Republic of Korea's Economic Success and The Paris Agreement Goal of Reducing Greenhouse Gas Emissions

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Abstract – South Korea is one of the most polluted countries in the world — in 2016, Korea had 76 days with bad air quality and only 45 days with good air quality. This is an issue of immense significance: medical studies conclude that polluted air can cause serious health problems such as stroke, heart disease, lung cancer, and other ailments. Particulate matter floating in the air smaller than 10 micrometers profoundly threatens children and asthmatics and can be easily absorbed into the bloodstream of adults. The Republic of Korea or ROK is a signatory to the Paris Agreement, which aims to reduce greenhouse gas emissions below the current Business As Usual (BAU) emissions by 37% by 2030. The ROK Ministry of Environment currently oversees Korea's pollution monitoring and regulations; however, attaining the Paris Agreement goals may be difficult considering the nature of Korea's export-oriented economy. The ROK is the 5th largest exporter of goods in the world — the resulting success and trade surplus have significantly increased per capita income and improved the standards of living. An atmospheric test using measuring equipment provided by NASA found that half of the air pollution in Korea originates from industry, power generation, buildings, and transportation vehicles. The fact that the majority of South Korea's air pollution comes from within makes proactive solutions possible. This paper will investigate the path forward, examining how industrial contributors to air pollution in Korea can work with NGO actors, environmental experts, and government officials to achieve the ambitious Paris Agreement goals.

Key Words – South Korea Air Pollution, Particulate Matter Harm, Paris Agreement signatories – South Korea, ROK trade surplus correlation with increased air pollution

INTRODUCTION

From immensely popular K-everything to the country's rapid growth in the 20th century, South Korea has crawled its way to the spotlight in recent years. And yet, despite how prosperous the nation may be, it faces an immense problem: air pollution. In 2018, 17,000 people died in South Korea because of air pollution, according to the "State of Global Air 2019" report published by the Health Effects Institute (Nam, 2019). It's not uncommon for South Korean citizens to spend the majority of their days in masks. School events and sports practices get canceled due to poor air quality. Residents of South Korea regard this issue as a major aspect of their lives.

The issue of air pollution naturally draws concern. After all, air pollution is identified as the cause of one-third of deaths from stroke, lung cancer, and heart disease (World Health Organization, 2019). In 2017, South Korea was designated as one of the most polluted countries in the world, with estimated costs to the country of $9 billion annually. According to the website AirView, three of the most polluted cities in the world are in South Korea, one of which is the nation's capital: Seoul (Harris and Buseong, 2017).

The fundamental cause of health problems in both humans and animals attributed to air pollution is from particulate matter smaller than 10 micrometers, or PM10. These microscopic substances pose great risks because they can easily infiltrate into the bloodstream or to the lungs, penetrating deep into the respiratory and circulatory systems. This may cause damage to the lungs, heart, and brain (WHO, 2019).

Particulate matter represents a harsher threat when children and asthmatics are impacted. After studying the hospitalization and health records of children, medical experts identified detrimental health effects from the air pollution measured in South Korea's population centers, and concluded it's a problem that must be addressed with more care and attention. (Lee, Kim, Song, Hong, Cho, et al, 2002).

When considering these detrimental health effects, the fact that air pollution has grown to be an almost all-consuming factor in South Korean life is undoubtedly concerning. With increasing concern towards this issue, the Korean government has indeed taken steps to remedy it. Not only has the government signed on to the Paris Agreement, but South Korea has also attempted to cut down on air pollution by decreasing coal-fired plants and increasing public bike stations (Babe, 2018). Despite such efforts, the government has displayed some tensions in relation to China's role in

Korean air pollution. These tensions must be well navigated in order for South Korea's air pollution to show drastic improvement; the truth behind China's supposed major role in South Korea's air pollution is a topic that demands discussion. When considering South Korea's rapidly expanding economy, China's role in the equation may be less than what is expected.

AIR POLLUTION IN SOUTH KOREA

South Korea is one of the most polluted countries in the world. Noelle Selin, Associate Professor of Engineering Systems and Atmospheric Chemistry at the Massachusetts Institute of Technology, states that a carbon footprint is the "amount of carbon dioxide (CO2) emissions associated with all the activities of a person or other entity (e.g., building, corporation, country, etc.)." (Selin, 2010). In 2018, Norwegian researchers found Seoul to have the worst carbon footprint out of 13,000 world cities, with inhabitants producing 276.1 metric tons of carbon dioxide a year (Babe, 2018).

