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Marketing Efficiency of Autarkic Systems: The Case of North Korea

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Abstract

The issue of marketing efficiency, or how to better transform inputs into outputs within a marketing system, has always occupied a special place in the macromarketing literature. The concept of marketing efficiency has not been studied in closed and isolated systems that exhibit distinctive behavioral patterns compared to conventional open systems and can explain important and understudied marketing phenomena, including autarky. This study challenges some of the conventional premises of marketing systems by defining autarky as a closed marketing system that 1) operates with the specific purpose of propaganda in a relatively predictable and efficient manner; 2) has minimal, though not entirely absent, interaction with the international environment; and 3) involves participants (actors) who do not engage in voluntary exchanges with one another but rather collectively, as well as individually, adhere consistently to the self-reliance ideology. We demonstrate how a classical thermodynamic model (i.e., the Carnot cycle for maximum energy efficiency) can be metaphorically associated with the behavior of the North Korean autarkic system to better understand the long-term efficiency of its propaganda machine. To the best of our knowledge, this is the first attempt to develop a holistic metaphorical framework for exploring the efficiency of an autarkic system and to establish common criteria for measuring relationships between autarkic properties and autarkic processes.

Keywords

chemistry of marketing, autarky, closed marketing systems, marketing efficiency, carnot cycle

“It is easy to say that the goal of marketing organization is efficient performance, but nobody yet knows how to get the most output for the resources used in marketing.”- George Fisk (1967)

Marketing Systems, An Introductory Analysis. Part I, p. 15

Introduction

The issue of marketing efficiency, or how to better transform the inputs into outputs within a marketing system, has always occupied a special place in the macromarketing literature. Marketing efficiency has been part of the aims and scope of the *Journal of Macromarketing* since its inception: “The word macromarketing implies that we care about the consequences of large marketing systems on large social issues. Examples of these issues include environmental deterioration and renewal, economic development of national economies, the influence of marketing on the quality of life, and marketing efficiency in mobilizing and allocating resources. In short, we seek knowledge to improve marketing strategies and policies that affect social welfare” (Fisk 1981, p. 3). Dixon (1981) even discusses the paramount importance of marketing efficiency in the theories of economic development that emerged between ca. 1500 and the middle of the eighteenth century, and Shaw (2020) states that the reason “why marketing systems occur,

survive and grow is because a marketing system offers the most efficient means for supplying and distributing products and services that people demand relative to the opportunity cost of alternative methods for acquiring products and services” (p. 277).

The concept of marketing efficiency has not been studied in closed and isolated systems that, according to a recent study, have distinctive behavioral patterns compared to those of conventional open systems and can be studied through the lens of chemistry to explain the nonlinear and understudied phenomena of autarky (Stoyanov, Stoyanova, and Stoyanov 2023). Since the design of the famous homeostatic device (Ashby 1960), the prevailing marketing literature has been inspired to develop models of complex adaptive systems that modify their behavior in response to environmental changes (Layton 2011, 2014; Layton, Domegan, and Duffy 2022). This obsolete

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mentality according to which (macro)marketers should largely adopt a market (exchange) perspective does not help the field of macromarketing evolve (Benton 2021). This motivates Wooliscroft (2021) to suggest the adoption of closed system assumptions in studying macromarketing phenomena. Autarkic (self-sufficient) systems, which are often associated with the behavior of deglobalized countries, are not necessarily adaptive because, by definition, they exclude the possibility of environmental exchange (Stoyanov, Stoyanova, and Stoyanov 2023). While factors that motivate countries to move toward national self-sufficiency policies are clear (Helleiner 2021) and shifts toward deglobalization are historically cyclical world-economy phenomena (Jones 2005; Kim, Li, and Lee 2020), how autarkies maintain and improve their efficiencies in the long run remains unclear.

The Democratic Popular Republic of Korea (or North Korea) is one of the most isolated countries in the world. Since 1972, it has continuously developed and promoted the *juche* (*juché*) ideology—a national policy of political, economic, and military self-sufficiency that endows its supreme leader with strong godlike (cult) qualities that are considered to be sufficiently powerful to fully control the destiny of the entire world.¹ Considering that North Korea does not provide any economic-performance data to the international community, forecasting its behavior is simply impossible. Some researchers even consider it to be the last country to transition toward a free-market economy, describing it similarly to how Winston Churchill (1874–1965) defined Russia in 1939: “a riddle wrapped in a mystery inside an enigma” (Koen and Beom 2020, p. 6). Although the North Korean autarkic system has been expected to fail for decades (e.g., in the aftermath of the death of Kim Il Sung, the country’s founder, in 1994), this has not yet transpired. Ahrens (2007) explains that “[m]ore often than not the country’s destiny has been predicted as collapse, chaos, and in the end, absorption by South Korea. However, ... [the] regime proved viable and cultivated the art to survive within a globalizing world without opening up” (p. 66).

To bridge the abovementioned gap and provide some clarity, we looked for inspiration in the *chemistry of marketing*, an emerging research area that bridges concepts from chemistry (including physical chemistry) and marketing to better comprehend the causal mechanisms behind the nonlinear behavior of closed and isolated marketing systems (Stoyanov, Stoyanova, and Stoyanov 2023). We aim to provoke an interesting discussion on how a conventional efficiency-maximization model used in chemical thermodynamics (e.g., the most efficient possible heat engine proposed by Sadi Carnot) can be metaphorically transferred to marketing to improve our understanding of the behavior and efficiencies of autarkic systems. “For example, a study of the efficiency of marketing systems may have both positive and normative aspects; it may both describe existing marketing practices and prescribe more appropriate practices” (Hunt 1976, p. 23).

The rest of this paper is organized as follows: First, we briefly examine the concepts of autarky and marketing efficiency, adopting an evolutionary perspective. This approach

is rooted in the belief that understanding history provides valuable insights into how marketing trends endure or fade away, the various approaches and conditions for addressing marketing issues, and the reluctance to change and impulsive enthusiasm for new ideas in marketing (Hollander, Nevett, and Rassuli 1996). We conclude the historical review by providing a novel definition of autarky which challenges some of the conventional premises of marketing systems. Second, we suggest a metaphorical framework for studying the propaganda efficiency of the North Korean autarkic system with the Carnot cycle for maximum energy efficiency and make some assumptions regarding the relationship between the autarkic properties and autarkic processes. Third, we construct our database of autarkic performance indicators and provide preliminary evidence regarding the degree to which the assumed relationships between autarkic processes and autarkic properties align with the observed ones. Finally, we conclude by highlighting some of the limitations of this study and suggesting directions for future research.

Literature Review

Autarky as a Macromarketing Phenomenon: the Shift Toward Deglobalization

The forms “*autarchy*,” “*autarchie*,” and “*autarky*” have been interchangeably used over the years to describe the phenomenon of self-sufficiency or more specifically “(a policy of) economic self-sufficiency in a political unit” (Oxford English Dictionary 2023).² Ancient Greek philosophers (e.g., Herodotus, Thucydides, Demosthenes, Plato, and Aristotle) were among the first to discuss the importance of autarky; they considered it an ideal state for both cities and individuals/households and even used the term in reference to happiness and god (Mayhew 1995). In *Politics*, Aristotle (1999) highlighted the importance of cities moving toward self-sufficiency, by presenting it as the final goal and most desirable state of existence of any city: “be self-sufficing is the end and the best” (p. 5). A self-sufficient city is one that has all the goods that it needs: 1) external goods (e.g., wealth), 2) goods of the body (e.g., health), and 3) goods of the soul (e.g., courage, wisdom, and other virtues). Two complementary types of self-sufficiency can be distinguished in Aristotelian autarkic philosophy: 1) self-sufficiency with regard to life or living—when a city lacks nothing to satisfy its basic needs (e.g., food, clothing, and shelter), and 2) self-sufficiency with regard to living well—when a city lacks nothing required for a good life (Mayhew 1995). Contextualizing the idealistic autarkic views of ancient thinkers is crucial. In an era marked by unpredictable climate and unreliable communications, leading to inadequately connected markets, pursuing autarky was considered a logical strategy to mitigate risk and guarantee food security. Achieving complete autarky was consistently an unattainable practical ideal (Morley 2013).

Various autarkic philosophies were developed between the 17th and 21st centuries to promote deglobalization, with each

of them sharing the following common premises: “(1) insulation from foreign economic influence, (2) insulation from foreign political and/or cultural influence, and (3) the promotion of international peace” (Helleiner 2021, p. 935). Even the British economist John Maynard Keynes (1883–1946) considered today as one of the founders of modern macroeconomics, recognized the importance of greater national self-sufficiency: “I WAS brought up, like most Englishmen, to respect Free Trade not only as an economic doctrine which a rational and instructed person could not doubt but almost as a part of the moral law. I regarded departures from it as being at the same time an imbecility and an outrage. ... Yet the orientation of my mind is changed; and I share this change of mind with many others. ... National self-sufficiency, in short, though it costs something, may be becoming a luxury which we can afford, if we happen to want it. ... the policy of an increased national self-sufficiency is to be considered, not as an ideal in itself, but as directed to the creation of an environment in which other ideals can be safely and conveniently pursued” (Keynes 1933, pp. 177–185).

Layton (2010) sees autarchy as one of the four distinct states of complex, adaptive, and multi-level marketing systems. He suggests that autarchy was the initial state in the evolution of marketing systems but does not exclude a new paradigm shift toward autarchy, triggered by a myriad of events, such as natural disasters, wars, diseases, or even a systematic collapse degrading the entire system to a state similar to autarchy (Layton 2011). Today deglobalization is viewed as a historically recurring phenomenon in the world economy: 1) the first stage of deglobalization lasted for approximately 50 years (between 1929 and 1979) and was primarily triggered by the Great Depression and the First World War, while 2) the second stage of deglobalization started with the global financial crisis in 2008 (Jones 2005; Kim, Li, and Lee 2020). The world has become increasingly fragmented over the past few years due to the COVID-19 pandemic, the war between Russia and Ukraine, and climate change, with the largest economies already adopting significant autarkic measures toward greater national self-sufficiency (Dieter and Biedermann 2022). A recent study has provided initial evidence about the emerging significance of countries and world regions experiencing slowbalization and deglobalization, which can be metaphorically associated with closed and isolated macromarketing systems (Stoyanov, Stoyanova, and Stoyanov 2023).

