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ABSTRACT

Studying Economic Black Holes: Lessons from North Korea*

Some economies are "black holes" where reliable data is scarce due to government control, low capacity, or conflict. Despite these challenges, researchers have found ways to gather useful information. This paper draws on the literature on North Korea to review six key methods: satellite imagery, reports from aid agencies, trade data, prices, refugee surveys, and official documents. These sources are imperfect, and require close attention to research design and measurement error. Nonetheless, they demonstrate that it is possible to extract information from economic black holes and to draw meaningful insights about them.

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1. Introduction

Economists frequently face the problem of how to study jurisdictions on which data are scarce or even non-existent, up to and including entire countries. These problems may arise for at least three reasons. The first is closely correlated with the level of income, but may be exacerbated by terrain. The government in question—whether national or subnational—simply does not have the state capacity to collect reliable data, compounded in some cases by the remoteness of territory nominally under state control. This is the well-known problem of missingness which long plagued cross-national observational studies of development but clearly has wider implications, including for policymaking.

Political as well as economic circumstances might aggravate this problem, however. Insurgencies and civil wars remain a persistent problem in a number of low-income countries and conflict zones can also become economic black holes. Even the most intrepid humanitarian officials have little prospect of securing reliable information either from governments or their own research--for example from surveys or monitoring missions--in the face of war or civil war.

Finally, there is an emerging literature on how regime type might influence the veracity of information. Authoritarian regimes control data for a variety of political reasons. Dictators may want to inflate some indicators, for example, growth rates (e.g., Martinez, 2022) and to suppress other information, from the level of unemployment to caloric consumption or health outcomes. Hollyer, Rosendorff and Vreeland (2011), for example, find that democracies are more transparent than autocracies, controlling for level of income, country-fixed effects and time trends.

We use North Korea as an entry point to discuss these issues. North Korea is a low-income country, but does not face domestic political and social unrest and has a surprisingly capable of controlling state. But it is notoriously closed and has treated even the most basic economic data as state secrets.

While North Korea does publish some economic statistics, their scope and reliability are very limited. The national budget is one of the few regular releases, and more recently, the government submitted a Voluntary National Review (VNR) to the United Nations in 2021 (DPRK, 2021), which included high-level indicators such as GDP per capita and maternal

mortality rates. Yet these data points raise more questions than they answer. There is no transparency about how they are collected or sampled, and North Korea operates outside the system of international economic organizations that normally enforce standards through technical assistance and peer review. Much of the available data is episodic and framed in ways that limit its analytical value. In authoritarian regimes, the choice of what to report is itself political, often designed to suppress indicators that might reflect poorly on the regime. North Korea is no exception, and the result is a statistical landscape that is flawed, partial, and strategically curated.

Nonetheless, in part for policy reasons, North Korea has attracted a significant coterie of researchers determined to extract usable data from the country. Some of these do involve exploiting the government's willingness to allow outside data collection of some sorts even if other sources of information are partially or completely blocked. For example, the UN Office for the Coordination of Humanitarian Affairs and other specialized UN agencies have periodically gained access to and run projects in North Korea and otherwise closed countries.

Yet other sources involve what might be called "data leakage": channels through which information becomes available to outside researchers despite efforts on the part of the government to control its collection and dissemination. This data is almost by definition imperfect, in part because of the difficulty of correlating across indicators. Moreover, some of these forms of data leakage are vulnerable to selection problems.

However, something is better than nothing and we will show that researchers have managed to extract descriptive information and even draw causal inferences about economic black holes such as North Korea. The approaches we survey align with the concept of "forensic economics," which aims to uncover concealed behaviors, usually using data to test null hypotheses derived from economic theory (Zitzewitz, 2012). Our work provides a typology— not necessarily mutually exclusive or exhaustive—of these "forensic economics" techniques.

We focus on six sources of information: (i) data derived from remote sensing using satellites, (ii) information gleaned from periodic access by humanitarian agencies, (iii) "mirror statistics" trade and aid data which relies on foreign partners rather than the government, (iv) information on prices collected surreptitiously, (v) information and data generated by refugee surveys and interviews, and (vi) creative use of official documents that unintentionally provide information that the government might actually seek to control. For each of these

sources, we survey how it is collected in principle and provide concrete examples of how it has been put to use in the North Korean case, both descriptively and for the inferences that have been drawn from it. Although focusing on North Korean examples, our objective is wider: to foster research on the sources and methods for attacking the problem of economic black holes.

2. How to explore economic black holes

(1) Remote sensing using satellites

A novel approach to extracting economic information from data-scarce regions challenges the conventional 'black hole' metaphor. We can in fact use information from satellites for a variety of purposes, including as an innovative proxy to estimate economic activity. Since the data collected by satellites is observed directly by sensors, it avoids bias that arises from the way data is collected authoritarian contexts, in the presence of violence or where state capacity is low. An additional advantage of satellite-based data is that it can be monitored at more granular scales, including provinces, counties, and even villages; it thus lends itself to spatial analysis of economic activity.

Satellite data can be broadly classified into daytime imagery, which produces visual representations similar to direct human observation, and specialized remote sensing data, which includes data on environmental and ecological factors such as precipitation, air pollutants, the nature of land cover and other environmental factors. This latter category of data is more promising for economic purposes and we explore the example of the growing use of night lights as a proxy for economic activity.

Daytime imagery from satellites is primarily used to detect and analyze specific changes in the observed environment and much of it has developed around open-source intelligence analysis that is complementary to classified satellite imagery. For example, C4ADS[5], Beyond

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5 At https://c4ads.org/north-korea/

Parallel[6], and 38 North[7] utilize high-resolution satellite imagery to monitor North Korea's nuclear facilities, missile launch sites, military bases, and other related military activities. Additionally, they track port and vessel movements via satellite imagery, providing critical evidence of North Korea's sanctions evasion and arms trafficking activities. In some cases, the fact that satellite imagery is recurring means that some of this data can be used to generate descriptive time series, for example on the number of rail cars moving between North Korea and Russia or other economically relevant information such as the number and even location of markets (Cha and Collins 2018).

Although daytime imagery contains a wealth of information, it is generally challenging to utilize as structured data and it is often more akin to qualitative intelligence or the type of information that would be contained in a case study. However, Lee, Suh, Kim, and Baek (2024) have used daytime satellite imagery to identify the location and characteristics of economically disadvantaged urban areas in Pyongyang. Ahn et al. (2023) applied a machine learning approach to transform daytime satellite imagery into quantitative indicators of changes in the city's economic activity over time. Their findings revealed that the North Korean capital, along with regions undergoing development projects initiated by the North Korean authorities, had experienced notable economic growth.

Compared to qualitative data derived from daytime imagery, nighttime lights have become an important source that can be easily converted into quantitative form and systematically structured for economic analysis in regions lacking reliable data. Night lights data has been consistently recorded since the 1990s and has now been widely used in development research (Hodler and Raschky, 2014; Storeygard, 2016; Michalopoulos and Papaioannou, 2014; Henderson, Storeygard, and Weil, 2012; Pinkovskiy and Sala-i-Martin, 2016).[8] Two sources have been used most frequently: from the Defense Meteorological Satellite Program (DMSP) and from the Visible Infrared Imaging Radiometer Suite (VIIRS). The two cover different time periods. DMSP data is available on an annual basis from 1992 to 2013 but was

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[6] At https://beyondparallel.csis.org/

[7] At https://www.38north.org/

[8] For more information, see the review studies: Donaldson and Storeygard (2016) and Gibson, Olivia, and Boe-Gibson (2020).

discontinued due to changes in the satellite orbit and technical constraints on its quality.[9] The VIIRS data addressed these limitations, and the dataset is available on an annual, monthly and even daily basis from 2012 to the present.

Night lights have been used to estimate the size of North Korea's economy and growth trends (Kim, 2022b) as well as to estimate regional economic disparities (Kim, 2022a).[10] Two studies—one on growth, the other on regional disparity—demonstrate the diverse uses to which night-time lights data can be used.

In the absence of official economic statistics from North Korea, the Bank of Korea, South Korea's central bank, has estimated North Korea's GDP and economic growth rates for each year since 1991. Its efforts to do so reflect clearly the difficulties of relying on official information from black hole jurisdictions and resultant bias. The core of the BOK approach is to gather the types of quantity data favored by a state-socialist economy—tons of steel, kilos of rice—supplemented by intelligence gathered by the country's National Intelligence Service. Quantities are then converted to values using the value-added weights of the South Korean system of national accounts. The disabilities of the official data are clear, for example in the inability to capture the service and informal sectors, and critics have noted the divergence between BOK estimates and other information such testimonies from North Korean defectors and the nutritional status of North Korean children as documented by international organizations.

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[9] First, it suffers from light saturation due to its low brightness threshold, which makes it difficult to distinguish levels of beyond a certain level. Additionally, the data is affected by light smearing, which can distort the accuracy of light measurements.

[10] Beyond academic research, NASA's 2014 photo, *The Koreas at Night* (NASA, 2014), has gained widespread recognition for vividly illustrating the stark contrast between North and South Korea.

Figure 1. North Korea's GDP per capita estimated by BOK and night-time light
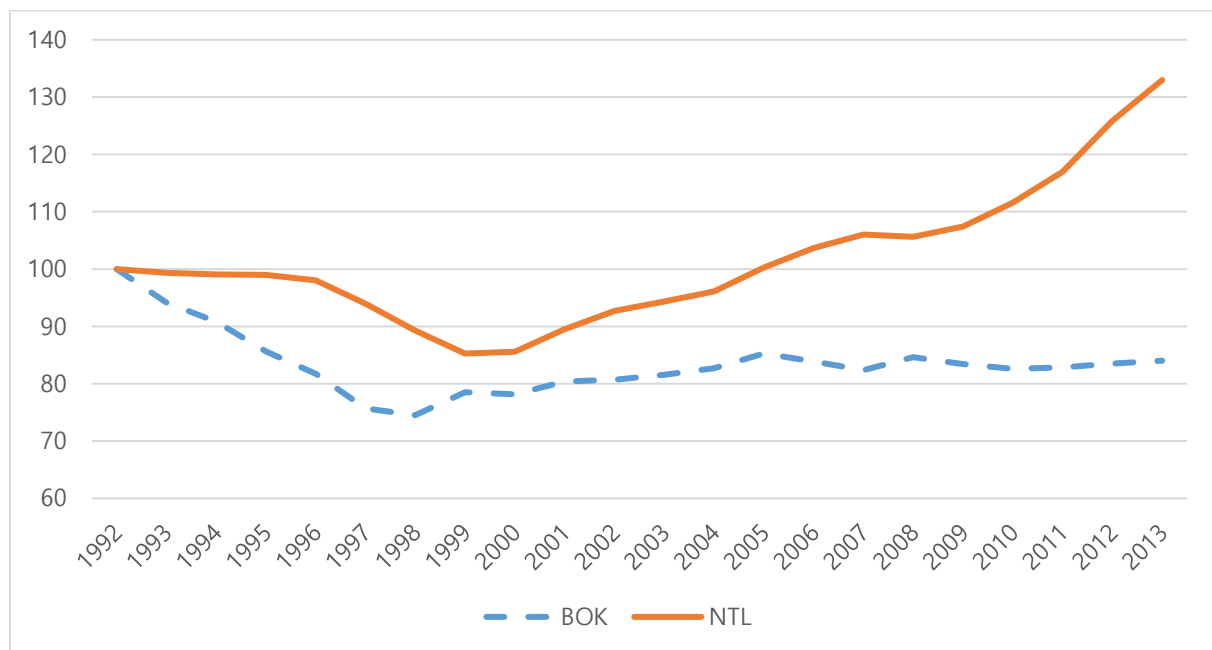
Note: Value of 1992 is indexed to 100.

Source: Bank of Korea and Defense Meteorological Satellite Program

Kim (2022b) used DMSP to construct an alternative time series for the 1992 to 2013 period. The alternative estimates diverge significantly from the BOK estimates. Figure 1 illustrates the trend of North Korea's GDP per capita, as estimated by the Bank of Korea and night-time light. Both estimates show a decline through the late 1990s—the period of the great famine and its immediate aftermath— although the timing differs. However, since 2000, the Bank of Korea's estimate has remained stagnant, whereas the night lights-based estimate indicates an upward trend. The discrepancy between the two estimates has widened since the mid-to-late 2000s, coinciding with the expansion of North Korea's informal sector.