Such poor air quality is a major topic of concern for South Korea's population — in a 2017 national survey, South Koreans identified fine dust and air pollution as their No.1 stressor in life (Haas, 2018). In fact, Koreans are more worried about getting sick from pollution than they are about nuclear weapons proliferation in North Korea (Haas, 2018). A 2018 study by the Ministry of Environment found 97% of Korean adults felt physical or psychological pain due to dust. 60% thought the problem was "serious" while another 30 per cent thought it was "extremely serious" (Lee, D., 2019). This concern is not unfounded. In 2016, Korea had 243 days with moderate air quality, 76 days with bad air quality, and only 45 days with good air quality (Haas, 2018). On an average day in Seoul, many citizens can be seen with masks donned to prevent harmful particles from entering their bloodstream. Mothers will chide their children to remember to bring their mask on their way to school. And at school, students will remind each other again of how the air quality is on that day. As such, concern for air pollution is a very real factor in Korean life.

LONG-TERM IMPACT ON HEALTH

The majority of concern about air pollution comes from its effect on health. Some aspects of the long-term effects of air pollution on health remain unknown. Still, evidence suggests that there is a direct connection between air pollution with higher rates of cancer, stroke, heart disease, and respiratory diseases (Nunez, 2019). One of the most compelling cases of evidence for this can be seen in the respondents to the 9/11 tragedy. These responders who attempted to rescue victims and retrieve remains at the World Trade Center in 2001-2002 (policemen, firemen, rescue paramedics and the drivers of busses and trucks) still suffer from poor health and are developing cancer 18 years later (Herbst, 2019).

According to Dr. Michael Crane, medical director of the World Trade Center Health Program at the Icahn School of Medicine at Mount Sinai in Manhattan, some 40,000 of these workers have developed health conditions, including 10,000 responders and volunteers diagnosed with various cancers associated with exposure to toxins (Herbst, 2019). Nearly 18 years after the terrorist attacks, more than 2,000 people have died of an illness related to this incident (Goldberg and Tracy, 2018).

It is expected that by the 20th anniversary of 9/11, more people will have died from 9/11-related illnesses than the 2,700 who died at the Twin Towers that day (Goldberg and Tracy, 2018).

EFFECTS OF AIR POLLUTION ON CHILDREN AND ANIMALS

As air pollution grows as a worrying issue in many countries, another topic of concern has emerged: its impact on the health of children. A published report found that 543,000 children younger than five die annually from respiratory disease caused by air pollution (World Health Organization, 2019). Not only that, but maternal exposure to air pollution during pregnancy is related to adverse birth outcomes such as early fetal loss, preterm delivery, lower birth weight, and more (Schwartz, 2004). Thus, air pollution is a health threat to society as a whole rather than a single age group.

Animals also reflect the harmful effects of air pollution. In truth, animals may actually be more vulnerable to this issue than humans (Pal, M., Yirgalem, M., Anberber, M., Giro, B., Dasguta, R. 2015). Because animals are not as well equipped to protect themselves from air pollution as humans are, they are naturally much more vulnerable to this presence of particulate matter (Pal, M., Yirgalem, M., Anberber, M., Giro, B., Dasguta, R. 2015). The harmful gases inhaled with contaminated air are believed to affect animals in the same manner as humans, leading to organ damage in the long run (Pal, M., Yirgalem, M., Anberber, M., Giro, B., Dasguta, R. 2015). This is a problem that affects farm animals and pets alike, causing disease such as acute bronchiolitis, emphysema, and heart failure (Pal, M., Yirgalem, M., Anberber, M., Giro, B., Dasguta, R. 2015).

REGULATIONS

In 2015, the government of South Korea (ROK) signed the Paris Agreement, joining many other nations. The Paris Agreement aims to reduce greenhouse gas emissions by 37% below BAU emissions by 2030. Because compliance with the Paris Agreement ensures that roughly a million lives would be saved annually by 2050 purely as a result of

reductions in air pollution, it has revealed itself to be one of the most critical aspects of South Korean regulation concerning air pollution (World Health Organization, How Air, 2019).

South Korea did not get off to a good start after signing the Paris Agreement – in the very next year, 2016, the non-governmental agency Climate Tracker found that the ROK increased emissions per capita and labeled the country's efforts as "inadequate" (Mattheson, 2016). The figure below shows the grey circles, which are the 2020 targets, with actual emissions much higher than the progress goal designated by the Paris Agreement.

