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Economic Shocks and Income Polarization under Quasi-Marketization: Evidence from North Korea

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Economic Shocks and Income Polarization under Quasi-Marketization: Evidence from North Korea

This paper examines how adverse economic shocks reshape the income distribution in an economy characterized by quasi-marketization, where market activities expand in the absence of fully institutionalized market-supporting institutions. Using repeated cross-sectional survey data on North Korean defectors from 2012 to 2020, the analysis exploits a plausibly exogenous economic shock during 2014–2015 in North Korea driven by climatic conditions, energy supply constraints, and external trade disruptions. Focusing on changes in distributional shape rather than average inequality, the paper employs the Median Relative Polarization framework and relative distribution analysis. The results show a significant increase in informal income polarization in the post-shock period, driven primarily by an expansion of the lower tail of the distribution rather than by gains at the top. A range of robustness checks indicates that these findings are not solely driven by sample selection. The findings highlight that in quasi-marketized economies without established market-supporting institutions (i.e., fair competition policies, taxation, and social safety nets), adverse shocks may generate asymmetric distributional adjustments—manifesting primarily as lower-tail polarization—rather than uniform increases in inequality.

Keywords: North Korean Economy, Quasi-Marketization, Informal Economy, Income Polarization, Median Relative Polarization

JEL Classification: D31, O17, P33

I. Introduction

This paper examines how adverse macroeconomic shocks reshape the income distribution in an economy where market activities expand in the absence of fully institutionalized market institutions. Economic inequality is commonly assessed using summary statistics such as the Gini coefficient or income shares, which provide useful benchmarks for cross-country and intertemporal comparisons. However, in economies where market activities expand in the absence of fully institutionalized market systems, adverse shocks may reshape the income distribution in ways that are not well captured by changes in average inequality alone. In such contexts, distributional adjustments are more likely to manifest as changes in the shape of the distribution, including income polarization across groups. This paper examines this possibility in the context of North Korea, focusing on whether the adverse economic conditions during 2014–2015 are associated with increased income polarization rather than merely higher overall inequality.

North Korea provides an extreme yet informative setting to study these dynamics. Recent discussions of the North Korean economy have predominantly focused on its unique dual economic system. Since the early 2000s, informal market activities in North Korea have expanded from subsistence trade to encompass consumer goods, labor, and finance, while the formal planned sector has remained chronically constrained.

However, the expansion of informal markets has occurred largely without the development of formal market-supporting institutions such as property rights, fair competition policies, taxation, or social safety nets. As a result, most market activities remain illegal or semi-legal, subject to arbitrary enforcement and pervasive corruption. Under this form of 'quasi-marketization,' economic opportunities are likely to be unevenly distributed, favoring individuals with political connections, access to capital, or privileged positions in informal trade, while limiting upward mobility for the majority (Sarte 2000).

Against this institutional backdrop, the North Korean economy experienced a significant adverse shock during 2014–2015. Severe drought reduced agricultural

output and hydroelectric power generation, while an economic slowdown in China and a collapse in global commodity prices sharply reduced mineral exports—the country's primary source of foreign exchange. This set of economic conditions observed during 2014-2015 provides a particularly suitable setting to investigate the change in income distribution because of its exogeneity and recurrence.

Using micro-level data from repeated surveys of North Korean defectors conducted between 2011 and 2020, this paper examines how the income distribution changed following the 2014–2015 shock. We employ the Median Relative Polarization (MRP) framework to assess changes in the shape of the income distribution. This approach allows us to distinguish between polarization driven by an expanding upper tail and polarization driven by an increasing concentration of low-income individuals. Our findings show that income polarization increased in the sample significantly in the post-shock period (2015–2019) relative to the pre-shock period (2011–2014). Crucially, this increase was driven primarily by a rise in the relative proportion of low-income individuals rather than by gains at the top of the distribution. This paper does not aim to provide point identification of a causal treatment effect. Instead, it documents how the income distribution responds to a plausibly exogenous macroeconomic shock in a quasi-marketized economy, with a particular focus on changes in distributional shape rather than causal magnitudes.

This study relies on survey data of North Korean defectors, which naturally raises concerns regarding non-random sample selection. Rather than treating selection as a confounding factor to be dismissed, we explicitly incorporate it into our interpretation following the self-selection framework of Borjas (1987). In particular, Borjas shows that negative selection into migration is more likely when income dispersion or downside risk in the origin economy increases. Accordingly, even under the most conservative assumption that the post-2014 increase in polarization reflects heightened negative selection of low-income defectors, this mechanism itself implies a deterioration of the income distribution within North Korea. We therefore advance a minimal but credible claim that income polarization worsened after the 2014–2015 economic shock,

regardless of whether it manifests through observed incomes or endogenous selection into defection. Nonetheless, various robustness checks were conducted to alleviate the concern of sample selection which will be introduced in later sections.

By focusing on income polarization rather than average inequality, this paper contributes to the transition literature by showing that under quasi-marketization, adverse economic shocks may primarily manifest as asymmetric distributional adjustments—particularly through the expansion of the lower tail—rather than through uniform increases in inequality.

II. Literature Review

A large body of comparative-economics literature argues that distributional outcomes during market-oriented transitions depend critically on how rapidly markets expand relative to the development of formal market-supporting institutions. Rather than viewing inequality as a transitory side effect of reform, this literature emphasizes the interaction between developments in institutional capacity, and marketization as central to understanding distributional change.

Milanovic (1998) provides systematic interpretations of rising inequality during the transition from planned to market economies, documenting that the collapse of administratively compressed wage structures and the reallocation of income toward market-based returns created substantial dispersion even before growth effects fully materialized. Building on this perspective, Aghion and Commander (1999) conceptualize inequality as an intrinsic feature of the transition process itself, stressing that restructuring and reallocation—particularly under weak institutional constraints—can generate persistent distributional tensions rather than temporary deviations.

Empirical evidence from post-socialist economies supports these arguments by documenting the institutional channels through which inequality emerged. Rosser, Rosser, and Ahmed (2000) show that income inequality across transition economies is positively associated with the size of the informal economy,

which they interpret as reflecting limited regulatory capacity and incomplete redistribution during marketization. Focusing on the Russian transition, Commander et al. (1999) analyze how changes in labor earnings and the partial effectiveness of redistribution mechanisms shaped inequality and poverty outcomes, highlighting that institutional adjustment lagged behind structural change. Similarly, Ivaschenko (2002) documents a sharp increase in inequality during the early transition period across Eastern Europe and the former Soviet Union and relates this pattern to differential exposure to restructuring and market opportunities.

Studies of gradual reform economies extend these insights by emphasizing segmentation and heterogeneous market access. For China, Kanbur and Zhang (1999) argue that aggregate inequality masks distinct structural components, particularly rural–urban and inland–coastal divides, which evolve differently as reform progresses. Their framework shifts attention away from a single inequality trajectory toward the composition of inequality itself. Complementing this view, Chen and Fleisher (1996) document widening regional income disparities during China's reform period, while Gustafsson and Li (2001) show that rising earnings inequality in urban China reflected broad-based changes in wage-setting across ownership types, regions, and education groups rather than isolated shocks affecting a narrow segment of workers.