A second innovative use of night lights is to focus on how their higher frequency and spatial elements can be used to add value. Kim (2022a), for example, has examined regional disparities in North Korea by taking advantage of night-time lights to combine geographic information for spatial analysis. She found that Sinuiju, a key trading hub with China, exhibits economic activity comparable to that of Pyongyang. In contrast, the border region with South Korea, following the severance of ties, has experienced a significant decline in economic activity.

Kim, Kim, Park, and Sun (2023) adopt a similar approach to estimate the effects of sanctions on North Korea. The country has fallen under a complex sanctions regime for decades. But their effectiveness continues to be a subject of debate because of the ability of the regime to circumvent them, both by finding alternative trading partners, engaging in illicit activities that are difficult to track (Haggard and Noland 2017) or engaging in import substitution. Kim, Kim, Park, and Sun (2023) focused their analysis on a compressed time period between 2016 and 2017, when China conceded to more forceful multilateral sanctions through the UN Security Council. The study combines quarterly nighttime light data (VIIRS), used as a proxy for manufacturing production activity at the county level, with detailed North Korean trade data constructed by UN Comtrade and North Korean company data.[11] The analysis revealed that regions with a high concentration of industries affected by trade sanctions experienced a more substantial decrease in nighttime light compared to other regions, indicating that the sanctions had a significant impact. For example, they find that Pihyeon County in North Pyongan Province experienced the sharpest decline in nightlights over the time period; the region primarily hosts garment factories and petrochemical plants, both of which are subject to sanction restrictions. In contrast, Yangdeok County in South Pyongan Province, experienced the least impact from the sanctions, with firms specializing in furniture manufacturing, lumber processing, and food production. Related work by Chor and Li (2024) has estimated the impact of the US-China tariff war in China with the same dataset, and the extensions to the effects of other types of shocks on the North Korean economy are clear.

Up until recently, analyzing nighttime lights required technical expertise that was specific to the particular nature of the data. More recently, researchers and policymakers have been able to draw on local GDP estimates from Rossi-Hansberg and Zhang (2025) instead of directly working with VIIRS data. These estimates are derived from the VIIRS data, available globally at a 1-degree resolution for 2012–2021, and are combined with population and emissions data. The data set not only covers multiple regions in North Korea but other problematic jurisdictions as well.[12]

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[11] North Korean company data organizes the location (county), industry classification, and frequency of mentions of companies in North Korea's official newspapers, the *Rodong Sinmun* and *Minju Chosun*.

[12] All data are accessible for download at http://bfidatastudio.org/gdp.

The use of night-time lights is not without its challenges, some of which are particular to the very type of political and economic systems characteristic of black holes. Nighttime light—as the name implies--measures economic activity at night, which may lead to an underestimation of agricultural activity which occurs during daylight hours and is not typically lit (Mellander, Lobo, Stolarick, and Matheson, 2015). Moreover, while North Korea strictly rations electricity use, it invests heavily in highlighting prestige projects, monuments and statues which may have little or no economic value. Nonetheless, the use of satellite imagery for the purposes of both macro and microeconomic analysis of black holes has by no means been exhausted. It can be of use not only in closed countries but in regions where data is limited because state capacity, remoteness and other political constraints on data collection such as civil war.

While nighttime light has been extensively used in development economics research to measure aggregate economic activity, satellites are also capable of capturing a variety of other economic variables that might be of interest to agricultural or environmental economists: precipitation, land cover, and air pollutants among others. The U.S. Department of Agriculture has long estimated North Korea's food production by utilizing satellite data. Keola, Andersson, and Hall (2015) used nighttime lights combined with land cover data to estimate growth in the agriculture and forestry sectors. Kim, Kim, Han, and Lee (2022) analyzed the impact of extreme weather on agricultural productivity in North Korea by using a precipitation and vegetation index constructed from satellite data, with crop growth used as a proxy for agricultural productivity. Nam (2024) constructed nitrogen dioxide concentration data for major regions in North Korea and explored the potential and limitations of using this data as an economic indicator. More broadly, Hayakawa and Keola (2021) examined the economic recovery of Asian countries following the Covid-19 pandemic by analyzing the collapse and return of air pollutants as an indicator.

In addition to their primary applications, satellite outputs are gaining increasing attention from researchers due to their potential as proxies for economic activity and performance. However, just like nighttime light, other satellite data needs to be converted into structured data, a process that is likely to be accelerated by the use of AI tools.

(2) Aid, humanitarian agencies and access

There is now evidence that authoritarian regimes are less transparent than their more democratic counterparts and that the attendant missingness of data can skew cross-national findings, for example on health outcomes (Ross, 2006). A number of international organizations, including the international financial institutions, as well as national aid agencies and NGOs require recipients to standardize the provision of economic and other information or comply with reporting requirements; where appropriate, technical support is provided to assist them in doing so. Such information is of particular importance in the provision of development and humanitarian assistance, where information on projects and target populations is a requisite for the efficient use of funds and appropriate targeting.

There is now an ample literature on the challenges external actors have faced in providing aid to North Korea (Smith and Lee, 2023; Zadeh-Cummings and Harris, 2020; Haggard and Noland, 2017; Kim, 2014). However, there are circumstances under which black hole jurisdictions are constrained to comply with data collection requirements in order to access external aid because aid is made conditional on such requirements. In effect, we can informally model data collection by outside actors as reflecting a bargaining game, in which the outside actors are seeking to maximize collection of data needed for assuring their compliance with humanitarian norms while the black hole jurisdiction has political, financial or ideological motives to restrict information flows. In some cases, negotiations break down altogether, in which case both food aid and the collection of information can slow or cease altogether.

The catastrophic famine of the mid-to-late 1990s in North Korea—which resulted in the deaths of hundreds of thousands of citizens—provided an opening for outside agencies (Haggard and Noland, 2007). This pivotal crisis enabled the international community to insist on collecting and analyzing pertinent data and in some narrowly defined range of activities established cooperative relationships between foreign and domestic specialists, for example in agriculture and public health. Ironically, such cooperation was possible in part because the regime was assured it could control the dissemination of such information domestically: that information casting a poor light on regime governance would not see the light of day among its subject population.

Evidence of these tussles over information can be found in the provision of development assistance, but is visible in humanitarian aid as well. In jurisdictions facing extreme distress, whether climatic or man-made as in the case of civil war, the international community has quite naturally focused on providing the basics: food and nutrition and health care. Such aid often takes the form of in-kind assistance because of skepticism about the diversion of funds if aid is provided in financial form; corruption and violation of humanitarian norms is a constant threat. However, the provision of in-kind assistance--food aid, medical supplies, including vaccines, and technological support to enhance health systems--faces similar risk. In North Korea and other black hole jurisdictions, aid providers continually face problems of diversion of assistance for political ends and violations of targeting norms.

When openings occur, however, health, nutrition, and food data collected by international organizations have the advantage of being directly measured, rather than based on estimates. When cooperative arrangements are forged, data collection can be institutionalized and regularly updated, enabling the analysis of long-term trends and providing valuable insights into structural changes over time. Furthermore, international organizations collect data using standardized survey methodologies and criteria, ensuring consistency and comparability across countries. This approach facilitates international comparisons and enhances the reliability of cross-national analyses.

Child nutrition and crop/food security provide examples of how such data can be exploited for purposes that reach beyond the interests of the donors narrowly conceived. Between 1998 and 2017, WFP and UNICEF conducted seven irregular surveys on child nutrition in North Korea. Figure 2 presents the trends in child nutrition in North Korea. From 1998 to 2017, the nutritional status of North Korean children showed signs of improvement. The data has been utilized in various studies that have examined child nutrition in North Korea (Katona-Apte and Mokdad, 1998; Lee, 2017), assessed North Korean living standards in comparison to those of other countries (Smith, 2016; Wee, 2016; Hong, 2018), analyzed differences in infant and child nutrition between South Korea and North Korea (Nam, Yoon, and Lee, 2021), and compared the nutritional status of North Korean children with those of defectors resettled in South Korea (Choi, 2021).

Figure 2. Nutritional Status of children in North Korea (%)
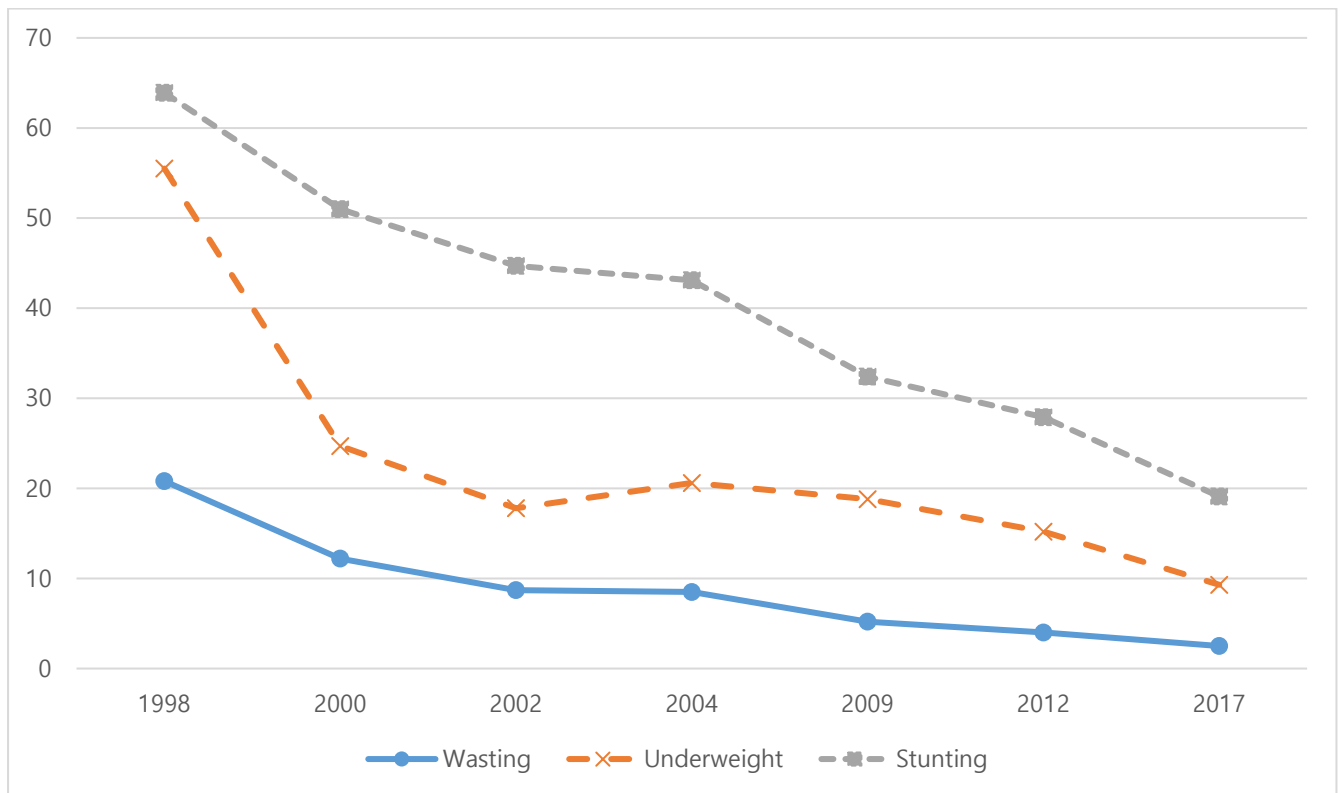
Note: Share of children who suffer from wasting, underweight, and stunting in North Korea. Wasting is defined as low weight-for-height, and it indicates recent and severe weight loss. Underweight is defined as low weight-for-age. Stunting is defined as low height-for-age, and it occurs due to chronic malnutrition.

