoms – the sort of problem exemplified in a nuclear power plant disaster.

What is interesting about these failures is that they are not issues of individual dishonesty or internal conspiracies which derailed an otherwise aboveboard and effective process (Kettl, 2009). That, at least, would offer some clear solutions to the government's failure in the disaster – eliminate the dishonest employees from the organization, and crack down on internal corruption to allow the system to run at its optimal efficiency. Unfortunately, failures in the Fukushima-Daiichi crisis occurred largely despite good-faith efforts by entire teams and agencies of well-intentioned human beings across the government. And in the post-Fukushima case, these failures occurred despite the valiant efforts of individuals across two different governments and the IAEA.

The inverse of the Fukushima-Daiichi paradigm, and thus a reasonable candidate to provide a concrete example of the theoretical principles underlying a reworked government approach to disasters, is the rocket science model. In space-flight missions, "a government agency is charged with an extraordinarily difficult and dangerous mission, where a misstep could lead to disaster; complex partnerships develop… and a management system focuses on a well-defined mission that assigns clear responsibility to managers for producing results" (Kettl, 2009, p. 185). Shuttle managers preemptively train a large number of experts both in their specialty (to ensure key knowledge areas are understood) and in broader emergency skills available to the astronauts (to facilitate collaboration amongst the experts) (Kettl, 2009). Should an issue develop mid-mission, the mission controllers do not defer to the authority of pre-defined standard operating procedures (SOP), but instead, "they put together an ad hoc team consisting of the experts they need to solve the problem at hand" they assemble a team of people with the required knowledge to solve said issue (Kettl, 2009, p. 185).

This organizational structure is not flawless – decentralizing power in such a manner as to allow individual mission controllers to define the solutions-finding process places immense responsibility directly into the hands of these managers. It also requires they think on their feet to synthesize the best elements of their training and knowledge of the situation to create an effective process. It demands much of these controllers, and in so doing requires a deep human resources pool. It is also risky – if the controller cannot develop an effective process, failure is likely. But insofar as the problems space crews face often fall into the famous category of 'unknown unknowns' that Donald Rumsfeld popularized (a category which defines situations in which the crew members do not know what they do not know), a predefined SOP model is almost guaranteed not to fit the specific problem. Emergency reaction teams must have the flexibility to construct a process which can adapt to suit previously unseen crises.

The rocket science model is based upon standards which generally serve as the underpinnings for the meta-process by which the mission controller constructs the solutions-building process. Kettl articulates seven guiding principles:

1. Clear objectives
2. Effective presence
3. Unity of effort
4. On-scene effort
5. Flexibility
6. Managed risk
7. Restraint (Kettl, 2009, pp. 194-196)

For Kettl, these overarching principles – in combination with the fast-paced and high-risk realities present in crises – culminate in the following seven tenets of the modern-day rocket scientist:

1. Focus on results.
2. Seek results through interrelated partnerships.
3. Use information to fuel communication.
4. Rely on bureaucracies as holding companies for expertise.
5. Create relationships of trust before the relationships are needed.
6. Steer resources.
7. Lead by making the public interest drive complex partnerships. (Kettl, 2009, pp. 210-212)

This list represents the strategies – the means to use as tools towards objectives – Kettl believes are ideal for individuals acting with agency in a 'leveraged government' seeking to address unprecedented wicked problems.

Possibilities for a Better Bureaucracy

Two general frames stand out as distinct options for implementation of these theories to the 'real world' problem at hand.

The first would be to operate within the current organizations, while making necessary changes to allow the Japanese government, US government, and IAEA to create their own combined crisis team embodying 'rocket science model' principles and tenants. In order to achieve sufficient organizational coherence, trust, and efficacy, this would have to be a pre-formed group rather than an ad hoc task force established after a crisis occurs. An obvious detriment of this approach is that it would only be of use in future nuclear crises that occurred in either the US or Japan, which are unlikely. The second option, which would be more broadly applicable, is an expansion of IAEA capabilities and responsibilities to allow the Agency a more direct and engaged role in nuclear crises. While this approach could more easily expand beyond cases involving the U.S. and Japan, it also is likely to be costlier in its implementation.

Regarding the first option, this paper considers the possibility of an improvement for the disaster response coordination directly between the U.S. and Japan, rather than through the IAEA. While much went awry during the mutual emergency response between the United States and Japan, the two nations also were quite successful in several regards. For example, although the U.S. may have doubted Japan's distribution of information, it did not doubt Japan had the technical ability to collect data, or that the on-site workers were knowledgeable and well-trained. Furthermore, "Thanks to deep mutual commitment, in this crisis there were relatively low hurdles to accepting deep involvement by the United States" deep, pre-existing ties between the two nations made trust and cooperation easy to facilitate. (Akiyama, 2013, p. 4). More willing and more capable than any other nation to provide assistance, the U.S. was crucial in partnering with Japan to mitigate the harms as much as the two nations did. In addition, the U.S. willingness to assist with "unhesitating provision of technological and response capabilities is something that would not have happened had the Japan-U.S. alliance not existed" the sharing and providing of advanced technological and response capabilities were only possible due to the two countries' military alliance (Sato, 2012, p. 48). However, even this component was not without hiccups. Japan, unaccustomed to being the recipient of emergency international assistance, "initially interpreted the U.S. proposal as a loan or sale, and this misunderstanding led to a delay in the provision of relief goods in the early phase" initially conceived of the aid as a loan to be paid back later, which significantly delayed the acceptance and distribution of this aid. (Sato, 2012, p. 48). The lesson here is the two nations' – and, indeed, the entire globe's – organizational and legal infrastructure for addressing international nuclear crises is in need of improvement.