While the factors that determine the state of self-sufficiency in marketing systems are clear and the current shift toward deglobalization is a historically cyclical phenomenon in the world economy, the long-run mechanisms through which autarkies maintain and improve their efficiencies, as well as the development they undergo, remain less apparent. Layton (2010) explains that “autarchy is [mostly] localized and temporary, as communities move swiftly to establish more efficient and effective trading patterns” (p. 489). He does not suggest any strategies for what exactly is needed for an autarkic system to operate continuously as a viable business model because he sees it as the opposite of a predictable, structured, and purposeful system. While the major premise of his theory

of marketing systems is that an “economic exchange is always embedded in a marketing system” (Layton 2010, p. 483), autarkies by definition exclude any type of environmental exchange, which raises the question: what behavioral pattern do they follow in order to be efficient in the long-term?

Efficiency of Macromarketing Systems

Efficiency is usually expressed as the ratio of the output value to the input value and is a primary engineering notion that macromarketers successfully adopted a long time ago. One study even found that the marketing literature published between 1900 and 1929 was largely influenced by the concept of engineering efficiency because engineering metaphors enable marketers “to include objective and systematic approaches to problem solving, a pragmatic, efficiency oriented scientific method” (Scully 1996, p. 325). Breyer (1934/1978) uses the term “acquisitive efficiency” in reference to “the power of an individual business to make net profits out of its marketing activities ... [with the only one] concern to make money” (p. 183).

Inspired by the first law of thermodynamics - the one on energy conservation that states that energy can neither be created nor destroyed in a closed system, Boulding (1961) discusses the distinction between available and unavailable energy in the following way:

$$\begin{aligned} \text{“Energy input} &= \text{Available energy output} \\ &+ \text{Unavailable energy output.} \end{aligned}$$

A ‘price system’ indicative of significance is then applied to the output. Since the valuation coefficients are 1 for available and 0 for unavailable energy, the value of the output is equal to the amount of available energy and the efficiency measure becomes:

$$\text{Efficiency} = \frac{\text{Value of output}}{\text{Value of input}} = \frac{\text{Available energy output}}{\text{Energy input}}$$

” (p. 333).

Due to the economic origins of marketing science, minimizing the various economic costs was initially viewed in relation to quality-service features as the main (although not the only) criterion for improving marketing efficiency (Barger 1955; Cox and Goodman 1956; Sevin 1954). Alderson (1957) sees the postponement of product differentiation as a way of promoting the efficiency of a marketing process – “[a]ccording to this principle, any change in the form of the product should be delayed to the last possible point in the distribution process; and any change in its location should be delayed until the last possible point in time” (p. 420). The notion of transvection, which in some way represents the outcome of a series of transactions and can be considered a measure of the efficiency of a system, is also influenced by the prevailing cost paradigm (Alderson and Martin 1965).

Fisk (1967) highlights the importance of measuring the social efficiency of a marketing system. He explains that while social efficiency may occasionally conflict with acquisitive efficiency,

more often than not, enhancements in acquisitive efficiency contribute to improvements in social efficiency. Slater and Jenkins (1979) state that “[m]acromarketing emerges when the performance of the system is evaluated, either in terms of an enhancement of the efficiency of marketing or adjusting priorities for the entire social system” (p. 373). Layton (2009) supports the notion of not only studying economic growth, but also outcomes related to the standard of living (quality of life). He categorizes marketing efficiency based on the time horizon into short-term and long-term (Layton 2011). In the short run, transaction costs for sellers and buyers are influenced by infrastructure, developmental stages, conflicting incentives, and decentralized information. Herein, efficiency is achieved by minimizing these transaction costs. Long-term efficiency involves addressing institutional barriers, such as standards, contract enforcement, regulatory systems, infrastructure, and incentives designed to support appropriate decision making. An efficient marketing system must innovatively respond to emerging opportunities. A recent systematic review of the marketing literature published between 2000 and 2020 found slight differences between micro- and meso-level efficiency measures (Watson and Wu 2022).

In his partially formalized theory of marketing systems, Shaw (2020) also discusses the topic of marketing efficiency. He explains that marketing system efficiencies depend on the law of reduced transaction costs and the law of bulk transactions. “The former reduces the input costs of marketing activities ..., on the one hand, while the latter increases the output value of market transactions ..., on the other. The interaction of these two laws creates the powerful synergistic efficiency of the marketing process” (p. 268). He formulates *the law of marketing system efficiency*, according to which “[i]f the costs of trading (e.g., searching, traveling and negotiation) are reduced ... while simultaneously increasing transaction value ..., then marketing system efficiency increases geometrically” (p. 275). Finally, according to his *law of maximum marketing system efficiency* “[t]he upper limit for increasing output resulting from the division of labor ... is the scarcest input ... or the extent of the market ... because further division of labor creates bottlenecks, resulting in diminishing returns ... and is therefore less efficient” (p. 275).

While acknowledging the significance of the aforementioned contributions to the literature on marketing efficiency, recognizing two common limitations shared by these studies is crucial: they all assume that marketing systems are predominantly open in nature and rely fundamentally on voluntary exchanges. Along with market and resource seeking, *efficiency seeking* is considered one of the three main drivers for the internationalization of marketing systems (Ghauri and Cateora 2021). In this study, we challenge these conventional premises of marketing systems by defining *autarky* as a closed marketing system that 1) operates with the specific purpose of propaganda in a relatively predictable and efficient manner; 2) has an extremely limited, though not entirely absent, interaction with the international environment; and 3) involves participants (actors) who do not engage in voluntary exchanges with one another but rather collectively, as well as individually, adhere consistently to the self-reliance ideology. Stepping on the chemistry of

marketing, which suggests that researchers should draw inspiration from chemical-thermodynamics-based efficiency-maximization models when exploring closed and isolated marketing systems (Stoyanov, Stoyanova, and Stoyanov 2023), in the following section, we present how a classical thermodynamic model (i.e., the Carnot cycle for maximum energy efficiency) can be metaphorically associated with the behavior of the North Korean autarkic system to better understand the long-term efficiency of its propaganda machine.

Methodology

Carnot Cycle for maximum Energy Efficiency: Metaphorical Assumptions

The “Carnot heat-engine” is the name of the ideal heat engine proposed in 1824 by the French military engineer, Sadi Carnot (1796–1832). The reversible cycle under which this heat engine operates is known as the *Carnot cycle of maximum energy efficiency* because it determines the upper limit of the efficiency of any thermodynamic engine that absorbs heat and converts it into work (Figure 1) and a specific relationship between system properties and system processes (Figures 2 and 3). Although it was developed two centuries ago, it remains a performance benchmark for all thermodynamic engines operating between high and low temperatures/ between hot and cold reservoirs (The Editors of Encyclopaedia Britannica 2023) and has an indisputable place in the chemical engineering hall of fame. The economic and/or marketing applications of this model are still quite limited. In the field of econophysics, Mimkes (2006) studied the Carnot cycle mathematically and associated it with the economic growth of companies, industries, and individuals: “The Carnot process is the basis of all economic processes [e.g., production, trade and finance] ... In economics every company, bank, and every person is a Carnot-like machine” (p. 22). One group of researchers has also developed a mathematical model for studying Carnot-type economic cycles under the assumption that an economic process can act as a reversible economic “engine” (Udriste, Golubyatnikov, and Tevy 2021).

We believe that the Carnot cycle can also be used to improve our understanding of the marketing efficiencies of autarkic systems. First, it serves as a well-established thermodynamic-efficiency benchmark. Second, it was originally developed for a piston cylinder device—a closed system—which means that it can metaphorically be associated with autarky, of course under the premise that “metaphors are partial truths and incomplete models. No single metaphor can capture the whole of a selected aspect of reality in its full complexity” (Arndt 1985, p. 17). Third, machine metaphors are easily associated with marketing systems because every machine has a structure (building blocks) and purpose for its existence, and its performance can be measured, optimized, and predicted, all of which enable the construction of useful analogies (e.g., “a smooth-running system” or “a system with no friction”). One of the key assumptions of the Carnot cycle

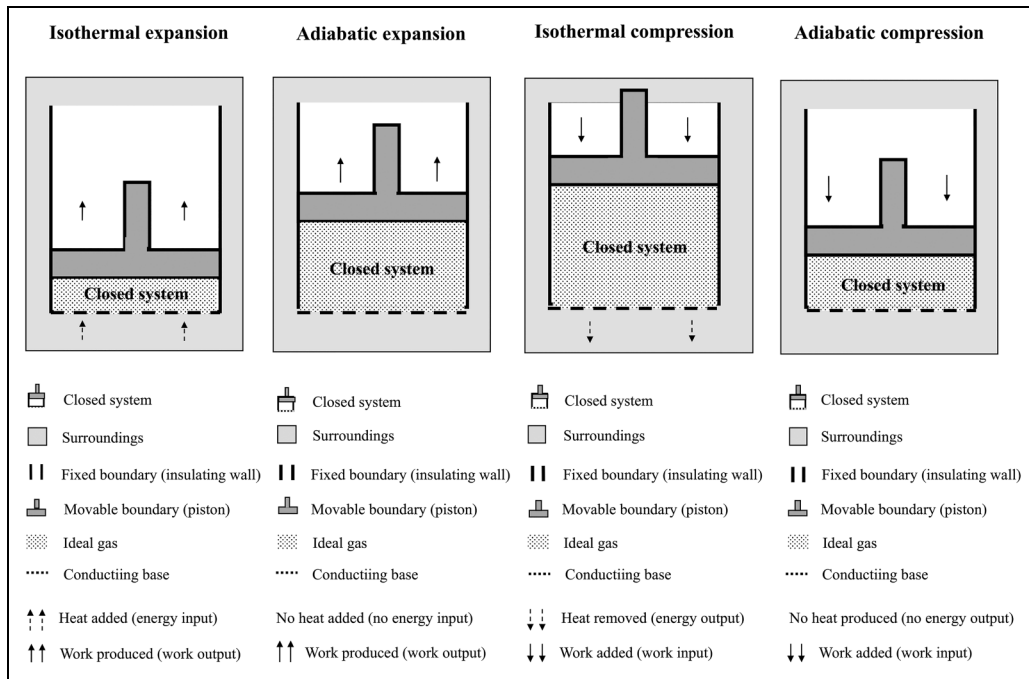


Figure 1. Carnot cycle: the four stages of the ideal piston-cylinder heat engine.