Source: DPRK & UNICEF, "Report on the Nutrition Survey of the Democratic People's Republic of Korea," Pyongyang, 1998, 2012; "The Multiple Indicator Cluster Survey in the Democratic People's Republic of Korea" 2000, 2010, 2017; "Report on the DPRK Nutrition Assessment" Pyongyang, 2003, 2005.
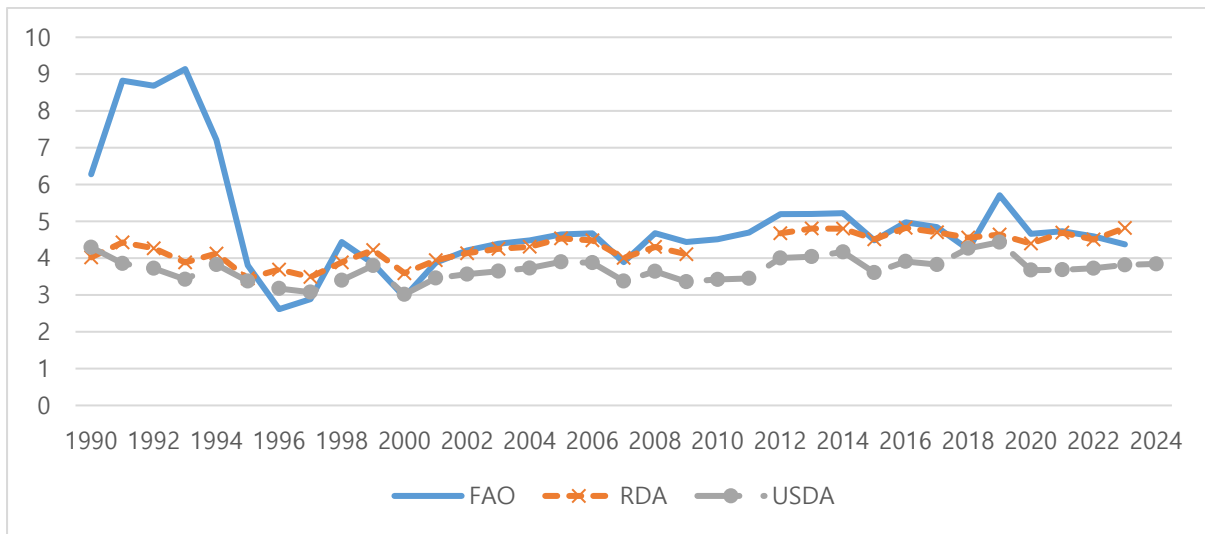
Such information can at least be put to comparative descriptive purposes. For example, Smith (2016) conducted an international comparison using low-income countries with similar income levels to North Korea as a reference group. During the 1990s famine, not surprisingly, North Korea exhibited worse nutritional status compared to these low-income countries. However, over time, it rapidly improved and, by the late 2000s, had surpassed the nutritional levels of many low-income countries. This trend suggests that the health and nutritional status of North Korean children may not be as dire as reported by the UN Human Rights Committee in 2014. Hong (2018) used similar comparisons to speculate on the possible sources of the improvement in infant and child nutrition, from improvement in agricultural output to improvements in allocative efficiency resulting from increased marketization to social factors, such as a predominantly socialist system.

Crop production is another crucial variable that international organizations have periodically been able to access through direct contact with officials in the Ministry of Agriculture, supplemented by satellite imagery. The FAO's data on North Korea's agriculture primarily relies on information provided by North Korean authorities. However, the organization has also established joint research teams with North Korean officials to conduct field visits and collect samples from cooperative farms. Initially, the survey was conducted within a limited geographic area (province, county); however, over time, its scope expanded to cover most of North Korea, accompanied by an increasing number of survey samples before access became more restrictive.[13] In addition, as noted the FAO incorporates satellite observations of climate and geographic features, such as precipitation, into their models to enhance the accuracy of its assessments. South Korea's Rural Development Agency has taken an innovative approach to estimating agricultural output by combining information from pilot farming trials in environments similar to North Korea's and triangulating findings with information provided by satellites, for example on precipitation.

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[13] FAO's field visits have the potential to be linked to field experiments in development studies, which assess the impact of specific policies or programs on economic and social outcomes in developing countries (Levitt and List, 2009). Interventions, such as agricultural technical assistance, which vary by region, could be used to establish treatment and control groups, thereby enabling an analysis of the impact of these technologies on grain yield.

Figure 3. North Korea's Total Crop Production

Unit: million tons

Source: FAO (https://www.fao.org/faostat/en/#data), RDA (https://kosis.kr/bukhan/), USDA (https://apps.fas.usda.gov/PSDOnline/app/index.html#/app/downloads)

It is important to underline that these statistical partnerships are fragile and prone to measurement error. Figure 3 presents the estimated trends in North Korea's grain production from 1990 to recent years, based on data from the FAO, RDA, and USDA. Estimates of North Korea's grain production vary by organization and in some cases quite significantly. In 2023, the FAO estimated production at 4.38 million tons, the RDA at 4.82 million tons, and the USDA at only 3.82 million tons. The reasons can be found in the fact that each organization's figures are derived using different methodologies and criteria (Kim, 2021). First, the types of grains included in the estimates vary across organizations.[14] Second, the reference years used by different organizations vary.[15] Third, organizations apply different

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[14] The FAO defines crops as including barley, maize, millet, oats, rice, rye, sorghum, and wheat. The RDA classifies crops more broadly, encompassing rice, corn, malt (barley, rye, oats), pulses (beans, red beans), sweet potatoes, potatoes, and miscellaneous grains. In contrast, the USDA estimates North Korea's grain production based on a narrower selection, including only rice, corn, and wheat.

[15] The FAO and USDA estimate annual production based on the crop year or market year, which corresponds to the planting and harvesting periods for each grain, encompassing production from the fall of the given year and the spring of the following year. In contrast, the

criteria when assessing the harvest status of grain.[16] As a result, outside researchers have periodically revised these official estimates (for example Haggard and Noland, 2009 and Noland 2024 on the FAO's food balances).

Nonetheless, these estimates of North Korea's grain production by external organizations, including the FAO, have served as a key basis for assessing the country's food security and generated productive debates. While food shortages are often cited as the primary cause of the famine in North Korea during the mid-to-late 1990s, the collapse of the food rationing system and limited access to food for the population were also significant contributing factors. Lee (2003) analyzes North Korea's total grain supply statistics and identifies the primary cause of the 1990s famine as a decline in food availability. Haggard and Noland (2007, 2009) by contrast used revised FAO crop reports and information on rations delivered by the Public Distribution System to suggest significant regional variation, which they interpret as signaling inaccessibility—partly political—as a cause of the famine.

In sum, the political economy of aid can open windows of outside access to data but such sources of data are inherently vulnerable. Since the onset of the COVID-19 pandemic in 2020, North Korean authorities closed the country's borders, halting the activities of international organizations. As a result, there is limited understanding of the post-pandemic situation, and investigations have yet to resume. Yet even when access is granted, data derived in this fashion is challenging. Despite negotiated agreements, black hole jurisdictions may still be able to skirt transparency in part where pecuniary motives such as diversion are in play (Haggard and Noland, 2007). In some cases, restrictions on access to data are geographic. Food aid negotiations with North Korea in the wake of the famine, for example, frequently stumbled on lack of access to particular provinces. These restrictions can quite obviously bias results, including with respect to surveys. In other cases, restrictions are functional. For example, North Korea has long resisted the collection of data on prices (see

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RDA estimates production based on the calendar year (January to December), leading to potential discrepancies among agency estimates.

[16] Grain is classified into coarse grain at harvest and polished grain after de-hulling, with weight loss occurring during processing. This weight reduction is quantified by the 'milling rate.' The FAO reports North Korea's rice production in terms of coarse rice, whereas the RDA and USDA report it in terms of polished rice. However, their conversion rates differ, with the RDA using 72% and the USDA using 65%.

below) or access to the informal markets that are believed to account for a significant share of output, as our discussion of night lights showed.

(3) Trade

The expectation that authoritarian regimes conceal information extends to all aspects of the foreign sector: trade, investment and financial flows and aid. North Korea, again, is extreme in treating all trade data as a state secret. But North Korea is not alone, and a number of countries—even significant ones— do not publish reliable trade statistics or omit information on trade in sensitive commodities or with certain partners.

However, economic black holes cannot completely conceal foreign transactions because they are captured in the official trade statistics of their trading partners: Chinese exports to North Korea are imports from China from North Korea's perspective and vice versa. As a result, it is possible to put together "mirror statistics" of any given country's trade with the rest of the world and this has long been a source of information on North Korea (Chung, 1974; Choi, 1991; Eberstadt, 1998; Haggard and Noland, 2017). These techniques have recently been used with respect to Russia as well as the quality of its data deteriorates (Borin et al. 2023). The construction of mirror statistics can serve a variety of analytic purposes, from the simple estimation of both the magnitude and direction of trade to more targeted topics such as the quality of exports and the effects of shocks—both natural and policy-induced--on a country's external economic relations.

Figure 4 provides an example, presenting North Korea's exports and imports from 2010 to 2022 using mirror statistics. In addition to providing an estimate of the current account deficit, simple description suggests the powerful impact of both UN Security Council sanctions and the COVID-19 border closure on trade volumes.

Figure 4. North Korea's trade

unit: billions USD
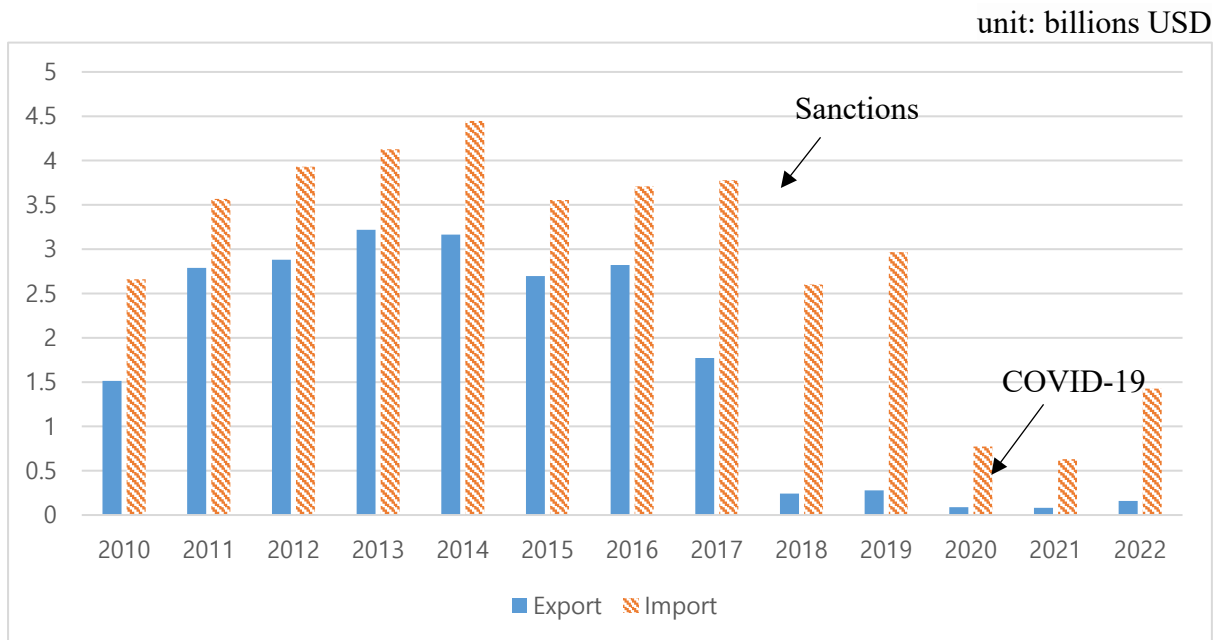
Note: The figure shows total exports and imports of North Korea, put together as "mirror statistics." Top three trading partners in 2010 were China (83.0%), Russia (2.7%), and Germany (1.4%). Top three trading partners in 2022 were China (96.7%), Vietnam (1.0%), and Argentina (0.8%).