Evidence from Vietnam points to similar mechanisms operating under a different reform path. Liu (2006) analyzes changes in wage structure during Vietnam's transition and shows that rising returns to education played an important role in widening earnings differentials, consistent with increasing segmentation of labor-market opportunities. Phan and Coxhead (2013) further argue that gradual and partial reform can generate long-run distributional costs, as rents and high-return positions become unevenly accessible during the reform process, contributing to persistent wage inequality.

Taken together, this literature suggests that inequality during market-oriented transitions is not solely the result of growth dynamics but is closely linked to institutional incompleteness and segmented market access. When

formal labor markets, social insurance, and redistribution mechanisms remain underdeveloped, marketization tends to amplify differences in households' ability to respond to economic disruptions. In such environments, adverse macroeconomic shocks are less likely to be absorbed by formal safety nets and more likely to translate into unequal income losses across the distribution.

North Korea represents an extreme case of this configuration. Market activities have expanded in the absence of fully institutionalized market-supporting institutions—a condition that can be described as quasi-marketization[1]. From a comparative perspective, this implies that the distributional consequences of exogenous economic shocks may be substantial. The finding of this paper—that an adverse exogenous shock is associated with a deterioration in income distribution in North Korea—can therefore be interpreted as extending the transition literature to a setting where marketization occurs almost entirely outside formal institutional frameworks.

A growing body of research documents that adverse economic shocks and economic crises often exacerbate income inequality, particularly in developing economies (Baldacci et al. 2002; Rewilak 2018; Furceri et al. 2022). However, the direction and magnitude of these distributional effects vary substantially depending on countries' stages of development, industrial structures, and labor market institutions (Goldberg & Pavcnik 2007; Jäntti & Jenkins 2010; Gokmen & Morin 2019). Many studies find that economic downturns tend to widen overall income inequality and disproportionately harm lower-income groups (Hoynes et al. 2012; Bodea et al. 2021), most of which, focusing on aggregate inequality measures such as the Gini coefficient or income shares.

As emphasized by Esteban and Ray (1994) and Wolfson (1994), such measures may fail to capture important distributional transformations associated with changes in group clustering and social mobility. In particular, adverse shocks may reshape the income distribution in asymmetric ways (e.g., thickening

1) Jung et al. (2022) analyze the marketization process of North Korea along three dimensions: price liberalization, privatization, and financial system development. They conclude that North Korea's marketization has progressed in a highly uneven manner, with substantial advances in price liberalization, weak institutionalization of de facto privatization, and an extremely underdeveloped financial system.

the lower tail rather than uniformly widening income gaps), an aspect that remains underexplored, especially in quasi-marketized economies with weak or incomplete institutions. This paper focuses on the change in shape and location of the income distribution by employing MRP suggested by Wolfson (1994).

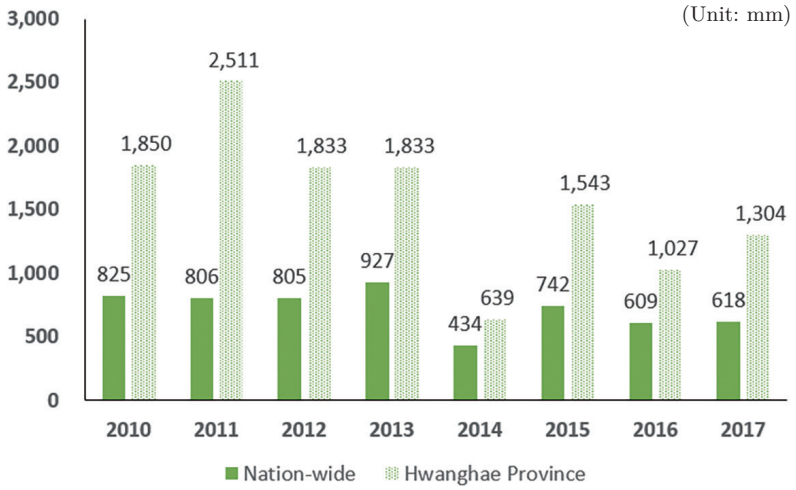
These considerations suggest that in settings with weak market-supporting institutions, adverse shocks may translate into asymmetric distributional changes. The next section examines this mechanism in the context of North Korea's 2014–2015 economic shock.

III. Adverse Economic Shocks in North Korea during 2014-2015

Adverse economic shock observed in North Korea during 2014-2015 provides a plausible example to examine the income distribution dynamics. First, during the period, North Korea has experienced a severe drought. According to Korea Meteorological Administration statistics, the sum of monthly average rainfall in Hwanghae Province – the province which has largest paddy field in North Korea – decreased by 34.8% in 2014 compared to 2013 during critical rice and corn-growing season of May to August, and decreased by 53.2% nation-wide as shown in Figure 1. This significant lack of precipitation has reportedly decreased rice and corn harvest by 6.5% and 4.5%, respectively in 2015 according to Rural Development Administration of South Korea[2)].

2) Annual estimates of North Korea's crop production are published by the Rural Development Administration (RDA) of Korea (https://www.rda.go.kr/main/mainPage.do). These estimates provide total and crop-specific production figures—such as rice, maize, potatoes, and other staple crops—based on an integrated assessment of meteorological conditions, remote sensing information, and auxiliary agricultural data, in the absence of official statistics released by North Korea.

Figure 1. Sum of Average Monthly Rainfall During the May-August Growing Season: Nation-wide and Hwanghae Province



* Source: Korea Meteorological Administration.
(https://www.weather.go.kr/w/index.do, accessed December 2025)

Although North Korea experienced a severe drought in 2014, rice production did not decline immediately. This may reflect the relatively high irrigation coverage of paddy fields, policy-driven prioritization of rice cultivation, and lagged effects of climatic shocks on agricultural output.

The decline in crop production led to a surge in food prices. The price of rice—the most representative staple crop in North Korea—began to rise in late August 2014 and continued increasing through late October, reaching levels 32.5% higher than in July and 20.1% higher than during the same period in the previous year to KPW 6,633. The prices have gained stability shortly after, but have increased again in September 2015 by 14.8% month on month to KPW 6,067[3)] which is likely to be attributable to sharp decline (68.1% year-on-year) in cereal imports including rice and maize (HS 10) from China (KITA database). While food prices themselves are not fully representative of food

3) The price data are drawn from Daily NK, a South Korean online media outlet that is widely cited in the literature on the North Korean economy as a source of market price information (https://www.dailynk.com/market/, Accessed December 2025). The prices are average prices of three cities of Pyongyang, Sinuiju, and Hyesan.