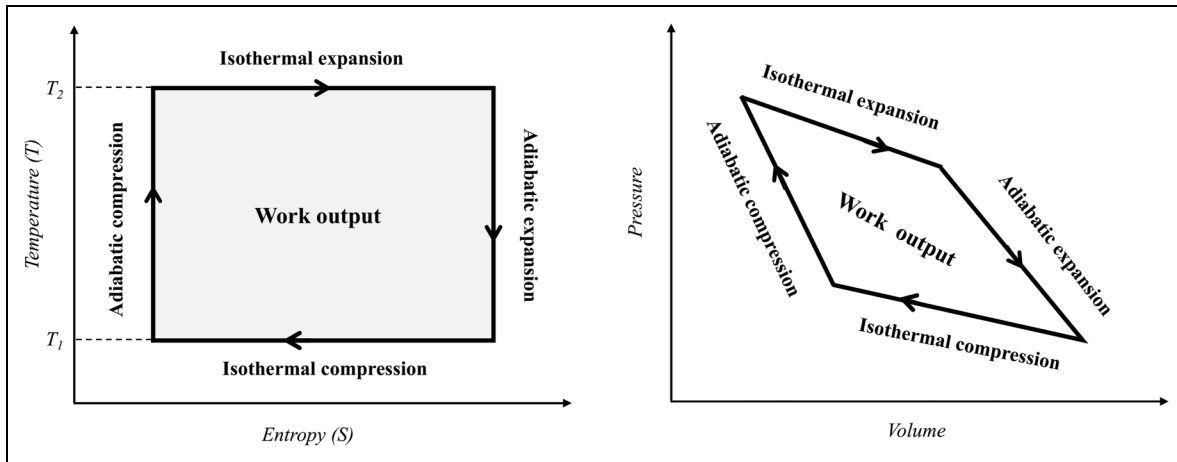


Figure 2. System properties and processes in the Carnot cycle: a graphical representation.

		System process			
		Isothermal expansion	Adiabatic expansion	Isothermal compression	Adiabatic compression
System property	Temperature	↔	↘	↔	↗
	Volume	↗	↗	↘	↘
	Pressure	↘	↘	↗	↗
	Entropy	↗	↔	↘	↔

Note: ↔ constant ↘ decrease ↗ increase

Figure 3. System properties and processes in the Carnot cycle: a tabular representation.

Table 1. Metaphorical Framework for Associating the Propaganda Machine Efficiency of the North Korean Autarkic System with the Carnot Cycle.

Thermodynamic concepts in the Carnot cycle		Marketing equivalents	
<i>Concept</i>	<i>Theoretical definition</i>	<i>Concept</i>	<i>Operational definition</i>
1. Closed system (a piston-cylinder device)	An area in space with limited environmental exchange - it exchanges energy but not mass with the surroundings.	1. Autarky	North Korea.
2. Surroundings	A set of objects situated outside a system that enable the regulation of its system properties.	2. Environment	International community: the rest of the world.
3. Boundaries	A real or imaginary line drawn between a system and its surroundings.	3. Boundaries	Scope of the <i>juche</i> ideology, personality cult, and international relations of the country.
3.1. Fixed boundary	A boundary that does not allow a system to exchange energy with the surroundings.	3.1. National policy framework	Scope of the <i>juche</i> ideology: the guiding rules and principles for political, economic, and military self-sufficiency, as defined in the constitution of the country.
3.2. Movable boundary	A boundary that moves during energy exchange between a system and its surroundings by either expanding or compressing the entire system from within.	3.2. Leadership vision	The strategic vision of the supreme leader for establishing and maintaining the personality cult.
3.3. Conducting base	A boundary that enables the exchange of heat energy between the system and the environment.	3.3. Scope of international relations	Scope of international treaties, agreements, and sanctions against North Korea.
4. Ideal gas	A working medium whose particles: 1) move chaotically rather than according to a specific pattern (e.g., they neither attract nor repel one another) and generate the internal energy of the system owing to their disordered motions, and 2) occupy no space/merely have no volume.	4. Place branding (madman theory)	The image that North Korea wants to build among the international community: the positioning of the country as an ideal place for its citizens (a happy and prosperous nation), but as an aggressive and irrational player regarding exchanges with the international community.
5. Energy exchange	Energy exchange between a system and its surroundings exists in two distinct forms: 1) Transfer of heat/thermal energy (Q) 2) Doing work/ transfer of mechanical energy (W)	5. Exchange policy	The domestic and foreign relationship policies established by the creators of the state propaganda (i.e., the supreme leader and the Workers' Party of Korea).
5.1. Heat energy (Q)	Thermal energy exchanged between a system and its surroundings due to a temperature difference between them.	5.1. International exchange	Diplomatic relationships with the rest of the world (e.g., based on provocations and/or negotiations).
5.2. Work (W)	Mechanical energy exchanged between a system and its surroundings.	5.2. Domestic exchange	North Korean domestic propaganda that promotes the <i>juche</i> ideology and cult of the supreme leader.
6. System properties	Macroscopic characteristics of a system.	6. Autarkic attributes	Macroeconomic characteristics of North Korea.
6.1. Temperature (T)	The degree or intensity of heat present in a substance or object.	6.1. Political self-sufficiency	<i>Chaju</i> is a term used in North Korea to describe the country's desired state of ideological independence in domestic and foreign affairs.
6.2. Volume (V)	The amount of space occupied by a working fluid (e.g., ideal gas) within a closed system.	6.2. Economic self-sufficiency	<i>Charip</i> is a term used in to describe the country's desired state of economic independence from the rest of the world.
6.3. Pressure (P)	The amount of force per area applied to the boundaries of a system.	6.3. Military self-sufficiency	<i>Chawi</i> is a term used to describe the country's desired state of defense independence from the rest of the world.

(continued)

Table 1. (continued)

Thermodynamic concepts in the Carnot cycle		Marketing equivalents	
Concept	Theoretical definition	Concept	Operational definition
6.4. Entropy (S)	The level of disorder and randomness of a system.	6.4. Entropy	Threats to the <i>juche</i> ideology and the overall stability.
7. Carnot engine	An ideal thermodynamic engine that absorbs heat and converts it into work at maximum efficiency.	7. Propaganda machine	The state propaganda designed to convert international diplomatic attempts for a peaceful co-existence with the country, into hostile threats against the country, aimed at reinforcing the domestic propaganda.
8. System processes (stages of Carnot cycle)	The transformations that a system undertakes when shifting from one state to another (e.g., due to changes in temperature, volume, and pressure)	8. Autarkic processes (stages of autarkic propaganda)	The image transformations that North Korea undertakes when shifting from one personality cult to another (e.g., due to changes in the relative level of importance of political, economic, and military self-sufficiency).
8.1. Isothermal expansion	A reversible process in which the heat energy added to a system produces work energy. It is characterized by constant temperature, and increases in volume and entropy, and a decrease in pressure.	8.1. Kim Il Sung (1972–1994)	President of the country, godlike leader (also known as the “Great leader”) and immortalized after his death as “the Eternal president of North Korea”. For propaganda to operate at maximum efficiency, his rule is assumed to be characterized by constant political self-sufficiency, increases in economic and military self-sufficiency, and a decrease in entropy.
8.2. Adiabatic expansion	A reversible process in which no heat energy is added to a system, but work energy is still produced by the system at the expense of its internal energy. It is characterized by constant entropy, decreases in temperature and pressure, and an increase in volume.	8.2. Kim Jong Il (1994–2011)	Addressed as “Dear leader” during the Great famine, titled the “Supreme Commander of the Korean People’s Army”, and immortalized after his death as the “Eternal General Secretary of the Workers’ Party of Korea” and “Eternal Chairman” of the National Defense Commission”. For propaganda to operate at maximum efficiency, his rule is assumed to be characterized by constant entropy, decreases in political and military self-sufficiency, and an increase in economic self-sufficiency.
8.3. Isothermal compression	A reversible process in which heat energy is removed from the system after the addition of work energy. It is characterized by constant temperature, decreases in volume and entropy, and an increase in pressure.	8.3. Kim Jong Un (since 2011)	The image of the modern, human-centered leader who improved North Koreans’ standard of living, and the supreme commander who significantly reinforced the country’s military defense self-sufficiency. For propaganda to operate at maximum efficiency, his rule is assumed to be characterized by constant political self-sufficiency, decreases in economic self-sufficiency and entropy, and an increase in military self-sufficiency.
8.4. Adiabatic compression	A reversible process in which no heat energy is produced by the system after the addition of work energy. It is characterized by constant entropy, a decrease in volume, and increases in pressure and temperature.	8.4. Next leader (forecast)	For the propaganda machine to operate at maximum efficiency, the rule of the next leader is assumed to be characterized by increases in political and military self-sufficiency, a decrease in economic self-sufficiency, and constant entropy.
9. Thermodynamic efficiency	Refers to how well heat energy is converted into work. $\eta = \frac{\text{Work produced by a system}}{\text{Heat energy added to a system}} = \frac{\text{Work output}}{\text{Energy input}}$ $\eta = \frac{\text{Heat energy removed from a system}}{\text{Work energy added to a system}} = \frac{\text{Energy output}}{\text{Work input}}$	9. Autarkic efficiency	The efficiency of the North Korean propaganda machine. It refers to how well the country uses its autarkic status (limited and strained exchanges with the international community) to reinforce its domestic propaganda, influence the thoughts, emotions, and attitudes of North Koreans, and ensure their loyalty to the supreme leader.
10. Carnot efficiency	Refers to the maximum thermodynamic efficiency of a reversible heat engine. It depends only on the temperature range through which the engine operates, and not on the properties of the working medium/fluid. $\eta = \left(\frac{T_2 - T_1}{T_2} \right)$	10. Maximum efficiency	The maximum efficiency of the North Korean propaganda machine primarily depends on changes in political self-sufficiency (Kim’s family’s change in political views on self-sufficiency) and less on other properties of the autarkic system.