Source: Authors' calculation with KOTRA (Korea Trade Promotion Corporation) data

The most commonly used sources for analyzing North Korea's trade include UN Comtrade, ultimately derived from the official customs statistics from individual countries, as well as specialized Korean agencies such as KOTRA which produces annual reports on the topic.[17] An important general point to note is that the quality of trade data varies across the underlying sources. Iran, for example, also does not produce trade statistics and there are increasing doubts about the veracity of some Chinese data. The community of North Korea watchers has also found errors such as the confusion of the Republic of Korea and the Democratic People's Republic of Korea in reporting countries. As a result, there is missingness and potential bias. Nonetheless, mirror statistics reflect one way to get meaningful economic data from black hole jurisdictions.

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[17] KOTRA (Korea Trade-Investment Promotion Agency)'s 'North Korea's Foreign Trade'

UN Comtrade provides annual data on trade by country and commodity at the 6-digit HS code level, offering a comprehensive overview of North Korea's trade patterns. KOTRA's trade data is regarded as more reliable because it involves a thorough review of the mirror data and corrections and revisions where appropriate. However, KOTRA only provides data at the 2-digit HS code level, which prevents detailed analysis of specific items. In some cases, analysts will be interested in particular dyadic relationships, and can go directly to national statistics. In the case of North Korea, official statistics from South Korean and Chinese customs have been used to understand North Korea's trade with South Korea[18] and particularly China, which accounts for the overwhelming majority of North Korea's commerce. South Korean and Chinese customs statistics are available at the 8-digit HS code level on a monthly basis and are typically released within a month, making them a valuable and timely source for monitoring North Korea's economic situation.

Various analyses of the North Korean economy have been conducted using trade data based on mirror statistics, starting with efforts to simply describe trends. North Korea is often described with the cliché of "hermit kingdom": an essentially closed economy. In policy terms that may be true: trade and investment are tightly controlled. However, Kim (2017a) used trade data to assess these claims and reached the conclusion that it should be classified as an open economy. He assesses that North Korea's trade has grown significantly since the mid-2000s, with its trade dependence (total trade as a percentage of GDP) reaching 50 percent in the early to mid-2010s before falling dramatically in the wake of sanctions and border closing. Moreover, if informal trade, such as smuggling, were accounted for, North Korea's trade dependence would have exceeded the global average; we come back to this as a measurement issue below.

Several studies have examined the factors contributing to the significant increase in foreign trade from around 2000 through the mid-2010's, including China's economic growth (Lee, 2010; Kim, 2013), the commodity boom of the period (Lee, 2010; Kim, 2013; Haggard and Noland, 2017), and political and security factors (Yang and Ha, 2012), including diplomatic initiatives on the part of China to re-establish political relations after a period of political

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[18] While the unique relationship between South Korea and North Korea, shaped by their unification aspirations, differs from typical international trade dynamics, it is still possible to gain insights into North Korea's trade through South Korea's trade data with the country.

tension (Reilly 2014). Similarly, and as noted in Figure 4, studies have noted the apparent effect of sanctions and the COVID border closure on the contraction of trade thereafter. Descriptive studies have also examined trade in particular commodities of interest, such as North Korea's anthracite coal exports, which have been the country's largest export since the late 2000s (Bae, 2011; Lee, 2015; Kim, 2017b), as well as oil trade between North Korea and China using both official and unofficial trade data (Kim, 2018; Kim, 2020).

South Korean research institutes, including KDI, have conducted annual assessments and forecasts of the North Korean economy based on mirror statistics trade data.[19] Using customs statistics from North Korea's major trading partners, China and Russia, KDI analyzes annual trade volumes, trade deficits, traded goods, and their changes over time, along with their implications. Specifically, KDI has assessed compliance with the sanctions, the impact of the COVID-19 pandemic on North Korea's trade, and identified new export products developed to circumvent sanctions. Additionally, KDI evaluates North Korea's trade over the past year by examining the authorities' intentions, including trade law changes and reports from inside the country.

Studies of trade have been used for wider purposes, though. The composition of imports and exports can provide further information on economic structure that would otherwise be unavailable. For example, Hausmann, Hwang, and Rodrik (2007) have proposed the idea that the quality of exports is a key determinant of long-term economic growth and advanced techniques for constructing measures of export quality. Kim (2018) has applied such an approach to North Korea's exports by tracking changes in export items. As shown in Figure 5, the trend in the quality of Vietnam's exported goods, measured in terms of human capital inputs, contrasts with that of North Korea. Vietnam's exports have gradually shifted towards higher-quality goods, from rice and coffee to apparel and then electronics. In contrast, as diplomatic and military conflicts severed trade ties with Japan and South Korea in the late 2000s, North Korea expanded its trade with China, where economic growth fueled demand for fossil fuels. Consequently, North Korea's anthracite coal exports surged, leading to a

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[19] Each January issue of the *KDI Review of the North Korean Economy* offers an assessment and outlook on the North Korean economy across various sectors, including macroeconomics, trade, market prices, agriculture, and industry. See https://www.kdi.re.kr/eng/research/monNorth

sharp increase in export volume but a decline in overall export quality. This suggests that North Korea's heavy dependence on anthracite coal exports to China and reliance on other commodities could dampen long-run growth.

Figure 5. Trade quality (Human capital input factors) comparison in export: North Korea vs. Vietnam

Unit: No of years in school, year
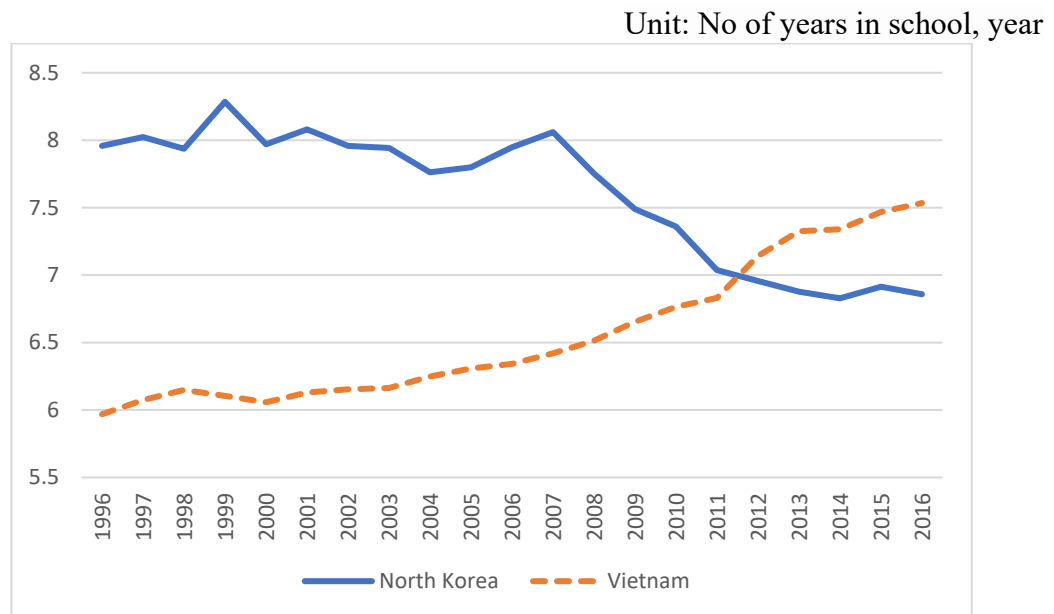
Note: The trade quality for North Korea and Vietnam was calculated as a weighted average, where the value of exports for each commodity was multiplied by the corresponding human capital input factor. The accumulation of human capital is a crucial driver of economic growth, as evidenced both theoretically and empirically. Therefore, the average trend in human capital input used for export items offers valuable insight into not only the quality of exports but also the long-term sustainability of its economic growth.

Source: Kim (2018)

The weakness of mirror trade statistics is that partner countries may intentionally under-report or make errors in their reporting. One of the most notable examples is the crude oil trade between North Korea and China. Prior to 2013, exports of crude oil to North Korea were reflected in China's official trade statistics. However, since 2014, these exports have

been excluded from the official records.[20] Figure 6 compares North Korea's imports from China as reported by China Customs and KOTRA, respectively. Assuming that North Korea continues to import crude oil from China, KOTRA estimates the total import value by multiplying the assumed annual import volume of approximately 520,000 tons by the international crude oil price for that year. This is the difference between the values published by the two organizations shown in Figure 6. Additionally, because mirror statistics rely on the 'official' trade data of partner countries, they fail to account for informal trade activities, such as smuggling. This is a crucial point to consider, as informal trade is likely to be a significant factor in countries subjected to trade sanctions, such as North Korea or other jurisdictions where data collection, including through customs, is weak or compromised by corruption.

Figure 6. North Korea's imports from China: Chinese Custom vs. KOTRA

Unit: thousand USD

Source: Chinese Custom (http://english.customs.gov.cn/), KOTRA(https://kosis.kr/bukhan/)
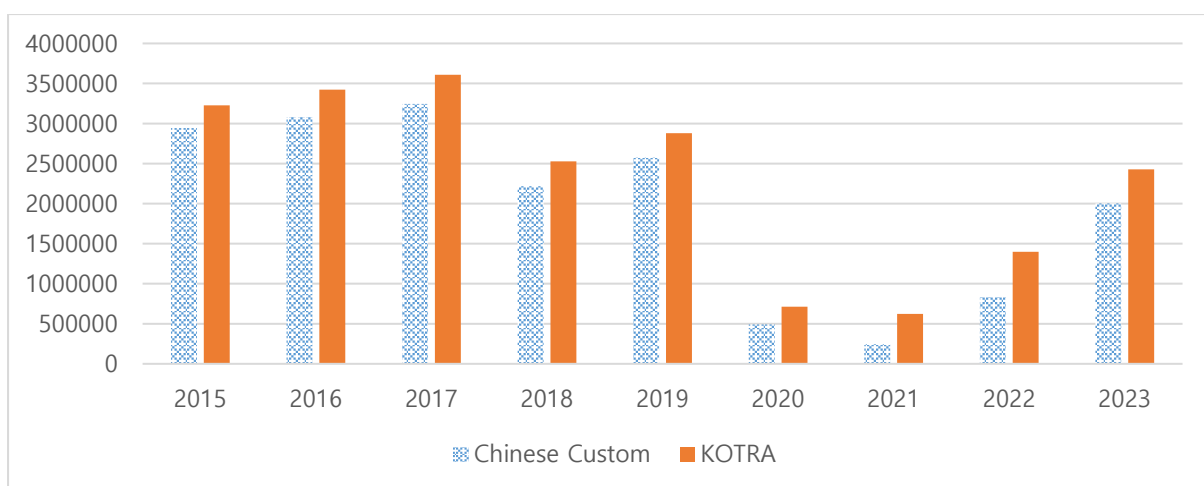
To address these gaps, think tanks, consulting firms, and media outlets have developed open-source intelligence networks that track trade and investment through other sources of external

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[20] Even after 2014, it remained widely understood that China continued to supply crude oil to North Korea. In 2018, when the United Nations Security Council proposed sanctions aimed at restricting oil shipments to North Korea, China formally acknowledged its ongoing provision of crude oil to the country.

data that nonetheless reflect the logic of mirror statistics: using external sources of information that nonetheless reflect real transactions with the jurisdiction in question. These include ship-tracking databases and corporate records (for example, Boling et. al., 2021). Forensic analyses using these methods have uncovered large-scale oil smuggling by North Korea, with volumes significantly exceeding both officially recorded trade figures and the limits imposed by multilateral sanctions (Haggard & Beu, 2021).

Recent geopolitical developments further complicate trade monitoring. In March 2024, a Russian veto blocked the extension of the UN Security Council's Panel of Experts on North Korea Sanctions, raising concerns about weakening enforcement mechanisms. Meanwhile, the post-pandemic reopening has facilitated increased smuggling between North Korea and China, and growing North Korea-Russia ties amid the Russia-Ukraine war suggest that sanctions are becoming increasingly ineffective. These developments underscore the need for alternative methods to assess trade activities beyond official statistics.

(4) Prices

Markets played a limited role in the socialist rationing economy. However, following the collapse of the rationing system due to a famine in the mid-to-late 1990s, North Koreans increasingly relied on markets for survival. According to several studies (Kim and Song, 2008; Kim, 2017a), approximately 70% of North Korean household income is derived from market activities, indicating that markets constitute a crucial component of North Koreans' livelihoods. Since Kim Jong Un's rise to power, North Korean authorities have formally recognized official markets and imposed taxes on them. As a result, understanding the prices of goods transacted in the North Korean market became essential for analyzing the country's economic situation.