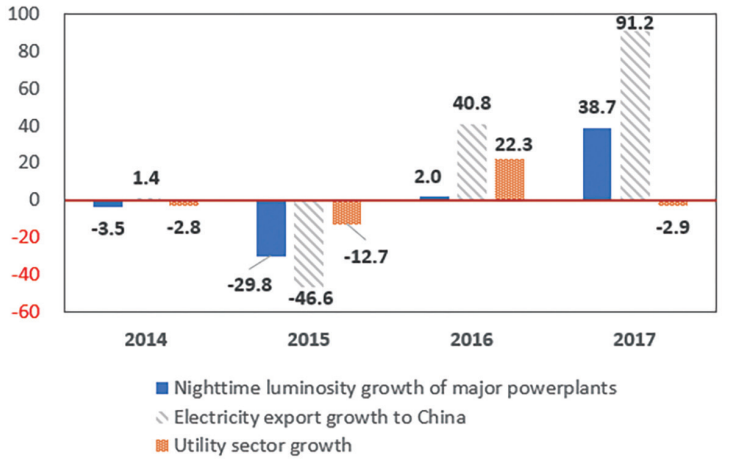
shortages (Kim, 2021), drought-induced disruptions in agricultural production and distribution plausibly tightened supply conditions, increasing competition over staple crops such as rice.

Another crucial side effect of the drought was a decline in hydroelectric power generation, a source that accounts for approximately 57% of total electricity generation in North Korea. According to estimates by the Bank of Korea, total electricity generated by hydroelectric plants decreased by approximately 30%, from 13 billion kWh in 2014 to 10 billion kWh in 2015, while generation from thermal power plants did not change substantially (from 8.6 billion kWh in 2014 to 9.0 billion kWh in 2015). Although there was a one-year lag between the drought and the observed decline in hydroelectric power generation, the drought is likely to have been a major contributing factor. Furthermore, nighttime light data for major power plants—including both thermal and hydroelectric facilities—show that total nighttime luminosity declined by 29.8 percent in 2015 relative to 2014, as illustrated in Figure 2. The figure also indicates that total electricity exports to China fell by 46.6 percent over the same period.

In addition, a steep decline in foreign trade was observed in 2015. In particular, trade with China—which accounted for approximately 91.3% of North Korea's total foreign trade—decreased by 14.7% year on year, amounting to USD 5.4 billion (KOTRA, 2016). Both exports and imports declined, by 12.6% and 16.4%, respectively (KITA database). The most pronounced contraction was observed in exports of mineral products (HS 25–27) and steel products (HS 72–83)—the state's principal sources of foreign-currency earnings at the time—which fell by 14.7% and 54.9%, respectively (KOTRA, 2016). The decline in imports appears to be largely attributable to weakened foreign-currency earnings resulting from reduced exports of major commodities. Previous studies attribute this export contraction primarily to the slowdown in China's steel industry and the stagnation of international commodity prices (KIEP, 2016; Lee, 2015; KOTRA, 2016).

Figure 2. Percent-Change in Nighttime Luminosity of Major Powerplants, Electricity Exports to China, and the Utility Sector

(Unit: %)

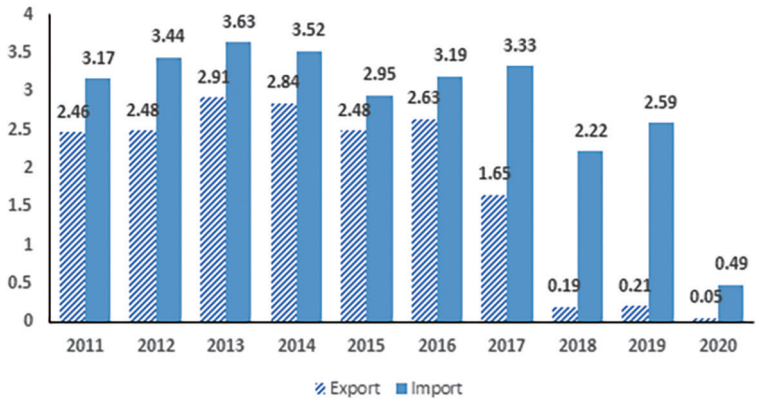


* Source: Author's calculation based on Earth Observation Group for nighttime light (https://payneinstitute.mines.edu/eog/), Korea International Trade Association (https://dl.kita.net/info/index.do) for electric power export to China, and Bank of Korea GDP estimates for growth of the utility sector (https://ecos.bok.or.kr/#/).

* Note: Major powerplants in the figure consist of 140 thermal, and hydro power plants across the country. Electric power export growth to China is calculated based on its amount in USD.

Figure 3. North Korean Export and Import to China (2011-2020)

(Unit: Billion USD)



* Source: Korea International Trade Association Database. (https://stat.kita.net/stat/istat/cts/CtsWholeList.screen, accessed January 2026)

The adverse economic conditions of 2014–2015 simultaneously constrained food and energy supplies. Reduced rice output contributed to rising food prices, while lower hydropower generation likely exacerbated electricity shortages. Policy options to mitigate these economic impacts likely have been severely limited by declining foreign-currency earnings, driven by sharp contractions in major export products. From an institutional perspective, in a quasi-marketized environment with limited redistribution and regulatory capacity, these shocks are likely to have translated into asymmetric real income losses across households.

Especially, North Korea's food economy makes agricultural supply shocks particularly distributionally salient. FAO/WFP crop and food security assessments emphasize that household access to food relies on multiple channels—own production (including household plots), state shops and the public distribution system (PDS), and formal and informal markets—and that markets and informal exchange have become increasingly important for household food security, especially in urban areas (FAO and WFP, 2012).

Against this backdrop, the 2014–2015 drought can transmit to informal incomes through several mutually reinforcing mechanisms. First, a drought-induced fall in staple output tightens local availability and pushes up the effective prices of key foods. Where a growing share of food is acquired via markets, scarcity of staple crops likely has compressed the relative purchasing power of low-income net buyers.

Second, droughts also directly reduce earnings opportunities for households connected to agriculture. Lower yields reduce in-kind resources available for household retention and sale, and they shrink marketable surpluses from cooperative farms and household plots that many households use to supplement incomes. FAO/WFP assessments further note that households dependent on the PDS and without access to kitchen gardens tend to be especially vulnerable, underscoring how limited self-production and weak distribution capacity can translate into sharp welfare losses when harvest outcomes deteriorate (FAO and WFP, 2013).

Third, quasi-marketization without robust market-supporting institutions can magnify these shocks through limited smoothing and rent extraction. In poverty-trap frameworks in general, large negative shocks can deplete assets and depress investment (including in human capital and small businesses), potentially pushing some households below critical asset thresholds and leading to persistent downward mobility (Carter and Barrett, 2006). In the DPRK context, refugee- and firm-survey evidence points to pervasive corruption and weak dispute resolution, implying that access to trading space, transport, and commercial permissions often depends on informal payments and connections (Kim, 2010; Kim and Koh, 2011; Haggard and Noland, 2010, Kim and Cho, 2025). These institutional frictions can exacerbate the dispersion of outcomes by weakening households' ability to smooth shocks while enabling better-connected actors to benefit from scarcity through arbitrage and rent seeking.

This particular event provides a well-suited case for analyzing income polarization under a quasi-marketized regime. Importantly, these shocks were largely orthogonal to household-level economic decisions and were not the result of endogenous policy choices or behavioral responses, reinforcing their plausibly exogenous nature for the purposes of distributional analysis. At the same time, they reflect structural vulnerabilities of the North Korean economy—dependence on weather-sensitive agriculture output, hydroelectric power, and a narrow export base—making similar shocks likely to recur in the future.