is that entropy does not change: due to its reversible nature the total entropy change (system + environment) is zero which is in line with the idea of the long-term overall stability of the North Korean propaganda. Fourth, the “need for marketing machinery” has long been justified in the literature: “To perform the work involved in carrying out the marketing functions demands the construction of a huge, highly complicated piece of business machinery. ... The parts of this machine are the various business concerns having to do with marketing. ... Were our machinery an automobile engine instead of the marketing machine, all that we would be doing in at present would be to examine individually its cylinder block, its valves, its piston rod, piston head and piston rings, its spark plugs, its cam shaft, its timer, accelerator, gears, driving axle, differential and all its other parts laid out before us, as an

inspection table. ... Any [marketing] institution is made up of two elements, first, a doctrine, or purpose, and secondly a structure or organization or mechanism to forward its doctrine or purpose” (Breyer 1934/1978, pp. 24–53).

We suggest a holistic metaphorical framework for associating the propaganda machine efficiency of the North Korean autarkic system with the Carnot cycle for maximum energy efficiency (Table 1) and make some explicit assumptions regarding the relationship between the autarkic properties and autarkic processes (Figures 4 and 5).

Considering the above metaphorical analogies, we can assume that the repetitive historical attempts of the international community for heating up or cooling its relationships with North Korea (e.g., any attempts to help the country to slightly open or impose sanctions on it and close it to a higher extent)

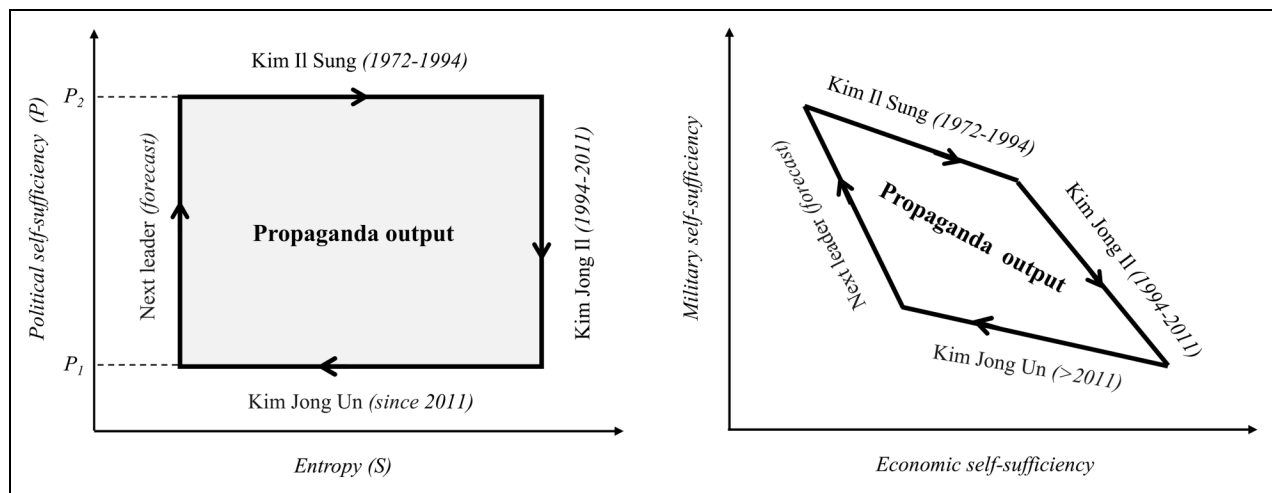


Figure 4. Assumed relationships between various autarkic properties and the stages of North Korean propaganda development: a graphical representation.

		North Korean propaganda stage (personality cult)			
		Kim Il Sung (1972–1994)	Kim Jong Il (1994–2011)	Kim Jong Un (since 2011)	Next leader (forecast)
Autarkic property	1. Political self-sufficiency	↔	↘	↔	↗
	2. Economic self-sufficiency	↗	↗	↘	↘
	3. Military self-sufficiency	↘	↘	↗	↗
	4. Entropy	↗	↔	↘	↔

Note: ↔ constant ↘ decrease ↗ increase

Figure 5. Assumed relationships between various autarkic properties and the stages of North Korean propaganda development: a tabular representation.

can be associated with the stages of expansion and compression in the Carnot cycle, and more precisely, with the exposure of the piston-cylinder heat engine to the hot and cold reservoirs (see Figure 1). The movement of the flexible system boundary (the piston) reflects the relative change in the strategic vision of the supreme leaders regarding the level of intensity in the implementation of the *juche* ideology: the piston moves in either of the two directions (upward or downward) without changing the system's state of closedness. We believe that regardless of the stage at which the North Korean state is, once it becomes a closed system, its state of closedness will stay unchanged as long as its main/fixed boundaries remain unchanged (the underlying constitutional principles for political, economic and military self-sufficiency).

North Korea has been efficiently using its limited political, economic, and military exchanges with the international community to maximize its domestic propaganda and to ensure the marketing efficiency of its entire autarkic system. Its strained relationships with the USA, South Korea, and Japan are meticulously used by creators of state propaganda to reinforce the personality cult and loyalty to the *juche* ideology. The international positioning of North Korea as an aggressive and irrational country that has nuclear weapons and, as a consequence, can behave in an unpredictable and chaotic manner at any time (i.e., the madman theory) also ensures that the country is taken seriously in the geopolitical landscape. "However, [t]his reputation for reckless violence has worked to North Korea's advantage in the present crisis; but in the long term, the overall consequences of the madman theory will be deleterious, both for the states that employ it and for global security" (Roy 1994, p. 307). Sadi Carnot initially believed that a heat engine is 100% efficient if it passes through the four thermodynamic stages of a specified process (i.e., isothermal expansion, adiabatic expansion, isothermal compression, and adiabatic compression). Over time, he realized that irretrievable energy losses to the environment are inevitable, regardless of the meticulous design of an engine. Even when operating in a reversible manner, an engine's efficiency is constrained by a fundamental limit known as thermodynamic efficiency. Constructing an engine with 100% efficiency is an unattainable task (Oxtoby, Gillis, and Campion 2012). As explained by Lucia (2016), later studies confirm that any endeavors to enhance Carnot's findings have consistently validated them, both in theory and through experimentation. It can be asserted that Carnot's results signify a universal law indicating a limit to the conversion rate of heat into mechanical energy (work). This limit has been recognized as a fundamental characteristic of all natural processes. We can assume that no matter how well designed and relatively predictable the North Korean propaganda machine is in terms of mispresenting information from the external world (e.g., converting the diplomatic attempts of the international community for peaceful co-existence to hostile threats against the *juche* ideology), it will have an upper efficiency limit and cannot manipulate every citizen, which is the most important macromarketing implication here. There have already been signals that North

Koreans trust state propaganda to a lesser extent than in the past (D'Ambrogio 2016). During the latest elections in the country, there were, for the first time since 1956, a few votes recorded against the ruling Workers' Party (Nerozzi 2023).

Data Collection

Inspired by the Carnot cycle, in Figures 4 and 5, we assumed that for North Korean propaganda to be maintained at maximum (though not 100%) efficiency, the system needs to pass through four stages (*autarkic processes*), each characterized by a distinctive pattern in terms of political, economic, and military self-sufficiency and entropy (*autarkic properties*). To examine initial evidence supporting the assumed relationships between autarkic processes and autarkic properties, we studied the North Korean autarkic development since the official adoption of the *juche* ideology in the country (1972–2021). First, we compiled our own database of autarkic performance indicators using secondary data sources from reputable institutions such as the KOF Swiss Economic Institute, International Monetary Fund (IMF), United Nations (UN) and Defense Intelligence Agency (Appendix 1, Table 1). Second, we used the constructed database to compute various descriptive measures of central tendency, dispersion, and growth, all of which will enable us later to offer preliminary evidence regarding the degree to which the assumed relationships between autarkic processes and autarkic properties align with the observed ones (Figures 6 and 7). The analysis was completed and situated within the context of the limited literature available on North Korea's past and current performance.

Building the Autarkic Database. This subsection provides a brief description of the key variables used to construct our database on North Korean autarkic performance, encompassing political, economic, and military self-sufficiency, as well as entropy, across the four predetermined propaganda periods.

Political self-sufficiency: the overall political self-sufficiency in our database was represented by the overall KOF Index of Political Globalization (KOFPoGI). This index, a well-established and complex measure of the political openness of countries and world regions (Gygli et al. 2019; KOF Swiss Economic Institute 2023), has been validated as relevant for studying the performance of closed and isolated marketing systems (Stoyanov, Stoyanova, and Stoyanov 2023). A lower KOFPoGI score corresponds to a higher level of political self-sufficiency, and vice versa. The KOFPoGI sub-indexes, *defacto* and *dejure* (KOFPoGI_{df} and KOFPoGI_{dj}), reflecting respectively the globalization outcomes and measures, allowed us to separately examine the political self-sufficiency of the country in domestic and foreign affairs. Alternative measures of political self-sufficiency with a comparable level of precision and complexity include the overall Index of Economic Freedom (IEF) and its subindexes. Due to their development by an American conservative think-tank (Heritage Foundation 2024), we opted not to include them in our analysis to mitigate potential geopolitical biases, given the traditionally tense

relations between North Korea and the USA. IEF data is unavailable for the entire period between 1972 and 2021, only covering the period since 1995.