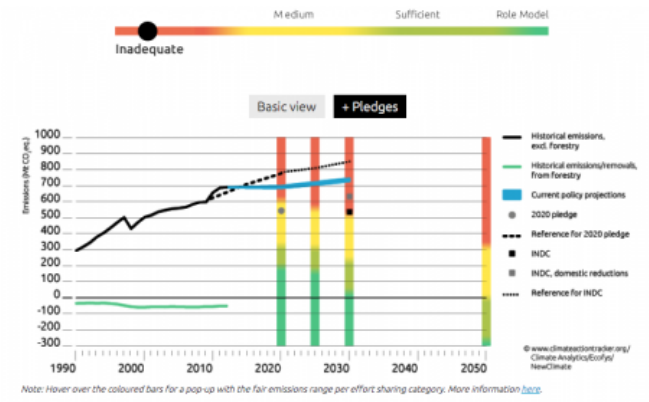

Figure 1. South Korea increased emissions in 2016 after signing the Paris Agreement (Mattheson, 2016)

The Ministry of Environment oversees South Korea's regulations concerning pollution monitoring and prevention, working with the National Legislature to enact policies that are designed to protect the environment. However, the Ministry will have a practical challenge hitting the quantitative targets of the Paris Agreement for the following reason: South Korea generates approximately 52% of its air pollution domestically, with the other half drifting over from the second-largest economy in the world - The People's Republic of China - from the West across the China Sea and from its neighbor on the Korean peninsula the Democratic People's Republic of Korea, most often referred to as North Korea (Da-sol, 2017).

According to the landmark atmospheric tests of air quality using measuring equipment provided by NASA, domestic air pollution in the RoK originates from industry, power generation, buildings and transportation vehicles (Hu, 2017). The single largest contributor to air pollution is coal-fired power plants. South Korea is home to 54 coal-fired power plants, which account for 30 percent of the country's power generation (Chung, 2019).

One of the coal-fired power plants in South Chungcheong Province is a major source of nitrogen compounds and sulfur dioxide that cause chain chemical reactions in the air, generating more fine dust and ozone (Lee, S. 2017). Therefore, the role that these power plants play in polluting the nation cannot be denied (Lee, S. 2017).

In July 2016, South Korea's Trade Minister announced that the country would aim to close down the 10 coal-fired plants by 2025, while also replacing turbines at several power plants to increase efficiency and reduce emissions (Lee, S.2017). The government also stated that existing coal-fired power plants will be more tightly regulated through tougher emissions standards (Lee, K. 2017).

To adhere to the standards presented by this agreement, the South Korean government has made a variety of attempts, including the installment of bike-sharing stations, enactment of fines on specific diesel-fueled vehicles and the discontinuation of government parking lots (Babe, 2018).

However, many of these measures have had little success. In 2019, seven major cities in South Korea suffered record high concentrations of harmful PM 2.5 particles, leading to popular backlash over current regulation (McCurry, 2019). Following this crisis, the national assembly passed a series of bills in March to provide authorities access to emergency funds for measures to mitigate these high concentrations, such as the installation of air purifiers in classrooms (McCurry, 2019). It is unclear how effective this new regulation will turn out to be.

The success of these regulations remains unclear as of the writing of this report. In all, the South Korean government can be said to take a moderately active role in placing regulations to reduce air pollution. However, based on the research we conducted for this paper, we do not believe that the implemented regulations are drastic enough to create significant changes in the number of days of poor atmospheric air quality. The government may need to take a more aggressive role in attempting to cut carbon if the nation's citizens are to see more days with blue skies than gray.

THE RELATIONSHIP WITH CHINA

China is commonly identified as the greatest cause of Korea's air pollution. However, a NASA study concluded that in reality, less than half of Korea's poor air quality can be attributed to China. The study determined that approximately 48% of pollution originated outside of the country, from the following regions - 22% from China's Shandong Province, 9% from North Korea, 7% from Beijing, 5% from Shanghai, and a combined 5% for the three regions of China's Liaoning Province, Japan and the West Sea (Sa-sol, 2017).

Experts also believe that the public blames China unfairly. "The government is sitting idly by while passing the buck to China," said Kim Shin-do, a professor of environmental engineering at the University of Seoul

(Harris and Beseoung, 2017). Professor Kim's assessment of China's share of the pollution blame is 20% (Harris and Beseoung, 2017).

The results are expected to silence those who blamed China the most for Korea's bad air quality. Some people even filed a compensation suit against the Chinese government earlier this year (Kim S., 2019). South Korea must acknowledge its own prominence in the harsh air pollution of the nation, rather than assigning blame solely to its neighbors (Hu, 2017). So far, the nation seems to be taking some action to do so. The National Assembly took action in February and March of 2019, passing several bills that paved the way for a 3 trillion won (US$2.65 billion) emergency fund to tackle the problem and designated fine dust as a social disaster. A second law, the Special Act on the Reduction and Management of Fine Dust, granted the government the ability to limit the use of vehicles, coal-fired power stations and building sites (Lee, D. 2019).