This choice also requires distinguishing our shock of interest from other major macro-level disturbances—most notably UN Security Council sanctions—which, despite their aggregate importance, pose distinct challenges for identifying near-term effects on informal market incomes. We do not select the UN Security Council sanctions as the primary exogenous shock in this study, despite their clear macroeconomic relevance, because our empirical focus is on informal (market-based) income and the timing and magnitude of sanctions' pass-through to domestic consumer-market conditions are not as straightforward as those of major exports and foreign currency earnings. In particular, Choi et al. (2024) using high-frequency satellite imagery to proxy market activity in North Korea find that the market-activity indicator continued to rise during 2017–2019.

This pattern suggests that the effect of sanctions on markets may have been neither instantaneous nor direct, amking it difficult to interpret the sanctions-implementation period alone as a near-contemporaneous negative shock to market functioning and market-based livelihoods. Consistently, the same report characterizes UN sanctions as gradually strengthened from 2016 and more fully implemented in 2018, yet notes that, while exports contracted, the supply of imported goods did not face major difficulties for a period (excluding restricted items), implying that direct disruption to market supply conditions may have been limited or delayed relative to the headline macro shock (Choi et al., 2024). Complementary evidence from our tabulations of China–North Korea trade statistics in Figure 3 also indicates that imports, which are closely linked to everyday market consumption, did not exhibit an immediate collapse until the COVID-19-related border lockdown of 2020, reinforcing the view that sanctions may not provide a clean, sharply timed "market-income shock" for the research objective of this paper.

IV. Data

1. IPUS North Korean Refugee Survey[4)]

This study utilizes survey data of 'North Korean Refugee Survey' published by the Institute of Peace and Unification Studies (IPUS) at Seoul National University. The survey is conducted on an annual basis from 2011 until 2020 on the North Korean refugees who have escaped North Korea one year prior to the year of survey. One distinctive feature of this survey is that it includes only refugees who entered South Korea directly, without having resided in a third country for a long period of time. This design likely reduces potential recall bias associated with prolonged migration trajectories, although recall error cannot be completely ruled out. It employs 'snowball sampling' method whereby first few samples are introduced by 'Korea Hana Foundation'[5)], then further samples were recruited by chain-referrals. The questionnaire is composed of two surveys. The first survey called 'Unification Perception of the North Koreans' asks perception-based questions on unification, South Korea, North Korea, and neighboring countries. The second survey called 'Societal Change of North Korea' focuses on details of social and economic conditions of North Korea. It includes questions on general daily life conditions, marketization, income, medical conditions and education system of North Korea.

Due to the snowball sampling design, the survey is not nationally representative. Although the survey is not nationally representative[6)], key demographic patterns are broadly consistent with the defector population[7)]. Table 1 reports the sample size and summary statistics for key demographic variables from 2011 to 2019, classified by the actual year of defection rather than

4) The North Korean Defectors' Survey was approved by the Seoul National University Research Ethics Team (IRB Approval Number: 2006/002-025). Unfortunately, the raw dataset is not publicly available due to concerns regarding personal data sensitivity. For other details of the survey, refer to the official IPUS website at https://ipus.snu.ac.kr/.

5) 'Korea Hana Foundation' is a government institution funded by the Ministry of Unification established to provide North Korean refugees assistance in various ways for their successful settlement in South Korea. Newly entered refugees are mandated to go through certain education program prepared by the foundation prior to entering the society.

6) The sampling bias problem will be addressed thoroughly in the later section.

7) For comparison of the survey samples and defector population, refer to Table A1 of Appendix.

the survey year. Several features of the table merit attention. First, the gender distribution shows that the share of females (59.4%) exceeds that of males (40.6%), largely consistent with official statistics on the North Korean refugee population published by the Ministry of Unification[8]. Second, individuals from the border provinces of North Hamgyong and Ryanggang are overrepresented, accounting for approximately 80% of the total sample which also is similar to that of the defector population. This reflects their close proximity to the Chinese border, which constitutes the primary escape route. The educational composition of the sample is also broadly consistent with state-published survey data from the *Socio-economic Demographic and Health Survey 2014 (SDHS)*[9]. On average, 68.6% of respondents across survey years reported having completed secondary education, compared with 63.2 percent reported in the SDHS as of 2014. Throughout the analysis, individuals are assigned to periods based on their year of defection rather than the survey year, in order to align reported income information with economic conditions prevailing at the time of residence in North Korea.

8) According to the latest statistics on the defector population published by the Ministry of Unification, females compose 72.2% of the total. In this sense, the defectors' survey data can be considered as less biased. Comparison of the survey data and the defector population is provided in Table 1A of the Appendix section. (https://www.unikorea.go.kr/web/unikorea/contents/statistics, accessed Dec.24.2025)

9) SDHS 2014 is a nationally representative household sample survey conducted by the Central Bureau of Statistics (CBS) of the DPRK. It covered social, economic, demographic, and health topics (including fertility, mortality, and reproductive and child health) using a national sample of 13,250 households from urban and rural areas across all provinces, and included module on the health and well-being of older persons. UNFPA provided technical assistance and independently monitored data quality.

Table 1. Demographic Statistics of IPUS North Korean Refugee Survey

(Unit: Individuals, %)

Year of Defection		2011	2012	2013	2014	2015	2016	2017	2018	2019	Total/ Avg.
Number of Samples		127	133	149	146	138	132	87	116	109	1,137
Gender	Male	44.1	44.4	33.6	39.0	38.4	53.0	43.7	35.3	33.9	40.6
	Female	55.9	55.6	66.4	61.0	61.6	47.0	56.3	64.7	66.1	59.4
Province of Origin	Pyongyang	0.0	0.8	2.0	2.1	3.6	1.5	2.3	0.0	0.9	1.5
	Ryanggang Prov.	30.7	43.9	48.3	41.1	45.7	63.6	59.8	75.0	70.6	53.2
	N.Hamgyong Prov.	51.2	38.6	35.6	43.8	42.0	25.0	23.0	15.5	13.8	32.1
Level of Education	None	1.6	0.8	0.0	0.7	0.0	0.8	0.0	0.0	2.8	0.7
	Elementary	3.2	0.0	2.0	2.1	0.7	2.3	6.9	0.0	1.8	2.1
	Secondary	65.4	71.4	61.7	61.0	74.6	72.0	73.6	70.7	67.0	68.6
	College	18.1	11.3	21.5	16.4	11.6	17.4	13.8	22.4	15.6	16.5
	University	10.2	16.5	13.4	19.9	13.0	7.6	5.7	6.9	10.1	11.5
WPK Party Membership		14.4	14.3	13.4	17.9	18.8	18.2	13.8	11.2	12.8	15.0
Official Occupation	Worker	37.0	31.6	30.9	26.0	22.5	43.9	32.2	26.7	26.6	30.8
	Farmer	8.7	3.8	7.4	4.8	9.4	3.8	11.5	3.4	5.5	6.5
	Office Clerk	4.7	9.8	12.1	8.9	10.9	6.1	6.9	8.6	5.5	8.2
	Expert	7.1	8.3	3.4	5.5	7.2	7.6	0.0	1.7	3.7	4.9
	Student	6.3	6.0	7.4	4.8	4.3	2.3	13.8	7.8	11.9	7.2
	Military	3.9	4.5	4.7	4.8	8.0	5.3	3.4	3.4	4.6	4.7
	Housewife	11.1	16.5	18.8	11.6	13.0	10.6	21.8	21.6	13.8	15.4

*Source: IPUS (2022)

V. Empirical Strategy and Main Findings

For the empirical analysis, we use a survey item that asks respondents to report their average monthly informal income immediately prior to leaving North Korea. Respondents were asked to record the amount in Korean won (KPW) without any predefined response categories.