Economic self-sufficiency was estimated using the Trade-to-GDP ratio, calculated from data on trade (exports, FOB + imports, CIF) and GDP at 2015 constant prices (to avoid any potential inflation biases). The data was sourced from the official websites of the International Monetary Fund (2023) and the United Nations Statistics Division (2023). This ratio is also known as the “trade openness ratio” (Organisation for Economic Co-operation and Development 2009) because it serves as a common indicator of a country’s economic openness and dependence on international trade. A lower Trade-to-GDP ratio corresponds to a higher level of the country’s economic self-sufficiency, indicating that a country relies less on trade to meet its domestic needs. A higher Trade-to-GDP ratio corresponds to a lower level of the country’s economic self-sufficiency, indicating that a country relies more on trade to meet its domestic needs. It also serves as a primary measure for illustrating the cyclical pattern of globalization and deglobalization in the world economy (Van Bergeijk 2019). A potential limitation of this indicator is that as an aggregate measure it tends to oversimplify the complexity of international trade relationships. North Korea may be self-sufficient in some product categories (e.g., agricultural products) but heavily reliant on imports for others (e.g., food, consumer electronics, and industrial equipment). Foreign aids, remittances, and informal trade exchanges with China and Russia, which also impact the economic performance of the country, fall outside the scope of Trade-to-GDP. Alternative measures of economic self-sufficiency are the ratios between domestic production and consumption developed in the European Union (EU) to measure its level of independence for various agricultural products from the rest of the world (Kaufmann et al. 2022). Due to limited data available on North Korean performance, we could not calculate this indicator for the country.

Military self-sufficiency: in our database, military self-sufficiency was quantified by the number of events related to missile launches and nuclear tests based on a report from the Defense Intelligence Agency (2021). Our premise is that a higher frequency of such events signifies a greater level of military (defense) self-sufficiency, and vice versa. A more sophisticated alternative measure of military self-sufficiency is the PowerIndex or *PwrIndx*, which has been estimating the military strengths of countries and global coalitions since 2006 (Global Firepower 2024). This composite index considers various factors, including but not limited to the size of military forces, equipment, manpower, logistical, and technological capabilities. Due to its limited temporal scope, it was not integrated into the constructed database to measure the military self-sufficiency of North Korea.

Entropy: in our database, entropy, originally a measure of disorder and randomness in a thermodynamic system, is measured by the GDP (implicit price) deflator, expressed in US dollars—chosen as a common and comprehensive measure

of inflation. It estimates changes in the prices of goods and services produced within a country relative to a specific base year, which, in our case, is 2015, selected for no specific reason except for the limited availability of inflation measures (United Nations Statistics Division 2023). Our assumption is that a higher level of inflation is associated with an increased level of entropy, serving as a measure of deviation from order or stability. We are aware that a significant decrease in inflation may not necessarily correspond to a decrease in entropy because it could be linked to a phenomenon known as “deflation,” which may also have negative impacts on the overall stability of the North Korean autarkic system. An alternative measure of entropy, for which data was available, was the GDP deflator expressed in the domestic currency—the North Korean Won (United Nations Statistics Division 2023). While this measure could be more representative of the price changes experienced by the local population and help us avoid potential geopolitical biases discussed previously, we still choose to present the evolution of the price changes in US dollars due to concerns about the accuracy or reliability of the data communicated by the North Korean government.

Selection of Descriptive Measures of Autarkic Performance. This subsection provides a rationale for the specific descriptive measures of central tendency, dispersion, and growth that we selected to measure the change in North Korean autarkic performance (autarkic properties) over the four predetermined propaganda periods. These measures form the basis for later analyzing the disparities between assumed and observed relationships between autarkic processes and autarkic properties.

Arithmetic mean value is the most common measure of the central tendency used to analyze linear relationships—when variations in the time series are mainly additive rather than multiplicative (e.g., the total number of missile launches and nuclear tests) or when no extreme values exist (outliers) in the dataset.

Geometric mean value is a less common measure of the central tendency usually applied to analyze the multiplicative effects of nonlinear phenomena. Compared to the arithmetic mean, it shows less sensitivity to outliers or skewed datasets and can provide more-accurate estimations when the data involve ratios (e.g., the Trade-to-GDP ratio), indices (e.g., KOFPoGI, KOFPoGI_{df}, and KOFPoGI_{dj}), or percentages and indicators whose reliabilities are sensitive to the base year for which they are calculated (e.g., the GDP deflator at 2015 constant prices). As the geometric mean can only be determined for positive values, it remains irrelevant when the dataset contains zero values (e.g., the number of missile launches and nuclear tests). An arithmetic mean equal to the geometric mean implies that every number in the dataset is the same (in which case they are all that number).

Arithmetic standard deviation: it measures the amount of dispersion in the dataset by taking into consideration the absolute differences between the data points and the arithmetic mean. In contrast to the geometric standard deviation, it provides a more precise estimation of the variability in the

dataset when the data points are absolute numbers rather than ratios, proportions, or indices (e.g., we used it to analyze the dispersion in the number of missile launches and nuclear tests).

Geometric standard deviation measures in ratios rather than absolute differences in the amounts of dispersion between the data points and the geometric mean. It holds more relevance than the arithmetic mean for analyzing the variability of ratios, proportions, or indices (e.g., KOFPoGIdf, KOFPoGIdj,

Trade-to-GDP ratio, and GDP deflator). During the rule of Kim Jong Un (since 2011), the geometric standard deviations of the KOFPoGIdf and KOFPoGIdj indices are both unity, which shows that the data points are evenly distributed around the geometric mean. The geometric standard deviation for the Trade-to-GDP ratio (%) is 2.52, which demonstrates that the data is 2.5-times more dispersed. It also enables researchers to more precisely estimate variability when GDP

Personality cult (time period)	Change measures	1. Political self-sufficiency			2. Economic self-sufficiency	3. Military self-sufficiency	4. Entropy
		in domestic affairs KOFPoGIdf	in foreign affairs KOFPoGIdj	overall KOFPoGI	Trade-to-GDP ratio (%)	Number of missile launches and nuclear tests	GDP deflator (US dollars)
Kim Il Sung (1972-1994)	1. Arithmetic mean value ^a	24.65	12.91	18.78	11.17	0.74	69.46
	2. Geometric mean value ^b	24.64	12.76	18.74	10.97	-	69.14
	3. Arithmetic standard deviation ^c	0.83	2.01	1.32	2.21	1.68	6.84
	4. Geometric standard deviation ^d	1.03	1.17	1.07	1.22	-	1.11
	5. Average annual growth rate ^e	0.24%	2.16%	0.86%	2.68%	-	-0.51%
	6. Compound annual growth rate ^f	0.22%	2.04%	0.84%	2.00%	-	-0.82%
	7. Cumulative change ^g	-	-	-	-	17	-
	Change in self-sufficiencyⁱ	↔	↘	↘	↘	↗	↘
Kim Jong Il (1994-2011)	1. Arithmetic mean value ^a	22.64	34.61	28.62	26.21	2.50	76.17
	2. Geometric mean value ^b	22.62	33.43	28.36	24.40	-	74.45
	3. Arithmetic standard deviation ^c	1.06	7.80	3.72	10.38	4.09	14.40
	4. Geometric standard deviation ^d	1.05	1.35	1.16	1.47	-	1.27
	5. Average annual growth rate ^e	-0.69%	6.78%	2.77%	10.33%	-	7.01%
	6. Compound annual growth rate ^f	-0.75%	5.71%	2.54%	7.82%	-	3.60%
	7. Cumulative change ^g	-	-	-	-	45	-
	Change in self-sufficiencyⁱ	↗	↘	↘	↘	↗	↗
Kim Jong Un (since 2011)	1. Arithmetic mean value ^a	21.87	41.48	22.17	32.77	10.55	104.34
	2. Geometric mean value ^b	21.87	41.48	21.99	25.29	-	104.23
	3. Arithmetic standard deviation ^c	0.47	0.46	3.30	17.10	9.61	4.92
	4. Geometric standard deviation ^d	1.02	1.01	1.14	2.52	-	1.05
	5. Average annual growth rate ^e	-0.34%	0.31%	-3.62%	-18.23%	-	1.37%
	6. Compound annual growth rate ^f	-0.36%	0.31%	-4.33%	-29.30%	-	1.27%
	7. Cumulative change ^g	-	-	-	-	116	-
	Change in self-sufficiencyⁱ	↔	↔	↗	↗	↗	↗
Next leader (forecasted values) ^h	1. Arithmetic mean value ^h	23.05	29.67	23.19	23.38	4.59	83.32
	2. Geometric mean value ^h	23.01	26.06	22.69	18.92	-	81.26
	3. Arithmetic standard deviation ^h	1.44	14.91	5.00	11.07	5.23	18.50
	4. Geometric standard deviation ^h	1.06	1.87	1.23	-	-	1.24
	5. Average annual growth rate ^h	-0.26%	3.08%	0.00%	-1.74%	-	2.62%
	6. Compound annual growth rate ^h	-0.30%	2.69%	-0.32%	-6.50%	-	1.35%
	7. Cumulative change ^h	-	-	-	-	158	-
	Change in self-sufficiencyⁱ	↔	↘	↔	↗	↗	↗

Figure 6. Observed relationships between autarkic properties and stages of North Korean propaganda development: a descriptive analysis. (continued)