As in many democratic countries with multiple political parties, when a national crisis occurs, the issue becomes politicized. South Korean President Moon Jae-in (Democratic Party) proposed a joint project with China to use artificial rain to clean the air in his country, but the Chinese Foreign Ministry Mr. Lu responded "I wonder if the South Korean side has any basis that its smog is from China," noting that fine dust readings have been higher in Seoul than in Beijing recently. "All countries realize that the cause is very complicated" (South Korea Proposes, 2019).

The politics of the issue are growing complex. The floor leader of the conservative Liberty Korea Party, Na Kyung-won, announced a necessity for Mr. Moon to address the current levels of air pollution as a national disaster (Kim, 2019). For President Moon, the dirty air appears to be eroding his approval rating, which dropped to 44% in March 2019 from a peak of 81% in June 2017, according to data from Gallup Korea (Lee, D. 2019).

In all, the role of China in Korea's air pollution problem remains complex. While the particles blowing in from China are undeniably real, the truth remains that there is much that can be done within South Korea to mitigate its own carbon emissions. The common "man in the street" in Seoul wants to hold China responsible, as scientists have attributed roughly 50% of harmful particulate matter pollution drifting over from multiple regions of China. However, it will not be easy to craft a mutually agreeable solution with the Communist power (Choi and Chao, 2019).

The South Korean government and public must stop framing China as the sole source of blame. Rather, the nation must focus on its own internal affairs to reduce emissions. After such steps have been taken, diplomacy with China about joint-mitigation of carbon emissions may prove to be easier.

IS COAL TO BLAME FOR THE FINE DUST PARTICLE?

52% of air pollution generated domestically was created by the coal-fueled power industry, diesel cars/buses, heating homes, apartments, and office buildings, as well as diversified industrial manufacturing. According to the comprehensive report measuring CO2 emissions for all countries, South Korea ranked 9th in Fossil CO2 emissions. The top 10 nations on the list contributed 67% of the planet's CO2 gases (Crippa, et al 2017).

Nevertheless, there are many other countries in the world — especially in Europe — that produce smog and pollution because coal is the primary source of their power generation plants, and a significant percentage of workers rely on coal production and/or economically rely on its supply chain.

This is why the location of the last meeting of the UN Climate talks, Katowice, Poland, was significant: it is in the heart of the Silesia Coal region. There is significant tension between the advocates of the environment and those who want to protect the jobs that coal creates. The result of the December 2018 negotiations in Poland was a document that became known as the Paris Rulebook (Evans and Timberley, 2018).

WHAT IS IN THE PARIS RULEBOOK?

Nearly 200 countries signed the Declaration at the end of the Katowice conference, pledging to follow a 156-page rulebook for implementing the landmark Paris Agreement on climate change (Cuddy, 2018). The landmark Paris Agreement 2015 deal aims to limit global temperature rises to "well below" two degrees Celsius (Cuddy, 2018). The UN says the new Rulebook guidelines "promote trust among nations that all countries are playing their part in addressing the challenge of climate change" (Cuddy, 2018). A consensus was finally reached when ministers managed to break a deadlock between Brazil and other countries over the accounting rules for the monitoring of carbon credits, deferring much of the discussion to next year (Cuddy, 2018).

Specifically:

The 256-page common rulebook, known as the Katowice Climate Change Package, is split into thematic sections. It details how countries should monitor and report their greenhouse gas emissions and the efforts they're taking to reduce them, and how they will update their emissions plans (Cuddy, 2018). Poor countries also secured assurances on getting financial support to help them cut emissions, adapt to changes, and pay for damages (Cuddy, 2018).

Guidelines in the package also explain how to conduct the "Global Stocktake" of how effective climate action has

been by 2023 as well as the process for creating new goals on finance from 2025 onwardsto aid developing countries (Cuddy, 2018).

KOREA'S SUCCESS AS A NET EXPORTER OF GOODS LEADS TO INCREASED WEALTH

After the Cold War, South Korea initiated a government-backed export policy which led to great success. Since 2008, Korea has only had two quarters with a trade deficit. The trade surplus hit a high of $12BN in 2016 (Trading Economics Reference site, 2019).