The empirical strategy proceeds in three steps. First, we examine whether there is a statistically significant structural change in the informal income distribution before and after the adverse economic shock using regression analyses. Second, once the threshold year is identified, we analyze changes in the upper and lower tails of the income distribution using the median relative polarization (MRP)

method. Finally, we conduct a series of robustness checks using alternative specifications to address potential concerns regarding sample selection bias.

Accordingly, the empirical strategy is designed to assess whether there exists a systematic and robust change in the shape of the income distribution following the shock, rather than to estimate a causal treatment effect. Prior to the empirical analysis, the informal income variable—the main variable of interest—underwent a data-cleaning process. To mitigate potential biases arising from measurement error in self-reported informal income, the data were systematically validated using responses to related survey questions. Observations exhibiting internal inconsistencies were excluded from the analysis. Specifically, these included cases in which respondents reported informal income while stating that they did not engage in informal work; identified informal activities as their primary source of income yet reported higher formal than informal earnings; or reported a low perceived social status.

In addition, to address the influence of extreme values, observations with informal income exceeding twice the 95th percentile were excluded. Individuals reporting total earnings below KPW 10,000 were also excluded. Both categories of excluded observations are unlikely to be representative of the income-generating behavior of general informal market participants, which is the primary subject of this study[10]. The resulting summary statistics for the variables used in

10) Six observations report informal income below KPW 10,000, and four exceed twice the 95th percentile of the sample distribution. As a robustness check, we replicate both the threshold year and MRP analyses on a full sample that includes all ten excluded observations. When all observations are included, the threshold year regression yields coefficients that are no longer statistically significant. To isolate the source of this change, we further estimate the threshold year regression excluding only the four upper-tail observations while retaining the six lower-tail observations. This specification produces results similar to those reported in the main analysis, confirming that the loss of significance is driven entirely by the four upper-tail observations — whose informal incomes (approximately KPW 8,600,000–8,980,000) are more than ten times the sample median and exert disproportionate leverage on OLS estimates — rather than by the lower-tail observations. By contrast, the MRP results remain qualitatively and statistically consistent with those in the main analysis regardless of whether the excluded observations are included. This divergence reflects the robustness of rank-based methods such as MRP to extreme values, in contrast to OLS. Full results are reported in Appendix Table A8, A9 and A10.

this chapter are reported in the following table. All informal income measures are converted to real terms using available CPI estimates for North Korea (see Appendix Table A2). The summary statistics of the variables used in the empirical analysis after data cleaning process are reported in Table 2.

Table 2. Summary Statistics of Key Variables

Variables	Observations	Mean	Median	Std. dev.	Min	Max
Age	781	37.7951	36	11.5167	18	73
Gender	781	0.5928	1	0.4916	0	1
Education: Secondary	781	0.6991	1	0.4589	0	1
Education: Tertiary	781	0.1063	0	0.3084	0	1
WPK Party Membership	781	0.1588	0	0.3657	0	1
Former Residents of Pyongyang	781	0.0077	0	0.0874	0	1
Former Residents of Ryanggang	781	0.5314	1	0.4993	0	1
Former Residents of N. Hamgyong	781	0.3291	0	0.4702	0	1
Informal Income	781	797,097	431,081	1,120,555	10,226	7,601,664

* Source: IPUS (2022)

* Note: 'Gender' is a dummy variable taking value 1 if the respondent is female and 0 if male. Both education variables are dummy variables taking value 1 if the respondent has graduated respective level of education and 0 otherwise. Former place of living variables of Pyongyang, Ryanggang, and North Hamgyong are also dummy variables taking value 1 if the respondent has lived in each respective province and 0 otherwise. 'Informal Income' refers to average monthly informal income in 2015 KPW.

1. Yearly Distribution

We first estimate a simple OLS specification in which the absolute deviation of informal income from the median is regressed on survey-year indicators, allowing us to test whether any particular year exhibits significantly higher dispersion.

$$Dev_{it} = \alpha + \beta X_{it} + \delta yeardef_t + \mu_r + \tau_i + \epsilon_{it} \quad (1)$$

Where $Devit$[11] represents absolute deviation of individual i's informal income in year t from the median informal income of year t. Xit consists of demographic characteristics of age, gender, level of education and communist party membership. 'gender' variable is a dummy variable taking value 1 if the individual is female and, 0 if male. There are two dummy variables each representing secondary education graduates and tertiary graduates taking value 1 if the individual has respective level of education, and 0 otherwise. The communist party membership dummy variable is also taken into account taking value 1 if the individual is a member of the communist party, and 0 otherwise. $yeardeft$ represents year of defection dummy variables which is of the main interest in this model. μr is province level region-fixed effect. τi represents occupation-fixed effects representing the individuals' informal occupation before leaving the country[12].

The estimation results are presented in Table 3. The year dummy variables for 2015, 2016, and 2019 are positive and statistically significant, indicating that the absolute deviation of informal incomes from the median in those years is, on average, significantly higher than in the reference year, 2011. Other year dummies are not statistically significant, suggesting that increases in dispersion are not uniform across years.

This pattern points to substantial year-to-year variation in informal income dispersion, with particularly large deviations observed in selected post-2014 years. While these results do not by themselves identify a precise structural break, they motivate an empirical strategy that focuses on changes across broader time periods rather than on isolated year-specific fluctuations. Accordingly, the subsequent analysis considers pooled pre- and post-shock periods to examine whether the observed increases in dispersion reflect a sustained shift in the

11) Absolute deviation of informal income of individual i is calculated as follows: $Dev_{it} = |\bar{\mu}_t - \pi_{it}|$ where $\bar{\mu}_t$ is the median informal income of year t, and π_{it} denotes individual i's informal income in year t.

12) The survey asks respondents: *"Which of the following occupations that you have experienced was the most profitable while you were living in North Korea?"* The response options are: (1) Retail sales, (2) Individual services, (3) Individual manufacturing, (4) Restaurants or other stores, (5) Wholesale trade, (6) Foreign-currency–related activities, (7) Private financial activities, (8) Part-time jobs, (9) Deployed worker, and (10) Other.

income distribution.

The estimated coefficients for the demographic control variables are not statistically significant, with the exception of the gender variable. The dispersion of informal income is, on average, higher among male respondents than among female respondents.