Notes:	
a	Own calculation, based on the "AVERAGE" function in MS Excel.
b	Own calculation, based on the "GEOMEAN" function in MS Excel.
c	Own calculation, based on the "STDEV.S" function in MS Excel.
d	Own calculation, based on the following MS Excel formula " =EXP(STDEV(LN(data_set/geometric_mean)))".
e	Own calculation, based on the average of the year-over-year (y-o-y) changes in autarkic performance for each pair of consecutive years within each propaganda period. The employed formula was the following one: Average annual growth rate, % = (Sum of y-o-y growth rates within the period / Number of years within the period) x 100
f	Own calculation, based on the geometric mean and the duration of each propaganda period (measured in years, n), illustrating the relative change in autarkic performance from the beginning to the end of each period. The employed formula was the following one: Compound annual growth rate = (Ending value / Beginning value) ^ (1/n) - 1. Example: Compound annual growth rate KOPPoGldf, % (1972–1994) = ((KOPPoGldf (1994) / KOPPoGldf (1972)) ^ (1/22)) - 1.
g	Own calculation, based on the "SUM" function in MS Excel. It represents the absolute change in autarkic performance by summing up the total number of missile launches and nuclear tests since the beginning of each period.
h	Own calculation, based on the "SUM" function in MS Excel.
i	Own calculations, based on various forecasting techniques and functions in MS Excel: <ol style="list-style-type: none"> 1. Arithmetic mean was calculated using the "AVERAGE" function, based on the arithmetic mean values of the previous three periods/stages in the personality cult. 2. Geometric mean was calculated using the "GEOMEAN" function, based on the geometric means of the previous three periods/stages in the personality cult. 3. Arithmetic standard deviation was calculated using the "STDEV.S" function, based on the arithmetic mean values of the previous three periods/stages in the personality cult. 4. Geometric standard deviation was calculated using the "EXP(STDEV(LN(data_set/geometric_mean)))" formula, based on the data_set of geometric mean values of the previous three periods/stages in the personality cult and the geometric mean value of the current period/stage in the personality cult. 5. The average annual growth rate was calculated using the "AVERAGE" function, based on the average annual growth rate of the previous three periods/stages in the personality cult. 6. Compound annual growth rate was calculated using the "AVERAGE" function, based on the compound annual growth rates of the previous three periods/stages in the personality cult.
j	An aggregate measure that captures the overall change in the level of self-sufficiency based on all of the above measures.

Figure 6. Continued.

		Stages of North Korean propaganda (personality cult)							
		Kim Il Sung (1972–1994)		Kim Jong Il (1994–2011)		Kim Jong Un (since 2011)		Next leader (forecast)	
		Assumed change	Observed change	Assumed change	Observed change	Assumed change	Observed change	Assumed change	Observed change
Autarkic property	1. Political self-sufficiency	↔	↘	↘	↘	↔	↗	↗	↔
	2. Economic self-sufficiency	↗	↘	↗	↘	↘	↗	↘	↗
	3. Military self-sufficiency	↘	↗	↘	↗	↗	↗	↗	↗
	4. Entropy	↗	↘	↔	↗	↘	↗	↔	↗

Note:
 aMatrix cells colored white indicate deviations of the North Korean propaganda machine from its assumed maximum level of efficiency.
 bMatrix cells colored dark grey indicate adherence (conformity) of the North Korean propaganda machine to its assumed maximum level of efficiency.

Figure 7. Heat map showing gaps between assumed and observed relationships between autarkic properties and propaganda stages.

is adjusted for inflation (estimated in constant prices through the application of the GDP deflator). During the rule of Kim Jong Un (since 2011), the geometric standard deviation of the GDP deflator is 1.05, which demonstrates almost negligible variability in the dataset, while data dispersion measured through the arithmetic standard deviation provides an absolute difference of 4.92, which is less straightforward to interpret.

Average annual growth rate is employed to quantify the relative change in autarkic performance based on the average of the year-over-year (y-o-y) changes in autarkic performance for each pair of consecutive years within each propaganda period. The formula for calculating the average annual growth rate, expressed as a percentage, is as follows: Average annual growth rate, % = (Sum of y-o-y growth rates/Number of years) x 100. It serves as a relatively simple and straightforward indicator used to smooth annual

fluctuations. It facilitates the comparison of growth rates across different time periods, providing a clear and accessible measure of the change in autarkic performance. Average annual growth rate is not sensitive to outliers in the dataset and assumes linear growth, which may not accurately reflect scenarios with compounding effects. To compensate for these limitations and provide a more comprehensive measure of the change in autarkic performance, we also calculated the Compound annual growth rate.

Compound annual growth rate is used to measure the relative change in autarkic performance between the beginning and the end of each propaganda period by taking into consideration the geometric mean and the duration of the period in terms of the number of years (n). The formula employed for calculating it, expressed as a percentage, was as follows: Compound annual growth rate = (Ending value / Beginning value) ^ (1/n) - 1.

Cumulative change is used to measure the absolute change in autarkic performance by summing up the total number of missile launches and nuclear tests since the beginning of each period. We employed this indicator because zero values are presented for many of the years in the dataset, which makes it impossible to estimate relative growth rates in a meaningful way (i.e., average annual growth rate and compound annual growth rate) without making some adjustments and logarithmic transformations that may bias the data.

Change in self-sufficiency: an aggregate measure that captures the overall change in the level of self-sufficiency based on all of the above measures.

Analysis and Results

Building upon the analogies drawn and the database constructed in the preceding section, we provide in Figures 6 and 7 some preliminary evidence on the existing gaps between the assumed and observed changes in the relationships of the autarkic properties and stages of the North Korean propaganda machine. Based on the descriptive statistics calculated in Figure 6, we conclude that: Although most of the assumed changes in autarkic properties required for the North Korean propaganda machine to operate at maximum efficiency do not correspond to those actually observed, each North Korean propaganda stage is characterized by a distinctive pattern in terms of its autarkic properties:

The autarkic performance of the country was characterized in the following ways during the rule of Kim Il Sung (1972–1994):

- *a decrease in overall political self-sufficiency*
- *a decrease in economic self-sufficiency*
- *an increase in military self-sufficiency*
- *a decrease in entropy*

Although Kim Il Sung established the official autarkic state ideology, partially in an attempt to limit its ideological independence from the Soviet Union and China, the initial version of the *juche* ideology was largely influenced by the communist movements in these countries; it relied on Marxist–Leninist principles, the philosophy of Mao Zedong (1893–1976), and the Chinese communist party. Kim Il Sung even acknowledged that North Korea’s survival was largely dependent on the assistance of its communist supporters. He promoted strong economic and technical cooperation with socialist nations, considering it crucial for both economic advancement and ideological cohesion (Lee 2003). With the help of the Soviet Union, he even initiated his country’s nuclear weapons program.

The autarkic performance of the country was characterized in the following way during the rule of Kim Jong Il (1994–2011):

- *a decrease in overall political self-sufficiency*
- *a decrease in economic self-sufficiency*
- *an increase in military self-sufficiency*
- *an increase in entropy*

The rule of Kim Jong Il (1994–2011) was marked by an important increase in the level of entropy; between 1994 and 1998, North Korea was impacted by a series of natural disasters and faced its most severe food crisis since the adoption of the *juche* ideology (i.e., The Great North Korean Famine). It forced the country to receive humanitarian support from the World Food Program, UNICEF, the World Health Organization, and the Red Cross, which decreased its level of economic and political independence. In 2009, the North Korean “economy was thrown temporarily into chaos when a government currency-reform program reduced the won to 1 percent of its former value while limiting individuals to exchanging only a small amount of the old currency for the new. The revaluation—which was aimed in part at curbing private market activity—led to inflation, a food crisis, and public protests as many citizens saw their savings vanish” (Lee et al. 2023). In 1998, Kim Jong Il introduced the “military-first” policy (*son’gun chongch’i*) by prioritizing the Korean People’s Army over the previously ruling communist party in the government of the country and making the National Defense Commission the most important institution in the country (Suh 2002). He considered military self-sufficiency as the most important in completing the *juche* revolution of his generation, which led to North Korea conducting its first nuclear tests in 2006 and 2009.

The autarkic performance of the country was characterized in the following ways during the rule of Kim Jong Un (since 2011):

- *an increase in overall political self-sufficiency*
- *an increase in economic self-sufficiency*
- *an increase in military self-sufficiency*
- *an increase in entropy*

All three types of self-sufficiency (political, economic, and military) increased only during the rule of Kim Jong Un (since 2011). A more-careful look at the data reveals that “Simpson’s paradox” is the most likely reason for why the overall political self-sufficiency of the country increased during this period. “Simpson’s paradox” is a statistical phenomenon in which a trend observed in two or more population groups disappears or even reverses when the groups are aggregated. In fact, while domestic and foreign affairs exhibited relatively stable political self-sufficiencies, the overall political self-sufficiency score increased (See Figure 6). In 2013, Kim Jong Un adopted the *Byungjin* policy, which, in contrast to the “military-first” policy introduced by his father, attempted to balance nuclearization with the accelerated economic development of the country (Hastings and Lee 2023). A study by The Korea Institute for National Unification demonstrated that the country’s inflation significantly increased in 2020 (e.g., the prices of agricultural products increased by 122.7% while those of food products increased by 39.1%, leading to an average annual increase of 17.2%) due to the closure of state borders during the COVID-19 pandemic, as reported by Oh (2021).

Based on the principles of the Carnot cycle, the autarkic performance of the country during the rule of the next supreme leader (e.g., Kim Yo-jong or Kim Ju-ae) is expected to be characterized by:

- a stable overall political self-sufficiency
- an increase in economic self-sufficiency
- an increase in military self-sufficiency
- an increase in entropy

Military self-sufficiency is the only autarkic property that has increased during each of the four North Korean propaganda stages since the adoption the *juche* ideology in 1972. Consistent with a previous study, we see it as the key determinant for the survival and stability of the North Korean autarkic system (Woo 2014). Today, North Korea has the highest per capita military expenditure (Institute for Economics and Peace 2023) and the fourth largest army worldwide (Global Firepower 2023a). The country disposed of five nuclear warheads in 2015 and was estimated to have about 30 in 2023 (Federation of American Scientists 2023).