North Korea does not publish an official price index. Gathering pricing information from within North Korea requires the transfer of individuals or data across the country's borders, at some risk to the participants given that the North Korean regime considers such data breaches as criminal and even capital offenses. However, complex information networks, relying on cell phones with the ability to connect to China, have allowed outside news organizations to

put together consistent series of prices on basic commodities across multiple cities (Kim, 2014).

North Korean price data is collected and provided by media outlets specializing in reporting on the country, including DailyNK[21], AsiaPress[22], NK Investment and Development[23], and SPN[24] (Seoul Pyongyang News). Price survey companies typically focus on basic food items like rice and corn, exchange rates (U.S. dollar, Chinese yuan), and energy prices, including gasoline and diesel although, some look at baskets containing more items. Market price surveys encompass key regions of North Korea, including the capital, Pyongyang; major trade hubs with China, such as Sinuiju and Hyesan; and regional centers, including provincial capitals. Key items essential for analyzing the North Korean market, such as rice prices and exchange rates, are now surveyed biweekly, whereas items like electronics and service prices are assessed on a quarterly basis. Studies on the North Korean market price survey system (Kim, 2021; Jung, 2023) indicate that local surveyors visit markets to collect sales price data, which is then transmitted through phone calls or text messages.

This method of conducting price surveys presents several quite obvious limitations when compared to the standard methodologies used in inflation calculations in the advanced industrial states. First, North Korean price surveys are limited by the need to balance accuracy with the safety of the surveyors. As a result, North Korea's price data necessarily reflects shortcuts. Final reported prices are recorded without details on data collection methods, such as consistency across stores, time of purchase, or product quality. Second, verifying the accuracy of prices reported by North Korea's internal investigators presents a significant challenge. To address this concern, survey organizations claim to employ multiple investigators to cross-check the data, kin to processes of assessing inter-coder reliability. Independently reported trends in rice, corn, and energy prices from multiple sources are largely consistent, suggesting a minimal level of reliability. However, since the COVID-19 pandemic, market activity in North Korea has been severely restricted, leading to growing

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[21] At https://www.dailynk.com/english/

[22] At https://www.asiapress.org/rimjin-gang/

[23] At http://nkid.co.kr/

[24] At https://www.spnews.co.kr/

concerns about the reliability of market prices. Notably, price deviations between different survey organizations have increased suggesting the likelihood of an increase in measurement error (Noland 2024). Clearly such data should be interpreted with caution.

Figure 7. Trend in North Korea's Market Price index: 2006-2002
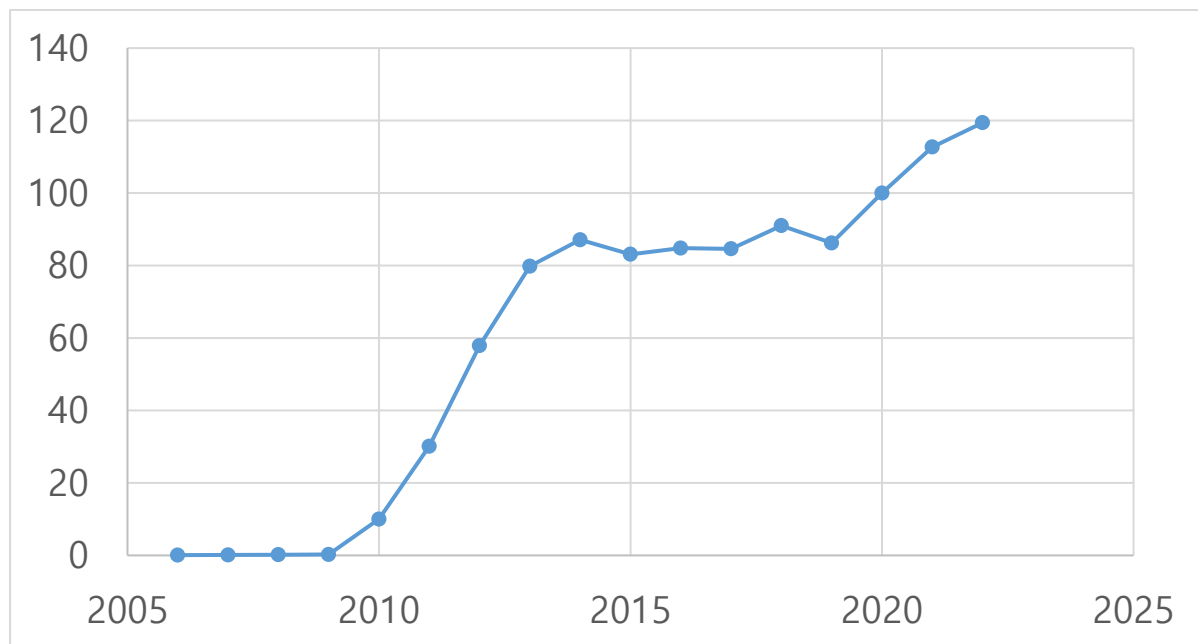
Note: Value of 2020 is indexed to 100.

Source: Authors' calculation with Lim and Moon (2023) data

Yet some of the findings from the data are suggestive and jibe with other known features of the economy. Consider efforts to measure the inflation rate in North Korea. Lim and Moon (2023) constructed a market price index for North Korea based on quarterly surveys of 71 items from 2006 to 2022. Until now, North Korea's inflation has primarily been analyzed through rice prices, but the contribution of this study is that it estimates inflation by examining the prices of various items over a long period.

Such estimates identify some striking macroeconomic turbulence in the country. North Korea's prices surged between 2010 and 2013, stabilized from 2013 to 2019, and then increased once more from 2020 to 2022 as shown in Figure 7. In late November 2009, the North Korean authorities unexpectedly implemented a currency reform. Over the course of one week, beginning on November 30, North Koreans were required to exchange old North

Korean won (KPW) for new North Korean won at an exchange rate of 100 to 1. While the redenomination itself was not inherently problematic, the reform's confiscatory nature—limiting the amount that could be exchanged to 100,000 KPW per household—led to a sharp decline in public confidence in the national currency, evident in a sharp depreciation of the exchange rate. In the three years following the reform, North Korea experienced significant price increases, and the use of foreign currencies, particularly the Chinese yuan and U.S. dollar, became increasingly widespread. Since 2013, prices in North Korea have remained relatively stable, likely due to the authorities recognizing the political as well as economic risks of such experiments and permitting limited use of foreign currencies while restraining monetary emission. However, in 2020, the COVID-19 pandemic again led to a sharp surge in prices as border closures and trade restrictions severely disrupted supply chains.

Price data can be used to variety of purposes, including the analysis of the effectiveness of sanctions (Kim 2020; Kim, Kim, Park, and Sun, 2023). Kim, Kim, Park, and Sun (2023) classified goods traded in North Korea's market into three categories—export-sanctioned, import-sanctioned, and unrelated items—and analyzed price trends before and after the imposition of sanctions. As shown in Figure 8, the price of refrigerators, an import-sanctioned item, rose sharply from the third quarter of 2016 in anticipation of the full implementation of sanctions. Meanwhile, the price of coal—a key export-restricted commodity—declined following the resolution of the relevant sanctions, presumably in anticipation of the ability of Chinese buyers to secure discounts on a trade that was now illicit. Furthermore, they find that the prices of goods not subject to sanctions remain stable before and after the implementation of sanctions. Based on these findings, they conclude that the restrictions on trade associated with the sanctions were real and influenced prices in North Korea's domestic market.

Price data also can be used to examine macroeconomic stability (see Noland, 2024). Jung, Kim and Kim (2024) go so far as to study the synchronization of market prices between North Korea and China. They found that North Korean market prices generally maintain a long-term equilibrium with Chinese prices, but this relationship was disrupted during the pandemic. This finding suggests that the price level was influenced through its economic ties with China. Far from being economically isolated, North Korea is highly vulnerable to its trade dependence on China.

Figure 8. Market Prices of Coal and Refrigerators in North Korea
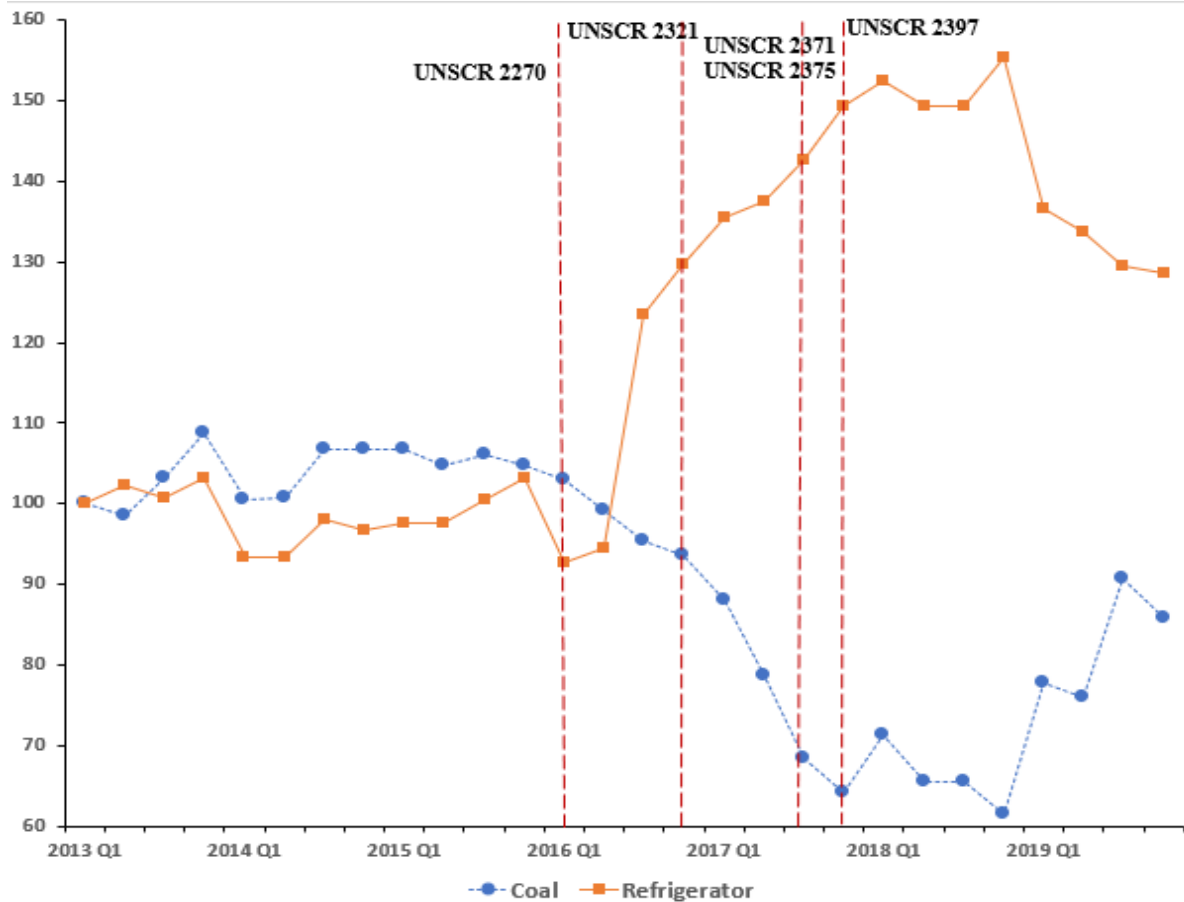
Note: The figure shows quarterly average market prices from 2013 Q1 to 2019 Q4. We normalized 2013 Q1 prices to 100. Price data is available for 77 items, of which 25 are export-sanctioned and 10 are import-sanctioned. The price trends of coal (export-sanctioned) and refrigerators (import-sanctioned) are shown as examples. The trade items prohibited or restricted by the 2016-17 sanctions are listed below. UNSCR stands for United Nations Security Council Resolution.