One potential solution lies with the expansion of NRC authority to join forces with its Japanese counterpart – the Nuclear Regulatory Authority (NRA) – to collaborate in crisis response. Recall that the difference in recommended evacuation zones between the two nations became a harmful contributor to the Japanese public's confusion and distrust of its own government, and therefore exacerbated the psychological stress of Japanese citizens. It is reasonable to aim for this focal point of discord when designing a potential solution. Furthermore, "in part because of the differences in the two countries' governmental and bureaucratic structures," partially due to the differences between the Japanese and American governmental and bureaucratic architectures, "the Americans at NRC had difficulty gaining access to the relevant parties at TEPCO and elsewhere, which created a major obstacle in gathering information" Americans at the NRC had issues finding their counterparts at TEPCO and other bureaus, complicating the sharing and gathering of information. (Sato, 2012, p. 59). One of these key structural issues was a mismatch in personnel rotations, so cooperation channels and personal relationships between the civilian nuclear authorities in each nation were not maintained over time (Sato, 2012). This is precisely what Kettl's notion of reform in bureaucracy seeks to solve: shifting from the SOP model of government to a design in which organizations operate as institutionalized repositories of personal relationships. If the NRC and NRA were to join forces in a disaster preparedness and response team, each nation's primary internal nuclear agency could coordinate personnel rotations with respect to the other, and thus each organization knows precisely how to communicate with its counterpart.

Such a mechanism also fits within the broader framework of U.S. civilian crisis response efforts in the region. Currently, in the Asia-Pacific, the assembling of crisis management personnel is the responsibility of the Disaster Assistance Response Team (DART), a program of the U.S. Agency for International Development (USAID) (Sato, 2012). In the case of the Fukushima Daiichi emergency, both the NRC and U.S. Department of Health played a central role under DART, and USAID's Office of Foreign Disaster Assistance coordinated with the Department of Defense and Department of Energy to finance the costs of nuclear scientists and other personnel involved in the U.S. response (Sato, 2012). The proposed NRC-NRA joint team could similarly function under DART. It would assume the primary coordination and administration role, and leverage the abilities of other actors – the NRC, Department of Health, Department of Defense, Department of Energy, etc. – to most efficiently address the crisis. Addi-

tionally, the inclusion of the primary Japanese domestic nuclear authority would reduce communication redundancies between the U.S. side and various Japanese agencies.

This clear and lasting partnership between the two organizations – if structured appropriately – would also allow each partner to utilize more effectively a Continuity Model of educating their populations on nuclear disaster response. Developing a clearer set of relationships and strategies well in advance of future incidents is necessary to implement education which more deeply build public trust upon which these agencies can rely in times of emergency. Each nation can further view this educational role as a lasting benefit of the NRC-NRA coordinated group's continued existence, which separates it from simply manifesting as a costly disaster response team that has been convened in advance of a disaster that may never happen.

POLICY RECOMMENDATIONS

Looking beyond bilateral solutions, the IAEA's Incident and Emergency Centre (IEC) is another candidate through which these two nations can improve nuclear disaster response efforts. As an organization, the IAEA maintained four roles in the response to a nuclear or radiological emergency at the time of the Fukushima Daiichi disaster: exchange of information through official contact points; provision of timely, clear, and understandable information; provision and facilitation of international assistance on request; and coordination of the inter-agency response (International Atomic Energy Agency, 2015). The IEC is the hub for this activity, and is already home to a variety of emergency, safety, and nuclear security training, reviews, and publications, including the requirements and guidelines of the IAEA Safety Standards (International Atomic Energy Agency, 2015). It boasts an emergency preparedness and response network predicated on the Convention on Early Notification of a Nuclear Accident, and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (International Atomic Energy Agency, 2016). But the latter document, while a strong step in committing IAEA Member States to assist each other, clarifies none of the logistical steps in the case of an actual emergency.

It should be noted the IAEA's plodding and confusing response to the crisis as a whole drew criticism (Brumfiel, Nuclear Agency Faces Reform Calls, 2011, p. 1). The IAEA's own report on the Fukushima Daiichi incident observes that communication with the official contact point in Japan was difficult, and not improved until the IAEA Director General visited Japan from March 17 to 19 (International Atomic Energy Agency, 2015). Additionally, Japan and the U.S. primar-

ily sought direct bilateral pathways as the best communication tools, leaving the IAEA to watch from the outside as the differing recommendations on how far their citizens should evacuate caused confusion and distrust amongst the public (International Atomic Energy Agency, 2015).