According to the Carnot cycle, the maximum efficiency of any reversible heat engine (η) depends only on the temperature range through which it works $(T_2 - T_1)/T_2$ and not on the properties of the working medium:

$$\eta = \frac{(T_2 - T_1)}{T_2}$$

A heat engine is more efficient when operated across a larger temperature difference. Although we assumed previously that the maximum efficiency of the North Korean propaganda machine primarily depends on changes in political self-sufficiency (see Table 1, Assumption No. 10), based on our findings (preliminary evidence) on the relative importance of the military self-sufficiency, we can speculate here that the efficiency of the North Korean propaganda machine primarily depends on changes in military self-sufficiency and less on changes in other autarkic properties of the system (political and economic self-sufficiency, and entropy). We can forecast the efficiency of the entire autarkic system to a greater extent by only knowing the level of military self-sufficiency. The autarkic system is calculated to be 89% efficient using the range in the total number of missile launches and nuclear tests through the assumed four-stage North Korean propaganda cycle (see Figure 6):

$$\eta = \frac{(158 - 17)}{158} = 0.89$$

Discussion and Managerial Implications

This study demonstrated how a classical thermodynamic efficiency engine can be used to study the propaganda machine efficiency of a typical autarkic system. By doing this, we simultaneously made theoretical, methodological, and empirical contributions to the marketing field, the primary implications of which are briefly discussed in the following subsections.

Theoretical Implications

Roger Layton (1934–2021) made some of the most significant contributions to the theory of macromarketing systems. His well-established definition of a marketing system describes it as “a network of individuals, groups, and/or entities linked directly or indirectly through sequential or shared participation in economic exchange that creates, assembles, transforms, and makes available assortments of products, both tangible and intangible, provided in response to customer demand” (Layton 2007, p. 230). In his theory of complex adaptive systems, influenced by evolutionary biology (Layton 2019), he assumed that marketing systems are predominantly open in nature and explicitly based on voluntary exchanges (Layton 2011; Layton, Domegan, and Duffy 2022). He defined autarkic systems within a micromarketing context, referring to households or individuals that are self-sufficient within their group or family unit. These systems can occasionally emerge in modern societies, and their behavior is characterized as random, non-purposeful, and unstructured (Layton 2009, 2010).

In this study, we took a distinct perspective by partially challenging the aforementioned definition and conventional premises of marketing systems. Our inspiration was drawn from the field of chemistry, specifically chemical thermodynamics, and its most energy-efficient thermodynamic engine closed to mass exchange with the environment. We conceptualized *autarky* in the macromarketing context of deglobalization as a closed marketing system that 1) operates with the specific purpose of propaganda in a relatively predictable and efficient manner; 2) has an extremely limited, though not entirely absent, interaction with the international environment; and 3) involves participants (actors) who do not engage in voluntary exchanges with one another but rather collectively, as well as individually, adhere consistently to the self-reliance ideology. Alderson (1957) associated closed marketing systems with self-sufficient systems in communication theory, using the example of a telephone circuit that runs efficiently only when the system is closed as opposed to being open and out of balance (e.g., in the case of a broken wire). We can assert that the efficiency of North Korea’s autarkic system in disseminating propaganda depends not only on the military’s self-sufficiency, as we concluded earlier, but also on the system remaining closed to the influences of globalization.

These findings and associative reasoning perfectly align with the two generalizations made by Alderson et al. (1956) regarding the Soviet Union—a closed system triggered by: 1) “morality in terms of military necessity” (p. 5) and 2) “a single doctrine ... accepted as the one true faith, and ruled by a priestly hierarchy who proclaimed themselves to be the guardians and interpreters of that faith” (p. 11). The resemblances between the North Korean and Soviet contexts are striking. The observations made by the Quaker delegation at the height of the Cold War and ours—about 70 years later, at the height of a potential nuclear conflict between North Korea and the USA—underscore a typical autarkic pattern throughout different historical periods.

Methodological Implications

Our conceptualization of autarkic systems enabled us to construct the first metaphorical framework of North Korean propaganda efficiency, inspired by an ideal model from chemical thermodynamics, and partially overcome the outdated mentality that (macro)marketers should exclusively adopt an exchange perspective instead of consistently looking for new interdisciplinary insights (Benton 2021). It also contributes to the development of the *chemistry of marketing* (Stoyanov, Stoyanova, and Stoyanov 2023) by extending its metaphorical premises to a specific phenomenon (propaganda) and context (North Korea) and incorporating a model of thermodynamic efficiency (Carnot cycle). The database of standardized self-sufficiency measures that we constructed for studying the relationship between autarkic properties and autarkic systems can effectively support future studies. It can serve as benchmark criteria for evaluating the performance not only of autarkic systems but also of conventionally open marketing systems, which may aim, for various reasons, to achieve a higher level of self-reliance in political, economic, and/or military terms. Short supply chains have been viewed as a determinant for improving the sustainability performance of food systems (Kaufmann et al. 2022), which is why, since 2017, the EU has improved its self-sufficiency rates on many agricultural products (Directorate-General for Agriculture and Rural Development 2023). Finally, we expect that our unconventional approach to examining propaganda efficiency in autarkic systems, while not without imperfections, will inspire and instill confidence in more researchers to experiment with alternative methodologies when studying marketing systems. Interactive systems simulations can be employed to test the reliability and validity of these unorthodox approaches in predicting macromarketing phenomena through the examination of input values and outcomes (Wooliscroft 2021).

Empirical Implications

While this study presents limited empirical evidence on the efficiency of North Korean propaganda and the relationship between autarkic processes and properties, it still provides a valuable evolutionary perspective on the country's performance in terms of political, economic, and military self-sufficiency, as well as entropy. Our findings reveal distinct patterns in the autarkic properties at each stage of North Korean propaganda, with military self-sufficiency emerging as the only facet of the *juche* ideology consistently advancing since its official establishment. Notably, during each propaganda stage, observable improvement is observed in at least one aspect of the *juche ideology* (e.g., military self-sufficiency during Kim Il Sung's rule, political self-sufficiency in domestic affairs and military self-sufficiency during Kim Jong Il's rule, and enhancements in all three types of self-sufficiency under Kim Jong Un's current leadership). The system constantly shifts its priorities from one type of self-sufficiency to another, yet it remains relatively stable (predictable) in a way that during each propaganda stage the *juche* ideology in the country improves in some areas (represented metaphorically

by the upward and downward movements of the piston cylinder), which gave us the basis to assert that the North Korean propaganda has been operating efficiently. Another interesting finding of our study, in line with the previous one, is that, except for the first stage of North Korean propaganda during Kim Il Sung's era (1972–1994), when the foundations of the autarkic ideology were laid, entropy consistently increases during all subsequent stages. This may indicate that as the autarkic system matures, entropy evolves, potentially because of the various challenges associated with sustaining self-sufficiency.

Understanding all these dynamics can inform policy decisions and strategic planning in areas such as economic development, political stability, and national security. These findings may serve as a foundation for future research, prompting scholars to delve deeper into specific aspects of autarky and its implications.

Concluding Remarks and Directions for Future Research

Under the metaphorical premise that autarkic systems are machines that operate with specific purposes (propaganda) in a relatively predictable and efficient manner, we investigated how an ideal thermodynamic engine (the Carnot cycle) can be used to better understand the efficiency of a typical autarkic system (North Korea). This study inevitably suffers from some limitations that future studies are expected to overcome by:

- 1) *Providing additional hard evidence for the applicability of the Carnot cycle to autarkic systems and relating it to other marketing theories:* As discussed previously, North Korea is a secretive country that rarely provides the international community with official data about its performance since the adoption of the *juche* ideology. Some of the country's statistics used in this study may be viewed as being insufficiently reliable, as available country statistics are often viewed as "guestimates" because they are mainly based on self-reported statements, data delivered by its primary trading partners (China and Russia), or predictions made by South Korean and international institutions (e.g., KOTRA, UN, IMF, and the KOF Swiss Economic Institute). Our findings may not represent the overall autarkic performance of North Korea due to the limited number of indicators that we managed to standardize for the entire period (1972–2021) and the descriptive nature of our analysis. Future studies that check the reliability of our assumptions and the validity of our conclusions in the same and other settings by applying more advanced statistical analyses will be important. As North Korean behavior can be linked to nonlinear phenomena in the context of the madman theory (Roy 1994), it would be interesting to apply nonlinear dynamic methods that are traditionally used to study chaotic elements in temporal processes (e.g.,

Malyutina and Shiryaev 2014) to verify the statistical significance and validity of our associative reasoning and descriptive analysis.

Although the term “propaganda” has traditionally had negative connotations, being associated with totalitarian regimes, some researchers have already demonstrated its historical importance to democratic societies (Bernays 1928/2005; Gardeström 2018), and it would be interesting to draw a parallel between the propaganda efficiency of closed and open marketing systems. North Korean propaganda stages may also be studied in relation to product lifecycle theory (Vernon 1966), in which the *juche* ideology is associated with the product of the North Korean propaganda and the four stages of the Carnot cycle, with the conventional stages of introduction, growth, maturity, and decline. Business cycles, which are usually longer when applied to capitalist processes, may provide another useful analogy (e.g., Kondratieff 1935; Schumpeter 1939) but can be adopted for the development of autarkical propaganda whose communist processes are primarily triggered by self-reliance rather than economic-growth priorities. The four stages of the autarkic development of North Korea may be compared with the conventional business cycles of open economies to identify consistent and distinct behavioral patterns: 1) isothermal expansion (*boom*), 2) adiabatic expansion (*peak*), 3) isothermal compression (*recession*), and 4) adiabatic compression (*trough*).