The trade surplus has declined since then, but over the last 10 years, one metric of wealth, GDP per Capita, has risen sharply. In 2009, GDP per Capita was $20,843 — in 2018, it was $31,335, an increase of 50% (Trading Economics Reference site, 2019). Koreans now are ranked 28th in the world as measured by GDP per Capita wealth (Trading Economics Reference site, 2019). The data proves that Koreans' success in exporting their goods increased the economic well-being of the average citizen, who has more money to heat up their apartments and travel by buses or cars. Rising wealth per person leads to the ability to pay for the natural resources that create carbon dioxide — this is the core problem that conflicts with achieving the Paris Agreement targets.

CAR SALES IN SOUTH KOREA, 2008-2018

In 2008, Koreans bought 1.2 million cars and light trucks (Dement, 2019). Sales rose steadily and hit a peak of 1.8 million in 2015 (Dement, 2019). In the last three years, sales have fallen by less than 1%, with 1.78 million cars and light trucks sold in 2018 (Dement, 2019). Despite this recent fall in sales, it is reasonable to conclude that this drastic increase of cars on Korea's streets would have contributed to the air pollution the nation struggles with today (Dement, 2019). As the Korean car industry continues to grow, its environmental impact must be carefully examined.

Year	Units Sold in South Korea
2018	1.784.614
2017	1.761.404
2016	1.795.215
2015	1.800.984
2014	1.629.763
2013	1.511.931
2012	1.516.300
2011	1.553.062
2010	1.541.433
2009	1.439.546
2008	1.200.283

Data from (Dement 2019)

CARBON CREDITS

Several emissions-trading schemes (ETSs) have been established to reduce CO2 emissions, such as the EU ETS, California-Quebec ETS, and New Zealand ETS, among others (Choi and Qi, 2019). The ETS provides a way to reduce pollutant emissions using market measures, which is more scientific and effective than compulsory administrative measures (Choi and Qi, 2019). The main compliance tools under the carbon ETS involve directly decreasing CO2 emissions and purchasing emission allowances, and thus, power plants must be well-versed in these two measures' costs and benefits (Choi and Qi, 2019).

Korea's coal-fueled power plants have the potential to play a key role in reducing carbon emissions, as they account for 43% of the nation's electricity generation and approximately 25% of its total carbon emissions (Choi and Qi, 2019). The energy and electricity-generation sectors collectively account for 43.6% of the ETS market's total quota, and thus, the Korean ETS' effectiveness should be based on that of the coal-fueled power industry (Choi and Qi, 2019).

Korea is the 11th largest economy worldwide and consumed approximately 2.2% of the world's total primary energy in 2017, making it the eighth-largest global energy consumer. Moreover, Korea accounted for 2.3% of global coal consumption in 2017, or sixth worldwide (Choi and Qi, 2019). To shoulder more of its various responsibilities — from curtailing global carbon emissions to relieving burdens on the domestic environment — the Korean government established its "low carbon-green growth" national carbon reduction policy in 2009, then passed a law mandating decreased national CO2 emissions by 37% below BAU levels by 2030 (Choi and Qi, 2019).

The Korean government should strengthen its regulations to more effectively implement a green economy. Policymakers could impose a carbon tax; substantially decrease the carbon emissions-free quota; and provide more incentives, especially to the energy-intensive, resource-saving, coal-fueled power plants.

CONCLUSION

This paper highlighted a conundrum that South Korea faces. The success of the government-backed economic programs, which emphasized investments in manufacturing export goods, was successful in creating a positive balance of trade, which accrued to the average worker as measured by significant increases in the per capita GDP. Companies that are selling goods at a profit want to produce more, which leads to an increase in industry-related air pollution. Workers with higher wages can afford to keep the heat on in their residences, which leads to an increase in CO2 emissions. And a stronger economy means more cars and trucks on the road, which also leads to an increase in air pollution.

In 2019, only four years after the signing of the Paris Agreement, South Korea experienced a "national emergency" because of persistent air pollution. The National Legislature took action in the Spring, but it's too early to judge the policy effectively. It is hard for observers who have studied the issue of South Korea to be optimistic at this time that the country can reduce its CO2 emissions by 37% in 11 years.

In a decade in which climate change is receiving more attention than ever, days with gray skies and complacent mask-wearing cannot become the norm. Students stuck inside and unable to play for fear of harmful particles in the air should not be normalized. Rather, one should feel safe on any day, when performing the most fundamentally human act of breathing. Students should be able to walk under a bright blue sky in a clean atmosphere without worrying about the air quality, worrying instead about friends or tests or what to eat for dinner. This is the future South Korea must envision.

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