Table 3. OLS Regression Result: Year-Fixed Effects Model

Dependent Variable: Absolute Deviation from Median	
Age	4,469
	(3,434)
Gender (Female=1)	-152,095*
	(84,482)
Education (Tertiary=1)	42,232
	(171,829)
Education (Secondary=1)	17,700
	(87,709)
Party Membership (Member=1)	-24,411
	(112,948)
Reference Year: 2011	
d2012	98,771
	(145,010)
d2013	132,798
	(148,456)
d2014	133,618
	(138,107)
d2015	270,429*
	(157,095)
d2016	359,466**
	(149,350)
d2017	33,020
	(143,423)
d2018	223,895
	(153,145)
d2019	308,748*
	(167,568)
Constant	508,208
	(388,544)
Observations	781
R-squared	0.087
Region FE	YES
Occupation FE	YES

* Robust standard errors in parentheses. (*** p<0.01, ** p<0.05, * p<0.1)

2. Threshold Year Analysis

Our next task is to empirically assess whether there is a statistically significant change in the dispersion of informal incomes between the pre- and post-shock periods. We estimate the following OLS model.

$$Dev_{it} = \alpha + \beta X_{it} + \delta yref_t + \mu_r + \tau_i + \epsilon_i \quad (2)$$

The dependent variable is the same as the previous model. $yref_t$ is newly constructed to replace the year dummy variables, taking the value of 0 for year t and all preceding years, and 1 for all subsequent years. For example, the dummy variable $yref_{2013}$ equals 0 for the years 2011-2013, and 1 for the years 2014-2019, whereas $yref_{2014}$ equals 1 for years 2015-2019, and so on. X_{it}, μ_r, and τ_i denote demographic controls, province-level region fixed effects, and occupation fixed effects, respectively.

This sequential threshold dummy approach is conceptually rooted in the tradition of grid-search-based structural break identification (Andrews, 1993; Bai and Perron, 1998, 2003). In the standard Bai-Perron framework, the unknown break date is identified by minimizing the sum of squared residuals over all candidate breakpoints — a procedure that is mathematically equivalent, in an OLS setting, to identifying the candidate year at which the period dummy achieves its maximum t-statistic. The present approach follows this same logic by systematically constructing and evaluating a binary dummy for each candidate threshold year and selecting the specification that yields the strongest statistical evidence of a distributional shift.

Direct application of the Bai-Perron sequential F-test, however, is not feasible in this setting. The DPRK survey data constitute a repeated cross-section with only nine time periods (T = 9), and the standard trimming restriction (typically 15 percent) would leave at most five interior candidate breakpoints, severely limiting statistical power. The *yref* approach addresses this constraint by exploiting the full cross-sectional variation within each period while retaining the grid-search logic of conventional break-date estimation.

A closely related grid-search rationale in the regression context appears in Muggeo (2003), who proposes iterative breakpoint identification in piecewise regression models for cases where the break location is unknown.

The results are reported in Table 4. Columns (1) through (4) show that the coefficients on the threshold dummies are positive and statistically significant when the candidate threshold year is set between 2011 and 2014, indicating that deviations of informal income from the median are systematically larger in the years following 2014 relative to earlier periods. In contrast, as shown in Columns (5) through (8), the coefficients for threshold years from 2015 onward are not statistically significant, suggesting the absence of further discrete shifts in dispersion within the post-2015 period.

This pattern is consistent with a one-time level shift in dispersion occurring around 2014–2015 rather than with multiple structural breaks. While this specification does not formally identify a unique threshold year, the results provide corroborating evidence that the post-2014 period is characterized by persistently higher dispersion. Accordingly, we define the period from 2011 to 2014 as Period 1 and the period from 2015 to 2019 as Period 2 for subsequent distributional analyses.

It is worth noting that this data-driven periodization also bears on the choice of 2014–2015 over the period of strengthened UN Security Council sanctions (2017–2018) as the primary shock of interest. As shown in Table 3, the year dummy for 2017 is not statistically significant, suggesting that the tightening of sanctions did not coincide with a discrete increase in informal income dispersion of the kind documented for 2014–2015. Moreover, Column (7) of Table 4 shows that the threshold dummy yref17—which assigns 1 to years 2018 and 2019—yields a statistically insignificant coefficient, indicating the absence of an additional structural shift around the sanctions period. These empirical patterns are consistent with the institutional argument developed in the preceding section: because UN sanctions primarily targeted formal trade and export channels, their pass-through to domestic informal market incomes was likely indirect and delayed, making 2014–2015 the more appropriate shock for the purposes of this analysis.

Table 4. OLS Regression Results: Threshold Year Model

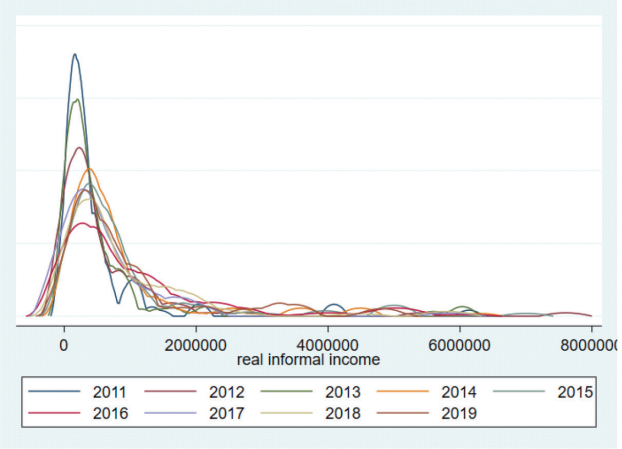
Dependent Variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Absolute Deviation from Median	2011	2012	2013	2014	2015	2016	2017	2018
Age	4,518	4,468	4,493	4,307	4,208	4,348	4,167	4,168
	(3,370)	(3,355)	(3,344)	(3,364)	(3,376)	(3,402)	(3,413)	(3,377)
Gender (Female=1)	-150,952*	-155,245*	-151,407*	-146,744*	-143,769*	-145,778*	-149,934*	-151,636*
	(84,865)	(84,385)	(84,378)	(84,458)	(84,622)	(84,720)	(84,616)	(84,954)
Education (Tertiary=1)	25,857	43,387	35,631	48,803	43,084	27,137	30,044	26,097
	(170,778)	(171,298)	(171,153)	(172,395)	(171,816)	(173,393)	(171,728)	(171,317)
Education (Secondary=1)	17,491	25,593	17,600	16,206	24,011	24,728	24,091	24,288
	(89,745)	(88,847)	(89,100)	(89,261)	(89,082)	(89,426)	(89,612)	(89,484)
Party Membership (Member=1)	-18,356	-19,199	-15,829	-8,127	-2,979	-11,956	-5,990	-8,951
	(112,432)	(111,990)	(111,398)	(111,606)	(111,588)	(112,442)	(112,244)	(111,387)
yref11	194,236*							
	(108,436)							
yref12		161,229*						
		(89,048)						
yref13			146,459*					
			(79,399)					
yref14				158,795**				
				(80,608)				
yref15					114,909			
					(81,013)			
yref16						4,029		
						(82,565)		
yref17							92,451	
							(95,317)	
yref18								135,491
								(134,487)
Constant	580,914	596,413*	617,470*	596,325*	708,315**	780,042**	772,032**	765,698**
	(366,029)	(355,148)	(354,181)	(356,264)	(336,237)	(344,262)	(348,484)	(351,788)
Observations	781	781	781	781	781	781	781	781
R-squared	0.078	0.079	0.079	0.080	0.078	0.075	0.076	0.076
Region FE and Occupation FE	YES	YES	YES	YES	YES	YES	YES	YES

* Note: Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1)

3. Distributional analysis

This subsection provides an in-depth analysis of the change in the informal income distribution before and after the threshold. First, kernel density estimates were derived for each sample year to provide graphical representations of the yearly informal income distribution. Figure 4 provides a descriptive overview of year-by-year distributional changes depicting changes in the informal income distributions over the years in both shape and location (for informal income quantiles by year of defection, refer to Table A3).