- 2) *Metaphorically associating autarkies with other classic performance maximization models developed for closed thermodynamic systems*, such as those of Stirling, Helmholtz, and Gibbs. The theoretical efficiency of the Stirling cycle approaches that of the Carnot cycle; it represents an ideal model of a small and quiet heat engine that also consists of a series of reversible processes and provides insight into the conversion of heat into work within a closed system. Helmholtz and Gibbs free energies are both benchmarks used to measure the thermodynamic potentials of closed systems (the maximum amount of useful work that can be obtained by a closed system at chemical equilibrium). While the Helmholtz free energy measures the amount of useful work obtained from a closed system at constant temperature and volume, the Gibbs free energy measures the maximum amount of useful work obtained from a closed system at constant temperature and pressure.
- 3) *Associating autarkic efficiency with perpetual motion in an isolated system*. The concept of a perpetuum mobile device (a device that can operate infinitely without an external energy source) is considered epistemologically impossible as it contradicts the laws of thermodynamics. As some models have already claimed to provide important contributions in this direction (e.g., Maxwell’s daemon, the Brownian ratchet, and zero-

point energy), we believe that they can nevertheless be metaphorically associated with autarkic systems to provide marketers with valuable insight. Studying how an autarkic system without military self-sufficiency can operate efficiently would be interesting in the context of the zero-point-energy model, which determines the lowest possible energy that a system can have at a temperature of absolute zero. In this regard, Bhutan would provide an interesting case study given its status as one of the most isolated (deglobalized) countries in the world (Stoyanov, Stoyanova, and Stoyanov 2023) and its weak military (Global Firepower 2023b).

- 4) *Developing more holistic models that are not only limited to improving the efficiencies of closed or isolated systems*. The primary aim of this study was to inspire researchers and eventually improve their conceptual and methodological understandings of marketing efficiency. As explained by Fisk (1967) “[e]ven if we could somehow gain as much efficiency as technically possible, we would still be haunted by the question of effectiveness” (p. 15). This is due to the inherent ambiguity surrounding the concept of efficiency, including divergent interpretations of the concept, difficulties in establishing a connection between a specific unit of output and past inputs, and complications arising from variability in measurement units. Future studies should also investigate effectiveness, as an alternative and/or complementary measure of marketing performance. Meng (2015) developed a framework that simultaneously relies on efficiency and effectiveness benchmarks for measuring the impact of marketing activities on sustainability. To fully comprehend the causality of an autarkic system, we believe that future researchers should be inspired by Aristotelian physics and study the four possible behavioral causes in the following way: 1) *The material cause* – what are the factors related to the material culture of an autarkic system (e.g., technology, economics, and geography) that mathematical models and/or machine learning algorithms can use to better understand and forecast its behavior? 2) *The formal cause* – what constitutes the typical structure or design of an autarkic system, shaping its identity (e.g., political system and social institutions)? 3) *The efficiency cause* – what triggers the (lack of) change in performance of an autarkic system? 4) *The final cause* – what is the primary goal of existence of an autarkic system (e.g., self-sufficiency and survival, growth or simply maintaining equilibrium in the universe by resisting a globalized world dominated by open systems)?

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Associate Editor

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Notes

1. Although the *juche* ideology was officially adopted in North Korea in 1972, the establishment of its conceptual development started after the death of Joseph Stalin (1953) and was followed by the consecutive adoption policies on economic self-sufficiency (1956), political self-sufficiency in domestic affairs (1957), military self-sufficiency (1962), and political self-sufficiency in foreign affairs and diplomacy (1966), and finally the election of Kim Il Sung as the president of North Korea (1972).
2. We are aware of the existence of alternative views on this topic. Benton (2021) explains that “autarchy and autarky are not alternative spellings of the same word. They have different etymological roots and are different words. Autarchy (autocratic or despotic rule) comes from *αυταρχία* while autarky is derived from *αυτάρκεια*, itself derived from *αυτάρκης*, meaning self-sufficient” (p. 99). As many previous studies refer to self-sufficient systems as autarchies and to avoid any potential confusions when reviewing the previous literature on the topic, we clarify above that the forms “*autarchy*”, “*autarchie*”, and “*autarky*” are reviewed in this study as synonyms whenever they are employed by researchers in reference to self-sufficiency.

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Appendix I

Table I. Initial Evidence for the Presumed Relationships Between Autarkic Properties and the Stages of the North Korean Personality Cult.

Personality cult (time period)	Year	1. Political self-sufficiency			2. Economic self-sufficiency	3. Military self-sufficiency	4. Entropy
		in domestic affairs KOFPoGIdf ^a	in foreign affairs KOFPoGIdj ^b	overall KOFPoGI ^c	Trade-to-GDP ratio (%) ^d	Number of missile launches and nuclear tests ^e	GDP deflator (US dollars) ^f
Kim Il Sung (1972-1994)	1972	24.14	10.18	17.16	N/A	0	64.74
	1973	24.14	10.18	17.16	N/A	0	64.74
	1974	24.14	10.18	17.16	N/A	0	64.74
	1975	24.14	10.18	17.16	N/A	0	64.74
	1976	24.14	10.18	17.16	N/A	0	64.74
	1977	24.14	10.18	17.16	N/A	0	64.74
	1978	24.14	12.57	18.36	N/A	0	64.74
	1979	24.14	12.57	18.36	N/A	0	64.74
	1980	24.13	12.53	18.33	N/A	0	64.74
	1981	24.12	12.48	18.30	10.61	0	64.74
	1982	24.10	13.22	18.66	10.54	0	78.42
	1983	24.15	13.17	18.66	9.46	0	75.54
	1984	24.16	13.13	18.65	8.41	7	69.43
	1985	24.19	13.08	18.64	8.25	0	65.98
	1986	24.23	13.04	18.63	8.17	0	73.58
	1987	24.26	13.77	19.01	10.43	0	76.49
	1988	25.77	13.72	19.74	12.36	0	74.39
	1989	25.68	14.04	19.86	10.94	0	81.52
	1990	27.00	14.76	20.88	12.15	2	79.41
	Kim Jong Il (1994-2011)	1991	25.70	15.83	20.77	12.39	2
1992		25.83	16.08	20.96	13.63	1	75.76
1993		25.20	15.99	20.60	15.37	4	68.41
1994		25.34	15.87	20.61	13.72	1	54.03
1994		25.34	15.87	20.61	13.72	1	54.03
1995		23.00	15.34	19.17	16.16	0	32.98
1996		22.90	26.79	24.84	21.12	0	74.51
1997		21.61	30.81	26.21	17.62	0	77.68
1998		21.78	34.47	28.13	15.58	1	78.02
1999		21.71	35.21	28.46	14.37	0	73.59
2000		21.62	35.43	28.53	22.11	0	75.63
2001		21.56	36.64	29.10	28.94	0	75.74
2002		21.52	37.66	29.59	21.00	0	74.08
2003		23.26	38.11	30.69	19.30	3	73.70
2004		23.27	37.50	30.38	24.12	1	72.96
2005		24.35	37.86	31.10	28.03	2	82.05
2006		23.73	38.94	31.33	33.41	10	87.56
2007		22.50	39.98	31.24	38.75	7	92.54
2008		22.60	40.34	31.47	41.12	6	83.28
2009		22.37	40.38	31.37	28.98	14	75.84
2010	22.13	40.78	31.46	38.14	0	88.30	
2011	22.28	40.81	31.55	49.32	0	98.55	

(continued)

Table 1. (continued)

Personality cult (time period)		1. Political self-sufficiency			2. Economic self-sufficiency	3. Military self-sufficiency	4. Entropy
		in domestic affairs KOFPoGldf ^a	in foreign affairs KOFPoGldj ^b	overall KOFPoGI ^c	Trade-to-GDP ratio (%) ^d	Number of missile launches and nuclear tests ^e	GDP deflator (US dollars) ^f
Kim Jong Un (since 2011)	2011	22.28	40.81	31.55	49.32	0	98.55
	2012	22.08	40.85	31.47	47.28	4	98.63
	2013	22.24	41.21	31.73	49.65	1	101.62
	2014	22.37	41.25	31.81	45.79	13	105.62
	2015	22.47	41.27	31.87	41.61	7	100
	2016	21.44	41.61	31.53	39.85	23	99.25
	2017	21.51	41.94	31.73	34.68	24	106.38
	2018	21.17	41.95	31.56	21.86	0	111.77
	2019	21.56	41.95	31.75	21.49	25	104.01
	2020	21.57	41.95	31.76	5.41	10	105.72
	2021	N/A	N/A		3.49	9	111.81

Notes:

^aBased on the original data from the KOF Swiss Economic Institute (2023). The KOF index of Political Globalisation, de facto (KOFPoGldf), is an aggregate measure that assesses the degree of political openness in countries on a scale of 0 to 100. It is based on the following variables: absolute number of embassies in a country, personnel contributed to U.N. Security Council Missions (% of population), and the number of internationally oriented nongovernmental organizations (NGO) operating in that country.

A lower KOFPoGldf score corresponds to a higher level of political self-sufficiency in terms of the country's domestic affairs, and vice versa.

^bBased on the original data from the KOF Swiss Economic Institute (2023). The KOF index of Political Globalisation, de jure (KOFPoGldj), is an aggregate index that measures the level of political openness on a scale of 0 to 100. It assesses countries based on variables such as the number of international inter-governmental organizations in which a country is a member, international treaties signed between two or more states and ratified by the highest legislative body of each country since 1945, and the number of distinct treaty partners of a country with bilateral investment treaties.

A lower KOFPoGldj score corresponds to a higher level of political self-sufficiency in terms of the country's foreign affairs, and vice versa.

^cBased on the original data from the KOF Swiss Economic Institute (2023).

The overall KOF Index of Political Globalisation (KOFPoGI) represents the average score of the KOFPoGldf and KOFPoGldj indices.

A lower KOFPoGI score corresponds to higher overall political self-sufficiency in terms of the country's domestic and foreign affairs, and vice versa.

^dOwn calculation based on data from the International Monetary Fund (2023) and the United Nations Statistics Division (2023).

Trade-to-GDP ratio (%) = (Trade / GDP at constant 2015 prices) × 100, where: Trade = Exports (FOB) + Imports (CIF).

A higher trade-to-GDP ratio corresponds to a lower level of the country's economic self-sufficiency, and vice versa.

^eBased on a report from the Defense Intelligence Agency (2021, p. 26).

A higher number of events related to missile launches and nuclear tests corresponds to a higher level of military self-sufficiency, and vice versa.

^fBased on the original data from the United Nations Statistics Division (2023).

A higher level of inflation corresponds to a higher level of entropy, and vice versa.