1. Increase IEC Responsibilities and Authority

One recommendation is to empower the IEC with disaster response capabilities that include human and material resources. Making this legal and functional shift in the IEC's role would likely quicken its response time, as it would no longer need to coordinate between multiple states to secure those response capabilities in the first place. Furthermore, the deployment of IEC personnel would also expedite the organization's ability to collect data, and thus to report on that data collection. No longer would it only depend on reports from state authorities – which, in a crisis, are not a nation's top priority – for the procurement of this data.

This solution is advantageous in that it is not limited to only the case of the U.S. and Japan. The reformed IEC could undertake direct response and information-gathering roles in any number of nations experiencing nuclear incidents or emergencies. Another positive point is that the IAEA recognizes the need to address the psychological impacts of nuclear accidents, such as those exacerbated in the public communication mistakes of both the U.S. and Japanese governments. To this point, the IAEA Fukushima Daiichi Report warns of the repeated failures of international recommendations and radiological protection standards in addressing the psychological consequences of radiation exposure accidents (International Atomic Energy Agency, 2015, p. 139). Because the IEC is housed within an organization which already recognizes the severity of these mental health impacts, it is better prepared to integrate practices which address these important psychological realities.

2. Expand IAEA's Role in Disaster Management

A more cost-effective alternative would be for the IAEA to expand its role in other directions that do not include the functional ability to provide on-the-ground response. One option is to grant the IAEA permission to collect real-time data from instrumentation and computers located within and around nuclear power plants. Currently, the IAEA is host to the Power Reactor Information System (PRIS), which is a comprehensive worldwide database covering reactor specification data, technical design characteristics, and performance data (International Atomic Energy Agency, 2016). This database contains information on nuclear power reactors in operation, under construction, and those being decommissioned. However, PRIS is updated via reports, and not real-time data. This is of no use in a nuclear emergen-

cy; as one specialist in international agreement compliance explained, "If you say to a reactor operator: 'Your reactor is melting down, please do not forget to fill in form 33b and fax it to the IAEA', they're not going to do it" (Brumfiel, Nuclear Agency Faces Reform Calls, 2011, p. 2). However, if Member States were willing, automated systems could be installed in nuclear power plants to collect this data and instantly send it to the IEC to provide constant updates. Then, should an incident arise at a nuclear power plant, the IAEA could immediately interact with international partners using the most up-to-date information, rather than waiting on state authorities – who are likely to be occupied with managing the issue itself – for this data. This would greatly facilitate its ability to provide the public with clear information, rather than allowing for the significant delay present in the aftermath of the Fukushima Daiichi situation (International Atomic Energy Agency, 2015).

This approach still depends on states to provide the human resources and equipment to mitigate a nuclear disaster, but it is likely much cheaper than the system in which the IEC provides these responses. Especially after the instrumentation is installed, it seems the upkeep costs would be far less than those of maintaining well-equipped and well-trained human response capabilities throughout the globe. This is again a system which could be employed throughout the world, rather than limited to the case of the U.S. and Japan. A disadvantage of this approach in comparison to a direct response capability is that in the event of a natural disaster occurring simultaneously with a nuclear incident, it is quite possible the instrumentation and reporting abilities of those devices become severely limited or fully disabled. The IAEA could then find itself in the same position as it did in the Fukushima Daiichi case. However, even in the case of a crippled instant-reporting system, the IAEA would have acquired all data leading up to system failure (instead of relying on scientists at the site to report it), and if any reporting capabilities have survived, it is likely able to acquire some data it would not have obtained in a short timeframe otherwise. Some states may feel this would be an IAEA intrusion which would limit their own response capabilities in the event of an accident, or at least provide another source for criticism of that response. Yet the scenario in which the IAEA is fully aware of the immediate on-site situation is also one in which state authorities have a lower burden to spend precious time reporting information to the IAEA, and would expedite the IAEA's ability to participate in building a solution by offering the aid of informed experts and other resources. With knowledge of real-time data, this know-how is able to be more effective in solving the situation at hand.

CONCLUSION

The challenges of the Fukushima Daiichi disaster have showed that both the U.S. and Japanese governments, as well as the IAEA, can develop improved systems to address the 'wicked problems' they confronted. Doing so will likely improve institutional capability to manage the mental health impacts of these crises, and thus allow individuals to live healthier and happier lives. Yet solely enacting structural changes is no guarantee that the next response to a nuclear incident will be perfect, nor does it even guarantee it will be better than the multinational response in the Fukushima case. Treatment of future nuclear disasters will continue to rely on the intelligence, bravery, communication skills, and decision-making abilities of those involved. The paths proposed are merely suggestions for improving the massive human networks present in bureaucracies to better match the immense, complicated, and rapidly-evolving issues present in the aftermath of a nuclear accident. The cultural change may not be swift, and indeed, the necessary legal change is likely to be far slower, as it requires the shifting and creation of entire political and legal mountains. However, throwing the weight of two great nuclear powers behind this initiative could bring the effort some key momentum necessary for it to take hold. More importantly, in the face of communication and logistical discord responsible for suboptimal response times and significant damages to the mental health of the surviving evacuees, these nations have an impetus to seek more drastic – and effective – solutions than the organizational structures and approaches of the past.

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