Figure 4. Year-by-Year Informal Income Distributions (2011-2019)



* Note: Informal Income is in 2015 KPW and unknown densities are estimated by kernel density estimates with adaptive bandwidth.

In order to rigorously examine how the shape and location of the distribution changed from Period 1 (2011–2014) to Period 2 (2015–2019), this study employs the nonparametric relative distribution methodology introduced by Handcock and Morris (1998, 1999). This approach enables the identification of underlying structural changes between a "reference group" and a "comparison group." It is particularly well suited to the present analysis because it accommodates both longitudinal comparisons and repeated cross-sectional data, as in this study. Moreover, the methodology decomposes the relative density between the

two periods into location and shape components, allowing for a more nuanced interpretation of distributional change.

Location shifts capture distributional changes arising from proportional variations across all observations—in this case, informal income—that affect the entire distribution without altering its shape. The shape component, by contrast, isolates changes in the shape of the distribution after accounting for location shifts. The primary focus of this study is on how the shape component of the informal income distribution differs between the two periods.

In addition, the Median Relative Polarization (MRP) method is employed to formally assess whether the observed changes in the informal income distribution reflect a statistically significant increase in polarization. Originally proposed by Wolfson (1994) and further developed by Nissanov and Pittau (2016), the MRP is grounded in the relative distribution framework and is specifically designed to capture changes in the shape of the distribution, net of location shifts, with particular emphasis on movements away from the median.

Let Y_0 denote informal income in the reference period (Period 1: 2011-2014) with cumulative distribution function (CDF) $F_0(\cdot)$, and let Y denote informal income in the comparison period (Period 2: 2015-2019) with CDF $F(\cdot)$. The relative distribution maps observations from the comparison group onto the percentile ranks of the reference distribution by defining

$$R = F_0(Y) \tag{4}$$

where R represents the position of an observation from Period 2 within the income distribution of Period 1. The corresponding relative density is given by,

$$g(r) = \frac{f(F_0^{-1}(r))}{f_0(F_0^{-1}(r))}, \quad 0 \le r \le 1 \tag{5}$$

where $f(\cdot)$ and $f_0(\cdot)$ denote the density functions of Y and Y_0, respectively. If the two distributions are identical, the relative density is uniform over the unit interval.

Following Handcock and Morris (1998, 1999), the relative distribution can be decomposed into location and shape components by adjusting the reference distribution to have the same median as the comparison distribution. Let $F_A(\cdot)$ denote the location-adjusted reference distribution and let $g_0^A(r)$ be the corresponding location-adjusted relative density, which isolates changes in distributional shape independent of median shifts.

The MRP index is defined as:

$$MRP(F;F_0) = 4\int_0^1 \left|r-\frac{1}{2}\right| g_0^A(r)dr - 1 \tag{6}$$

And is normalized to lie between -1 and 1, where a value of zero indicates no change in polarization relative to the reference period. Positive values indicate increased polarization —i.e., a redistribution of mass away from the median toward the tails of the distribution—while negative values indicate convergence toward the median. The index is invariant to monotonic transformations of income and symmetric in the sense that $MRP(F;F_0) = -\mathrm{MRP}(F_0;F)$.

A key feature of the MRP is its additive decomposability into lower and upper polarization components. Specifically, the lower relative polarization (LRP) and upper relative polarization (URP) indices are defined as,

$$LRP(F;F_0) = 8\int_0^{1/2} \left|r-\frac{1}{2}\right| g_0^A(r)dr - 1 \tag{7}$$

$$URP(F;F_0) = 8\int_{1/2}^1 \left|r-\frac{1}{2}\right| g_0^A(r)dr - 1 \tag{8}$$

such that

$$MRP(F;F_0) = \frac{1}{2}LRP(F;F_0) + \frac{1}{2}URP(F;F_0) \tag{9}$$

Intuitively, the LRP captures changes in the relative concentration of observations below the median, while the URP captures changes above the median. The MRP therefore measures the share of the population that has

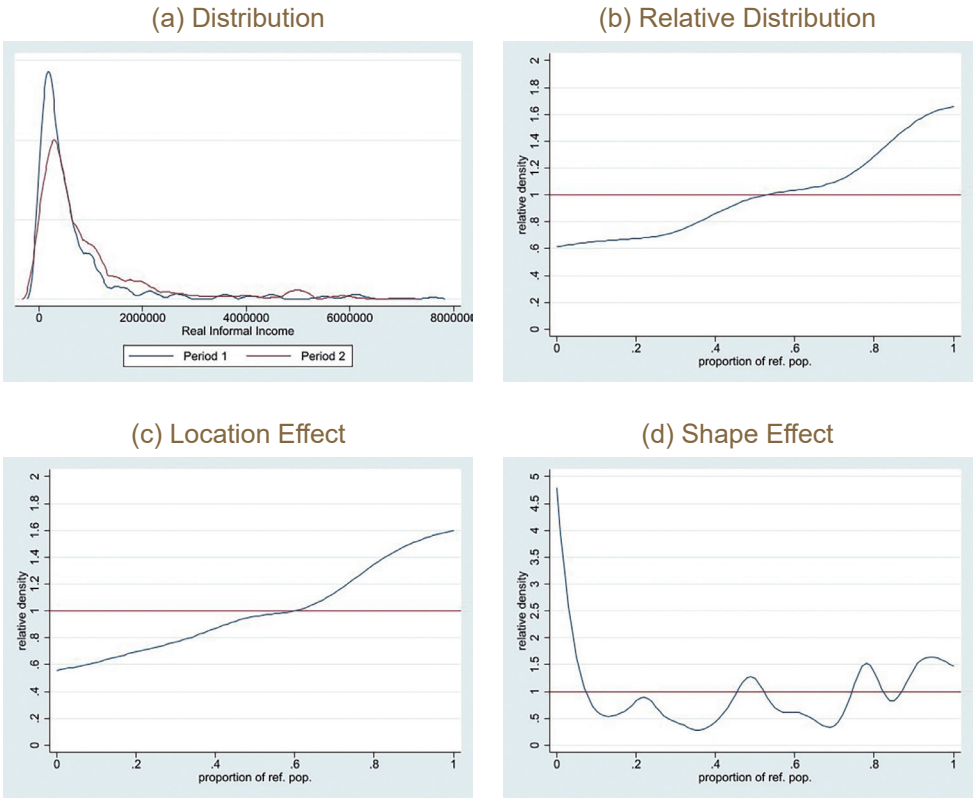
moved away from the center of the income distribution (Nissanov and Pittau, 2016). This decomposition is particularly informative in the present context, as it allows us to distinguish whether post-shock polarization is driven primarily by an expansion of the lower tail—reflecting downward income movements among low-income households—or by gains at the upper end of the distribution. The MRP, together with its lower and upper components, also permits formal statistical inference on the significance of distributional changes, the results of which are reported in Table 5.