UNSCR 2270 (2016.3): export (coal, iron ore), import (aviation fuel)
UNSCR 2321 (2016.11): export (silver, copper, zinc), import (helicopters)
UNSCR 2371 (2017.8): export (seafood),
UNSCR 2375 (2017.9): export (textile), import (petroleum products)
UNSCR 2397 (2017.12): export (agricultural products, machinery),
                               import (machinery, vehicles, metal)

Source: Authors' calculation with NK Investment Development data

Another approach to estimating prices that may be somewhat more reliable is through trade data, which typically includes both quantities and dollar values. For example, Haggard and Noland (2017) infer Chinese export prices for food and fuel from the trade data and compare those with world market prices. They found that China has exercised market power, with North Korea paying a premium in the 2000s for imported goods and China effectively securing discounts to world market prices on what it imported from North Korea. Incorporating trade data into the analysis could provide an additional layer of insight, helping to cross-validate price estimates derived from alternative methods.

We have shown that even in economic black holes, where the most fundamental indicator of macroeconomic stability—inflation—is not publicly available, it is possible to construct price data. North Korea is a notoriously closed economy, yet partly because of policy interest in the country, outside entities—including journalists, think tanks and probably intelligence agencies—have been able to incentivize the collection of data within a black hole jurisdiction. At a minimum, collection of such data probably rests on some cellphone or currier network with the outside. But given the spread of such technologies to less developed countries and the small incentives likely required to secure cooperation by those willing to take such risks, such methods are by no means impossible in other settings.

However, such methods raise complicated ethical issues as they involve significant risk. Given that jurisdictions such as North Korea see such efforts as a form of espionage, the individuals involved in the collection of such data are at personal risk, certainly if entering the country surreptitiously but even if simply using a cellphone. Going forward, it is appropriate for IRB's to consider whether such collection of data should be permitted at all and if so how it can be used ethically.

(5) Refugee surveys and interviews

There is a long tradition in the study of China and the Soviet Union, and Eastern Europe of conducting refugee debriefings, open ended interviews, and more structured surveys for the purpose of reconstructing patterns of economic activity in closed jurisdictions (see for example, Grossman 1977 on the informal economy in the Soviet Union). The same tradition continues with respect to North Korea and takes a variety of forms. These include studies of

perceptions of political and social issues in North Korea and refugee adaptation to life in the South, topics which go well beyond our purposes here (see for example Hur 2018, 2022). Nonetheless, such interviews can provide economic information of two sorts. Open-ended interviews can provide insights into issues such as market structure, smuggling and corruption. More structured survey instruments, by contrast, have been used to provide insights into the informal sector.

Two examples demonstrate a more qualitative tradition of economic research on the North Korean economy derived from open-ended interviews. Ward et. al. (2021) use a small sample of defectors to piece together the industrial organization of the fishing industry. They show that some portions of the value-chain function relatively independently of the state while others fall directly under state control. They speculate on how factors such as capital intensity and monitoring costs might influence these organizational arrangements. Hasting and Wang (2018) interview informal traders on the China-North Korea border and show how their trading strategies respond to a variety of risks, from policy changes in formal points of entry to crackdowns on smuggling.

More structured surveys of North Korean defectors have been primarily used for economic purposes to explore North Korea's informal sector and its effect on household income and expenditure. The approach involves surveying North Korean defectors about their experiences in the informal sector or the proportion of their household income derived from informal sources. Studies that have estimated the size of the informal sector by analyzing the share of household income have concluded that at least half, and in some cases up to 90%, of household income comes from the informal sector (Lee, Yang, and Jung, 2014; Lee, 2009; Kim and Yang, 2012; Haggard and Noland, 2010). There are also studies that attempt to estimate the size of the informal sector based on labor force participation, which suggest that the labor force participation rate in North Korea ranges from the 60% to 80% (Kim and Song, 2008; Kim and Koh, 2011; Kim and Kim, 2016). These findings suggest that the informal sector in North Korea is of significant size.

The North Korean Social Change Survey, conducted by the Institute of Unification and Peace Studies (Seoul National University 2022), provides a time series of surveys on North Korean defectors. Since 2012, the survey has been conducted annually, offering insights into time-series trends. According to the survey, for example, the percentage of North Korean defectors with marketplace experience fluctuated between 60% and 77% from 2012 to 2018, without

showing a consistent upward or downward trend. In 2024, South Korea's Ministry of Unification published the "*Report on North Korea's Economy and Society as Perceived by 6,351 Defectors[25]*", which drew on surveys and in-depth interviews with more than 6,000 North Korean defectors representing approximately 20% of the 33,000 North Korean defectors who have settled in South Korea. Moreover, since the survey data has been collected continuously since 2013, it also enabled a time-series analysis of economic and social changes within North Korea. The report offers comprehensive insights into the functioning of the North Korean economy, covering factors such as the proportion of state-owned and private economic activities, sources of household income (formal or informal), and the proportion of currencies used in market transactions (North Korean won, Chinese yuan, and U.S. dollars). Additionally, it highlights not only the expanding role of the private economy, but the prevalence of market fees, bribery and corruption (see also Haggard and Noland, 2010).

More recently, surveys of refugees have taken a behavioral turn. Laboratory experiments have recently sought to get at refugees' economic policy preferences, for example with respect to the market-economy and redistribution in the South. Kim et al. (2017) conducted an experiment on social preferences among North Korean and South Korean students and found that North Koreans exhibited less selfish behavior and were less supportive of the market and democracy compared to their South Korean counterparts. Their findings suggest that individual preferences are shaped by institutional influences. Choi, Kim, Lee, and Lee (2020) used a dictator game experiment to examine differences in giving preferences between South Koreans and North Koreans. They found that income sources influenced giving behavior differently for each group: South Koreans became more selfish when the income was individually earned rather than gifted. Also, North Korean exhibited more self-interested behavior if they had participated in market activities in North Korea. In this way, defector surveys have been used not only to gather information about North Korea but also to analyze how experiences under different regimes influence individuals' economic behavior and preferences.

Finally, it is worth noting that there have been a handful of efforts to survey firms doing business in North Korea (Jung and Kim, 2018, Hastings and Wang, 2018). Haggard and

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[25] https://unikorea.go.kr/nk_realities/ebook_eng/index.html#page=1

Noland (2017), for example, provide findings from surveys of Chinese and South Korean firms on the barriers to investment in the country, noting not only limitations arising from the quality of infrastructure but also the importance of property and contracting rights as sources of risk.

Collecting, organizing, and interpreting information from defectors' testimonies presents significant methodological challenges. Song and Denney (2019) identify the major issues that pertain across any black hole jurisdiction, including selection and demographic biases, financial incentives, language barriers and the ethical issues noted in our discussion of price surveys. Some issues are more particular to North Korea. For example, the majority of North Korean defectors originate from the North Korea–China border region, with over 80% being female. Additionally, defectors are more likely to provide negative assessments of North Korea, as their departure was typically driven by political persecution or economic hardship. Other limitations of defector surveys include the challenge of remembering events correctly particularly given the trauma of defection, confusion between experiences in third countries and those in North Korea, and the potential incentive to tailor responses to align with the perceived expectations of the surveyor. These limitations, stemming from sample bias and the potential for contaminated responses, are inherently difficult to mitigate.

Nonetheless, we believe that surveys of defectors or firms doing business in black hole jurisdiction can offer valuable insights into individual and household behavior and can in some cases be aggregated or extrapolated to suggest features of economic structure and domestic market trends, from reliance on the informal sector to corruption.

(6) Using official documents

North Korea is a particularly good example of an economic black hole because it publishes little if any usable economic data.[26] However, authoritarian regimes do not simply stifle information: they use government-controlled media to communicate core messages to elites and to promote and legitimize their policies. The North Korean regime is no exception and the array of such publications presents a potentially important field for the extraction of information, even if it requires careful reading: official news outlets, television broadcasts, speeches, and even academic journals reflect the government's ideological stance and economic policies. In addition, the government publishes laws and regulations that pertain to economic activity. In general, the information available from these official North Korean sources has been underutilized by economists because it rarely provides the sorts of data that would be of direct interest to researchers. But recent advances in text mining through machine learning or so-called "text as data" approaches have enabled the conversion of qualitative data into quantitative data that opens up research opportunities.

The *Rodong Sinmun* is North Korea's official propaganda outlet and is designed to advance ideological alignment across North Korean society. Economic reports published in the *Rodong Sinmun* primarily promote the policy directions set by supreme leader during national events such as party congresses, New Year's speeches, and all-party congresses. They also provide updates on the production performance and capital investment of major industrial facilities like factories. Although couched in hyperbole, we show how this information can be used for analytic purposes.

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[26] The North Korean authorities have released limited economic data, with the national budget being among the most notable. Frank (2019), for instance, used budget data to evaluate aspects of the North Korean economy. In July 2021, North Korea also submitted a Voluntary National Review (DPRK, 2021) to the United Nations, outlining its progress toward the Sustainable Development Goals (SDGs). This report included basic economic indicators such as real GDP per capita and maternal mortality rates. However, concerns remain regarding the reliability of the data released by the North Korean authorities, primarily due to the lack of transparency surrounding the underlying data and methodologies used to produce these figures.

In addition, North Korea publishes the *Journal of Economic Research* (*Kyongje Yongu*) and several other specialized journals. These can be analyzed or mined for their analysis of economic policies, and in some cases even internal debates about the appropriate direction of policy. The *Journal of Economic Research* aims to interpret and promote the economic ideas and theories of the Supreme Leader in depth, while systematically synthesizing the research contributions of North Korean economists. The journal targets economists, economic management workers, and university students and has been widely used as an analytical source for understanding the country's core economic policies, economic theories, and the perspectives of North Korean scholars.

Additionally, the country produces a range of laws, decrees, and monographs addressing various aspects of the economy. Since Kim Jong-Un assumed power, he has directed an institutionalized framework for governance, enacting and revising relevant laws to support changes in core economic policies. Consequently, alterations in economic laws and regulations serve as a valuable source for understanding the direction of North Korea's economic policies. In addition, there are propaganda pamphlets and commentaries that outline the North Korean government's economic ideas and policy framework. Among the economic decrees enacted and revised since Kim Jong-Un took power are the "Economic Management System in Our Style" and the "Socialist Enterprise Responsibility Management System". Yang (2017) interprets these decrees as resembling economic reforms in other socialist countries, particularly in their emphasis on expanding corporate autonomy and incentives. These measures are considered to represent a more advanced stage of reform compared to the 7.1 Measures announced in 2002 and subsequent policy changes. However, despite their broad acceptance of business autonomy and market mechanisms, they remain limited in key aspects, as they fail to address fundamental issues such as ownership rights, quasi-taxation, and cronyism.

Some examples suggest how these sources can be used. In an early contribution, Choi and Lecy (2012) investigated the process of economic policy change in North Korea by analyzing 1,558 articles from the official state economic journal, the *Journal of Economic Research*, covering the period from 1986 to 2009. They employed semantic network analysis, a method that examines the relationships between concepts to contextualize discourse and track shifts over time. Their findings suggest that while new policy discourses typically emerge gradually and deliberately, significant policy changes tend to occur swiftly during periods of crisis.

As text mining techniques have advanced since these earlier studies, several analyses have been published analyzing North Korea's economic policies using *Rodong Sinmun* and the *Journal of Economic Research* under Kim Jong Un's leadership (Kim, Sohn and Choi, 2020; Lee, Shin and Lee, 2021; Choi, 2023). While traditional textual research relied primarily on researchers' interpretations and evaluations (for example, Carlin and Wit, 2010), recent advances using text mining techniques have introduced a more quantitative approach. For example, Choi (2023) conducted a text mining analysis of fiscal, financial, monetary, and price-related articles published in the *Journal of Economic Research* from 1991 to 2020. Employing a range of techniques—including simple frequency analysis, TF-IDF, word network analysis, Lasso regression, and DOC2VEC—she examined shifts in economic discourse over time. DOC2VEC, the primary methodology, is a machine learning technique based on artificial neural networks that represents words as vectors in a shared coordinate space, allowing for the measurement of word associations. The analysis revealed that commercial banks have become more active in corporate finance, whereas household financial functions have remained limited. This trend aligns with the persistent lack of institutional development of the financial sector with respect to household; financial institutions continue to refrain from providing loans to individuals.

Figure 9. Example of North Korean companies reported in the official newspaper (*Rodong Sinmun*)

Note: The figure is the front page of the June 11, 2013, edition of *Rodong Sinmun* (State-run newspaper in North Korea). In the red box article, the paper makes mention of six chemical companies: a Heungnam Fertilizer Company, Namheung Chemical company, 2.8 Vinalon Company, Sinuiju Chemical Fiber Factory, Myunggan Chemical Factory, and Cheongjin Chemical Fiber Factory.

Source: Choson Sinbo (https://chosonsinbo.com/)

A second example of the innovative use of such source is the conversion of textual information from official media outlets into quantitative data with economic implications. Figure 9 shows the front page of the *Rodong Sinmun*, North Korea's official newspaper, in which an article lists the names of several North Korean chemical factories. KIET (Korea Institute for Industrial Economics and Trade), government funded research institute in South Korea, has aggregated these textual sources and organized information on more than 3,000 companies including not only their names but location and industrial classification as well.[27] The data offers insights not only into manufacturing enterprises but also into business trends across key industries in North Korea, including energy, mining, and construction, making it a crucial resource for research in these sectors. Kim, Kim, Park, and Sun (2023) utilized the data to analyze the impact of sanctions by identifying the distribution of North Korea's industrial structure by region. Since *Rodong Sinmun* does not provide information on firm size, such as sales or the number of employees, they instead use the frequency of mentions of firms' production activities and capital investments as a proxy for firm size.

In sum, economic black holes—and particularly those which are authoritarian in form—do generate economic information of various sorts but it does not take the form of directly usable data and typically has to be collated to be of any analytic use. In this section, we demonstrate how advancements in text mining techniques can provide new opportunities to analyze North Korea's economic policies through official literature. As the tools of text mining continue to advance, future research could expand these methods to include additional sources, such as speeches or policy documents, to further enhance our understanding of North Korea's economic strategies. The data developed using these techniques is confined to state-controlled sources, which, by their nature, reflect only the policy intentions of the regime. However as we have seen, these data sources can reveal information that the regime itself may not intend to share, providing a way to circumvent information restrictions.

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[27] KIET North Korean industry & company DB (http://nkindustry.kiet.re.kr/index.do)

3. Conclusion

Studying places with little or no data, whether due to poverty, government control, or conflict, is difficult but not impossible. Using North Korea as a testbed, we show how researchers, think tanks, analysts and reporters have found creative ways to gather useful economic information from the country. By using satellite images, humanitarian reports, mirror trade and aid statistics, price data, refugee interviews, and government documents, we have been able to learn important facts about one of these economies. These methods follow the idea of a "forensic economics" focused on uncovering hidden patterns and behaviors even without traditional data.

Each of the methods we outline has its own strengths and limitations. Table 1 provides a summary of practical applications, data availability, strengths, and weaknesses for the six approaches discussed in this article. Clearly, more insights are likely to be gained when these different methods are combined and triangulated in different ways. For example, Haggard and Noland (2007, 73-76) show how the estimation of excess deaths from famine required triangulation between census data—a rare official source—surveys and calibration to deaths in other famines. Kim, Kim, Park, and Sun (2023) utilized four of the six methodologies to assess the effects of trade sanctions: mirror trade statistics, government documents to measure county-level exposure, satellite imagery to monitor shifts in regional manufacturing activity, and price data to evaluate the impact on market prices and consumer welfare.

Table 1. Summary of Six Methodologies

Data Sources	Practical Examples	Data Availability	Strengths	Weaknesses
(1) Remote sensing using satellites	Estimating economic activities inferred from night lights	Widely available through NASA and other US agencies	Provides objective, large-scale, real-time data	Requires technical expertise to analyze the data
(2) Aid, humanitarian agencies and access	Observing nutritional status of children	Often infrequent and restricted due to security and political reasons	Ground-level insights, direct access to affected populations	Incomplete data, reporting bias, and limited geographical coverage
(3) Trade	Tracking changes in cross-border trade	Mirror statistics from some open data (e.g., UN COMTRADE), but often delayed	Captures economic disruptions and recovery patterns	Informal trade often missing, delays in official data
(4) Prices	Tracking the cost of living in an informal market	Limited information from media sources, price survey companies sell more detailed information	Reflects real economic conditions	Potential measurement errors due to biases in data collection
(5) Refugee surveys and interviews	Qualitative insights on politics, economy, society, and culture as well as structured surveys on the informal economy	Conducted by South Korean government and researchers but limited coverage	Rich qualitative insights and unique information on behavior, attitude, and value of people	Sampling bias, access limitations, and reliability of responses may limit utility
(6) Using official documents	Understanding economic policies and outcomes	Easy to access through official propaganda outlets and state economic journals	Unique information about policies, convertible to quantitative data through text mining	Contents are controlled by the government, vulnerable to selection problems

Advances in both microeconomics and macroeconomics have enabled researchers to draw more robust conclusions from limited observational data originating from economic black holes. For example, the Bartik instrument, which interacts local industry shares with national industry growth rates (see Goldsmith-Pinkham, Sorkin, and Swift, 2020), provides a means to establish causal relationships between exogenous shocks, such as trade sanctions, and local economic outcomes such as county-level GDP. In studying developing economies, macroeconomists have increasingly integrated structural models with experimental evidence to analyze the aggregate effects of economic policies and external shocks (see the review of Buera, Kaboski, and Townsend, 2023). Given that non-representative small-sample Randomized Controlled Trials have informed structural model estimation, we remain optimistic about leveraging limited observational data from economic black holes, provided it is complemented with rigorous econometric techniques that yield causal insights.

In the future, new technologies like artificial intelligence and machine learning could help make sense of scattered or incomplete data. For example, information can be more easily and systematically extracted from in-depth interviews with refugees and daily published newspaper articles. Several studies in economics and political science have shown large language models' performance in translating text to data (e.g., Brand, Israeli, and Ngwe, 2023; Ziems, et al. 2024).

We can also speculate about what other data might become available in the future. One potential source is high-frequency human mobility data derived from cell phone location signals. Such data has been used to analyze the impact of COVID-19 mitigation policies on disease transmission by leveraging its high-frequency nature (Argente, Lee, and Hsieh, 2022) and to document travel patterns within and beyond African cities using its granular detail (Blanchard, Gollin, Kirchberger, and Peters, 2025). Although North Korean authorities continue to crack down on the use of Chinese mobile phones, some individuals in border regions still connect to Chinese networks, inadvertently generating high-frequency mobility data for service providers. While access to such data currently seems unlikely, history is replete with data breaches, particularly when researchers have their eyes open for them.

It is also worth noting that economic black holes do not necessarily stay closed. Were the North Korean regime to fall, we suspect that there would be treasure troves of historical data of various sorts that would present endless opportunities for social scientists. For example, such information might allow us to reassess the economic divergence between North and

South Korea and evaluate its underlying causes. The two Koreas implemented distinct land reforms in the 1950s and pursued different industrial policies in the 1960-70s.[28] To what extent did these policy choices contribute to South Korea's economic takeoff and North Korea's stagnation? Just as economic historians have revisited Soviet-era policies using historical data following the USSR's collapse, similar research opportunities could emerge for Korea, offering valuable insights into the long-run effects of economic policy.

Studying economies with little data will always be challenging, but new tools and technologies are making it easier to extract economic information from black holes. As more sources of information become available and research methods improve, studying these jurisdictions could well become a distinct focus of inquiry within economics and other social sciences.

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[28] The effectiveness of the land reform and the industrial policy in South Korea has been studied recently by collecting historical data from multiple sources (e.g., Kim and Lee, 2025; Kim, Lee, and Shin, 2021).

References

Ahn, Donghyun, Jeasurk Yang, Meeyoung Cha, Hyunjoo Yang, Jihee Kim, Sangyoon Park, Sungwon Han, Eunji Lee, Susang Lee, and Sungwon Park. 2023. "A human-machine collaborative approach measures economic development using satellite imagery." *Nature Communications* 14.1: 6811.

Argente, David, Chang-Tai Hsieh, and Munseob Lee. 2022. "The Cost of Privacy: Welfare Effects of the Disclosure of COVID-19 Cases." *The Review of Economics and Statistics*. 104 (1): 176–186.

Bae, Jong-ryeol. 2011. "China's Demand for North Korean Coal Imports Surges and Entry into Najin Port", *Korea EXIM North Korea Economic Review*. (written in Korean)

Blanchard, Paul, Doug Gollin, Martina Kirchberger, Michael Peters. 2025. "High-Frequency Human Mobility in Three African Countries." *CEPR Discussion Paper* DP16661.

Boling, Andrew, Lucas Kuo, Luke Snyder and Lauren Sung. 2021. *Unmasked: Vessel Identity Laundering and North Korea's Maritime Sanctions Evasion*. Washington D.C. C4ADS.

Borin, Alessandro, Francesco Paolo Conteduca, Enrica Di Stefano, Vanessa Gunnella, Michele Mancini, and Ludovic Panon. 2023. "Trade decoupling from Russia." *International Economics* 175: 25-44.

Brand, James, Ayelet Israeli, and Donald Ngwe. 2024. "Using LLMs for Market Research." *Harvard Business School Marketing Unit Working Paper* 23-062.

Buera, Francisco J., Joseph P. Kaboski, Robert M. Townsend. 2023. "From Micro to Macro Development." *Journal of Economic Literature*. vol. 61, no. 2, pp. 471–503.

Carlin, Robert and Joel Wit. 2006. *North Korean Reform: Politics Economics and Security.* Abingdon: Routledge Press.

Cha, Victor and Lisa Collins. 2018. The Markets: Private Economy and Capitalism in North Korea? August 26 at Beyond Parallel https://beyondparallel.csis.org/markets-private-economy-capitalism-north-korea/

Choi, Changyong, and Jesse D. Lecy. 2012. "A semantic network analysis of changes in North Korea's economic policy." *Governance* 25.4: 589-616.

Choi, Jiyoung. 2023. "Changes in North Korea's Fiscal and Financial System after Kim Jong Un's Rule." *KDI North Korean Economic Review* 25.4 (written in Korean).

Choi, Seong-Woo. 2021. "Changes in health status of North Korean children and emerging health challenges of North Korean refugee children." *Clinical and Experimental Pediatrics* 64.11: 552.

Choi, Soo-young. 1991. "North Korean Trade 1946-1988: Structure and Performance", *Ph.D. dissertation Northeastern University*.

Choi, Syngjoo, Byung-Yeon Kim, Jungmin Lee, and Sokbae Lee. 2020. "A tale of two Koreas: Property rights and fairness." *Journal of Economic Behavior & Organization* 170: 112-130.

Chor, Davin, and Bingjing Li. 2024. "Illuminating the effects of the US-China tariff war on China's economy." *Journal of International Economics* 150: 103926.

Chung, Joseph Sang-hoon. 1974. "The North Korean economy: structure and development."

Donaldson, Dave, and Adam Storeygard. 2016. "The view from above: Applications of satellite data in economics." *Journal of Economic Perspectives* 30.4: 171-198.

DRPK. 2021. *Voluntary National Review on the Implementation of the 2030 Agenda for the Sustainable Development*, UN.

Eberstadt, Nicholas. 1998. "North Korea's Interlocked Economic Crises: Some Indications from" Mirror Statistics"." *Asian Survey* 38.3: 203-230.

Frank, Ruediger. 2019. "The North Korean Parliamentary Session and Budget Report 2019: Signs of Economic Stagnation and an Open Claim to Leadership on the Korean Peninsula," 38 North April 13 at https://www.38north.org/2019/04/rfrank041319/.

Gibson, John, Susan Olivia, and Geua Boe-Gibson. 2020. "Night lights in economics: Sources and uses." *Journal of Economic Surveys* 34.5: 955-980.

Goldsmith-Pinkham, Paul, Isaac Sorkin, and Henry Swift. 2020. "Bartik Instruments: What, When, Why, and How." *American Economic Review*. vol. 110, no. 8, pp. 2586–2624.

Grossman, Gregory. 1977. "The "second economy" of the USSR." *Problems of Communism,* 26 (5) pp. 25-40.

Haggard, Stephan and Samantha Beu. 2021 "North Korean Sanction Evasion: The UN Panel of Experts Report", KEI.

Haggard, Stephan, and Marcus Noland. 2007. *Famine in North Korea: Markets, Aid, and Reform*. Columbia University Press.

Haggard, Stephan, and Marcus Noland. 2009. "Famine in North Korea Redux?" *Journal of Asian Economics* 20.4: 384-395.

Haggard, Stephan and Marcus Noland. 2010a. "Reform from Below: Behavioral and Institutional Change in North Korea," *Journal of Economic Behavior & Organization*, Vol. 73, pp.133~152.

Haggard, Stephan and Marcus Noland. 2010b. *Witness to Transformation: Refugee Insights into North Korea*. New York: Columbia University Press.

Haggard, Stephan, and Marcus Noland. 2017. *Hard target: Sanctions, inducements, and the case of North Korea*. Stanford University Press.

Hastings, Justin V., and Yaohui Wang. 2018. "Informal trade along the China–North Korea border." *Journal of East Asian Studies* 18.2: 181-203.

Hausmann, Ricardo, Jason Hwang, and Dani Rodrik. 2007. "What you export matters." *Journal of economic growth* 12: 1-25.

Hayakawa, Kazunobu, and Souknilanh Keola. 2021. "How is the Asian economy recovering from COVID-19? Evidence from the emissions of air pollutants." *Journal of Asian Economics* 77: 101375.

Henderson, J. Vernon, Adam Storeygard, and David N. Weil. 2012. "Measuring economic growth from outer space." *American Economic Review* 102.2 (2012): 994-1028.

Hodler, Roland, and Paul A. Raschky. 2014. "Regional favoritism." *The Quarterly Journal of Economics* 129.2: 995-1033.

Hur, Arum. 2018. "Adapting to Democracy: National Identity and the Political Development of North Korean Defectors," *Journal of East Asian Studies* 18.1: 97-115.

Hur, Arum. 2022. *Narratives of Civic Duty: How National Stories Shape Democracy in Asia.* Ithaca: Cornell University Press.

Hong, Jea Hwan. 2018. "North Koreans' Current Living Conditions Based on UNICEF Survey Results: With a Focus on the Status of Infant Nutrition." *KINU Working Paper* (written in Korean)

Jung, Seung-ho. 2023. "North Korean Market Price Survey Methodology and Improvements." *KDI Review of the North Korean Economy*, (written in Korean).

Jung, Seung-ho, and Byung-Yeon Kim. 2018. "Trade Between North Korea and China: Firm-Level Analysis." *Emerging Markets Finance and Trade* 54.7: 1475-1489.

Jung, Seung-ho, Dawool Kim, and Kyoochul Kim. 2024. "Impact of COVID-19 and border closures on North Korean markets: A comparison with international prices." *Asia and the Global Economy* 4.2: 100096.

Katona-Apte, Judit, and Ali Mokdad. 1998. "Malnutrition of children in the Democratic People's Republic of North Korea." *The Journal of Nutrition* 128.8: 1315-1319.

Keola, Souknilanh, Magnus Andersson, and Ola Hall. 2015. "Monitoring economic development from space: using nighttime light and land cover data to measure economic growth." *World Development* 66: 322-334.

Kim, Byung-Yeon. 2017a. *Unveiling the North Korean economy: Collapse and transition.* Cambridge University Press.

Kim, Byung-Yeon, Syngjoo Choi, Jungmin Lee, Sokbae Lee, and Kyunghui Choi. 2017. "Do institutions affect social preferences? Evidence from divided Korea." *Journal of Comparative Economics* 45.4: 865-888.

Kim, Byung-Yeon, and Min-Jung Kim. 2016. "The evolution of the informal economy in North Korea." *Seoul Journal of Economics* 29.4: 457-480.

Kim, Byung-Yeon and Yumi Koh. 2011. "The Informal Economy and Bribery in North Korea," *Asian Economic Papers*, Vol. 10, pp.104-117.

Kim, Byung-Yeon, and Dongho Song. 2008. "The participation of North Korean households in the informal economy: Size, determinants, and effect." *Seoul Journal of Economics* 21.2: 361-385.

Kim, Byung-Yeon, and Moonsu Yang. 2012. "Markets and Government in the North Korean Economy." Unification Studies in Seoul National University 16, Seoul National University Press (written in Korean).

Kim, Dawool. 2022a. "Assessing regional economy in North Korea using nighttime light." *Asia and the Global Economy* 2.3: 100046.

Kim, Dawool, Bumhwan Kim, Halin Han, and Dae-Eun Lee. 2022. "International Cooperation for Climate Change Adaptation in North Korea: Focusing on Agriculture and Natural Disasters." *KIEP Research Series* (Written in Korean)

Kim, Jihee, Kyoochul Kim, Sangyoon Park, and Chang Sun. 2023. "The economic costs of trade sanctions: Evidence from North Korea." *Journal of International Economics* 145: 103813.

Kim, Jiyoung. 2014. "The politics of foreign aid in North Korea." *The Korean Journal of International Studies* 12.2: 425-450.

Kim, Kyoochul, 2017b. "Analyzing the Anthracite Trade between North Korea and China: focusing on anthracite prices." *KDI Review of the North Korean Economy*. (written in Korean)

Kim, Kyoochul. 2018. "The Quantitative Growth in North Korea's Trade: Is it Enough?". No. 93. *KDI Focus*.

Kim, Kyoochul. 2020. "Finding Loopholes in Sanctions: Effects of Sanctions on North Korea's Refined Oil Prices." *KDI Journal of Economic Policy* 42.4: 1-25.

Kim, Kyoochul. 2021. "A Study on the Determinants of Food Prices in North Korea." *KDI Policy Study* (written in Korean)

Kim, Kyoochul. 2022b. "The North Korean economy seen by satellite: Estimates of national performance, regional gaps based on nighttime light." *Journal of Asian Economics* 78: 101405.

Kim, Minki, and Munseob Lee. 2025. "Land Reform, Agricultural Productivity, and Human Capital Accumulation." *mimeo*.

Kim, Minho, Munseob Lee, and Yongseok Shin. 2021. "The Plant-Level View of an Industrial Policy: The Korean Heavy Industry Drive of 1973." *NBER Working Paper* No. 29252.

Kim, Seokjin. 2013. "Key Issues Related to North Korea's Recent Economic Performance", *KIET Issue Paper*, KIET. (written in Korean)

Kim, Soohyon, Wook Sohn, and Changyong Choi. 2020. "The North Korean Economy: Sustainable or Muddling-Through?." *Sustainability* 12.20: 8478.

Kim, Yonho. 2014. "Cell phones in North Korea." US-North Korea Institute, SAIS: 29-30.

Lee, Hae-Jung, Hoon-Sik Shin, and Hye-Jin Lee. 2021. "Analyzing Economic Policy in the Kim Jong Un Era through Text Mining." *National Strategy* 27.1. pp. 157-182. (written in Korean).

Lee, Jong Kyu. 2015. "What Determines the DPRK's Anthracite Exports to China? Implications for the DPRK's Economy." *KDI Journal of Economic Policy* 37.2: 40-63.

Lee, Seokgi, Moonsu Yang and Eun-I Jung. 2014. "Analyzing the North Korean market", *KIET Research Monograph*, KIET (written in Korean).

Lee, Si-Hyo, Moon-Gi Suh, Sung-Bae Kim, and Myeongsook Baek. 2024. "Urban poverty patterns in Pyongyang (North Korea): A deep-learning-based spatial analysis." *Cities* 151: 105109.

Lee, Soo-Kyung. 2017. "North Korean children: Nutrition and growth." *Annals of Pediatric Endocrinology & Metabolism* 22.4: 231-239.

Lee, Suk. 2003. "Food Shortages and Economic Institutions in the Democratic People's Republic of Korea." Doctoral dissertation, University of Warwick.

Lee, Suk. 2009. "North Korea's market: Size estimation and structural analysis", *Research Monograph*, KDI (written in Korean).

Lee, Suk. 2010. "Economic Sanctions and North Korean Trade-Estimating the Impact of Japanese Sanctions on North Korea in the 2000s." *Korean Development Studies* 32.2 pp: 93-143. (written in Korean)

Levitt, Steven D., and John A. List. 2009. "Field experiments in economics: The past, the present, and the future." *European Economic Review* 53.1: 1-18.

Lim, Song, and Seunghyun Moon. 2023. "Market Prices in North Korea: 2006~ 2022." *Bank of Korea WP* 13.

Martinez, Luis R. 2022. "How Much Should We Trust the Dictator's GDP Growth Estimates?" *Journal of Political Economy* 130(10): 2731-2769.

Mellander, Charlotta, José Lobo, Kevin Stolarick, and Zara Matheson. 2015. "Night-time light data: A good proxy measure for economic activity?." *PloS One* 10.10: 0139779.

Michalopoulos, Stelios, and Elias Papaioannou. 2014. "National institutions and subnational development in Africa." *The Quarterly Journal of Economics* 129.1: 151-213.

Nam, Jinwook. 2024. "North Korea's Economy Through Nitrogen Dioxide Levels: The Possibilities and Limitations of Environmental Satellite Data", *KDI Review of North Korean Economy* (written in Korean)

Nam, So Young, Jihyun Yoon, and Soo-Kyung Lee. "Comparison of the Nutritional Status of Infants and Young Children in South Korea and North Korea." *Journal of Nutrition and Health* 54.3 (2021): 239-246.

Noland, Marcus. 2024. "Turning Back the Clock: The Changing Nature of North Korean Food Insecurity." Unpublished Working Paper, 2024.

Pinkovskiy, Maxim, and Xavier Sala-i-Martin. 2016. "Lights, camera… income! Illuminating the national accounts-household surveys debate." *The Quarterly Journal of Economics* 131.2: 579-631.

Reilly, James. 2014. "The Curious Case of China's Aid to North Korea." *Asian Survey*. 54 (6): 1158–1183.

Ross, Michael. 2006. "Is Democracy Good for the Poor?" *American Journal of Political Science* 50.4: 860-874.

Rossi-Hansberg, Esteban, and Jialing Zhang. 2025. "Local GDP Estimates Around the World." *NBER Working Paper Series* No. 33458.

Seoul National University. 2022. "The North Korean Social Change Survey: 2012-2020", Institute of Unification and Peace Study.

Smith, Hazel. 2016. "Nutrition and Health in North Korea: What's New, What's Changed and Why It Matters." *North Korean Review*: 7-34.

Smith, Hazel, and Suk Lee. 2023. "International humanitarian aid to North Korea: Progress, results, and controversy". Dialogue on the North Korea Economy, *KDI Research Report*, December 2023.

Song, Jay, and Steven Denney. 2019. "Studying North Korea through North Korean migrants: lessons from the field." *Critical Asian Studies* 51.3 (2019): 451-466.

Storeygard, Adam. 2016. "Farther on down the road: transport costs, trade and urban growth in sub-Saharan Africa." *The Review of Economic Studies* 83.3: 1263-1295.

Ward, Peter, Andrei Lankov and Jiyoung Kim. 2021. "Embedded and Autonomous Markets in North Korea's Fishing Industry: Resource Scarcity, Monitoring Costs and Evolving Institutions," *Journal of East Asian Studies* 21.1: 53-74.

Wee, Hye-seung. 2016. "Are North Korean Children Really Malnourished?" *KDI Review of North Korean Economy* (written in Korean)

Yang, Moonsu. 2017. "The Economic Management System in Our Style' as Seen Through the Revised Decree After Kim Jong Un's Rule", *Unification Policy Studies*. (written in Korean)

Yang, Uncheol and Sang-Sup Ha. 2012. "The Limits of UN Economic Sanctions on North Korea: Limiting Enforceability and Expanding Strategic Options." *Unification Policy Studies*. (written in Korean)

Zadeh-Cummings, Nazanin, and Lauren Harris. 2020. "The impact of sanctions against north korea on humanitarian aid." *Journal of Humanitarian Affairs* 2.1: 44-52.

Ziems, Caleb, William Held, Omar Shaikh, Jiaao Chen, Zhehao Zhang, and Diyi Yang. 2024. "Can large language models transform computational social science?." Computational Linguistics 50, no. 1: 237-291.

Zitzewitz, Eric. 2012. "Forensic Economics." *Journal of Economic Literature* 50(3): 731-69.