Table 5. Median Relative Polarization Index (All Samples)

Polarization Category	Coefficient.	t	P>t
MRP	0.2548***	4.01	0.000
	(0.0636)		
LRP	0.3572 ***	3.55	0.000
	(0.1007)		
URP	0.1523**	2.48	0.013
	(0.0614)		
Period 1 Obs.	366		
Period 2 Obs.	415		
Obs.	781		

* Note: Standard errors are in parentheses. (*** p<0.01, ** p<0.05, * p<0.1)

Figure 5. Relative Distribution Analysis (All Samples)



* Note: Informal Income is in 2015 KPW and unknown densities are estimated by kernel density estimates with adaptive bandwidth

First, the estimated coefficients for both the LRP and URP indices are positive and statistically significant, indicating that the relative mass of observations in both the lower and upper tails of the income distribution increased in Period 2. As discussed earlier, the MRP index is defined as the sum of the LRP and URP components. For ease of interpretation, the implied contributions of the lower- and upper-tail components to overall polarization can be expressed by dividing their respective coefficients by two. Accordingly, of the total MRP value of 0.2548, the lower-tail component accounts for 0.1786, while the upper-tail component accounts for 0.0762.

The positive and statistically significant URP estimate warrants brief interpretation. In the MRP framework, a positive URP does not necessarily imply absolute income gains at the top; rather, it indicates that the relative mass of high-income observations in Period 2 increased compared to the reference distribution. In North Korea's quasi-marketized setting, this pattern is consistent with the behavior of a small group of individuals with privileged access to capital, political connections, or informal trade networks, who were better positioned to shield themselves from the shock—or to extract scarcity rents from tightened food and energy supplies—while the majority of market participants experienced downward pressure. Notably, the URP estimate is substantially smaller in magnitude than the LRP (0.0762 vs. 0.1786) and becomes statistically insignificant in the PSM specification (refer to Table 8 of the robustness checks section), suggesting that upper-tail dynamics are comparatively modest and less robust than the lower-tail expansion that constitutes the primary driver of polarization.

Figure 5 presents a relative distribution analysis comparing informal income distributions between Period 1 (2011–2014) and Period 2 (2015–2019). In this framework, Period 1 serves as the reference distribution, and the horizontal axis in panels (b)–(d) represents the cumulative proportion (percentiles) of the reference population, while the vertical axis reports relative density—that is, the ratio of the density in Period 2 to that in Period 1 at each percentile. A relative density value of one indicates no change between the two periods at that point of the distribution, values above one indicate a relative increase in mass in Period 2, and values below one indicate a relative decline.

Panel (b) reports the overall relative distribution, which incorporates both location and shape effects. The relative density is below unity at lower percentiles and gradually exceeds unity above the median, indicating that observations in Period 2 are relatively more concentrated at higher income ranks than in Period 1. While this pattern suggests a systematic redistribution of mass across percentiles, the overall relative distribution alone does not distinguish whether this change arises from a uniform shift in income levels or from changes in the shape of the distribution.

Panels (c) and (d) decompose the overall distributional change into location and shape components. Panel (c) isolates the location effect and indicates a positive shift in the central tendency of the income distribution. Specifically, the median income in Period 2 corresponds approximately to the 55th–60th percentile of the Period 1 distribution, implying a modest rightward shift of about 5–10 percentile ranks. This result indicates that part of the pattern observed in panel (b) can be explained by a general improvement in the location of the income distribution.

Panel (d) presents the shape effect net of location changes and reveals that the distributional adjustment cannot be fully accounted for by the median shift alone. In particular, the relative density below the 10th percentile in Period 2 exceeds 4.5 times the corresponding level in Period 1, indicating a pronounced increase in the mass of low-income observations after controlling for location effects. By contrast, changes in the upper tail are positive but comparatively modest.

This result is consistent with the median relative polarization results reported in Table 5, which show a positive and statistically significant MRP driven primarily by the lower-tail component. Furthermore, the positive location shift may reflect the fact that Period 2 spans several years following the shock (2015–2019), thereby capturing informal income outcomes not only during the immediate aftermath of the shock but also during subsequent periods in which informal market activities and income-generating opportunities may have partially recovered. An alternative interpretation can also be considered. The managerial and incentive-oriented adjustments introduced during 2013 and 2014—such as the "Field Responsibility System" and "Our Style of Economic Management Method"[13)]—which, while limited in scope and unlikely to

13) The managerial adjustments introduced around 2013–2014 primarily consisted of the expansion of the field responsibility system in agriculture and the adoption of the "Economic Management Method of Our Style." The former entailed a reorganization of agricultural production units into smaller sub-team or household-based units with limited output retention as incentives, while the latter referred to a set of administrative changes aimed at increasing operational autonomy and performance-based incentives at the enterprise and farm levels without altering overarching state ownership or control. Existing studies emphasize that these measures should be understood as incremental managerial adjustments rather than systemic economic reforms, reflecting attempts to improve efficiency within the socialist framework under persistent institutional and political constraints (Yang 2021; Kim 2022).

induce broad structural transformation, may have contributed at the margin to improved market supply conditions. However, given the lack of direct quantitative evidence, the contribution of these policy adjustments cannot be separately identified and should be interpreted as suggestive rather than causal. Since the central objective of this study is to examine changes in the shape of the income distribution following the shock, we refrain from drawing definitive conclusions about the sources of the observed location shift.

In contrast, the shape effect indicates that the distributional consequences of the shock were not fully reversed during the post-shock period. The persistence of a statistically significant increase in lower-tail mass, as previously observed in the MRP estimation, implies that income polarization remained even as overall informal income levels partially recovered.

Overall, the observed intensification of income polarization after 2014 can be understood as the interaction between an adverse economic shock and North Korea's quasi-marketized institutional environment. While rising food prices and energy shortages may have disproportionately affected market-dependent and low-income households, whose incomes are highly sensitive to input costs and subsistence expenditures. In the absence of market-regulating formal institutions such as the property rights, social safety net, labor market and fair competition, these households likely had limited capacity to smooth consumption or absorb income losses. By contrast, individuals with access to capital, political connections, or privileged positions in informal trade networks were better positioned to shield themselves from these shocks or even extract rents from scarcity. As a result, the shock may not have been translated into uniform income compression, but into a structural thickening of the lower tail of the income distribution, generating an increase in income polarization driven primarily by lower-tail dynamics.

Furthermore, our finding that polarization does not significantly reverse after 2016 is consistent with a hysteresis interpretation: in quasi-marketized systems lacking effective redistribution, secure and enforceable property rights, and rule-based labor-market protections, households pushed into the bottom tail by a large shock may not easily re-enter the middle. In poverty-trap terms,

the drought and associated price pressures can move households below critical asset or liquidity thresholds, slowing income recovery even after aggregate conditions stabilize (Carter and Barrett, 2006). Persistent corruption and weak dispute resolution can further impede mobility by raising transaction costs for poorer households and limiting access to higher-return activities.

VI. Robustness Checks and Discussions on Sample Selection

1. Robustness Checks

To minimize potential bias in the empirical estimation arising from compositional differences between the two periods inherent in pooled cross-sectional data, we employ a resampling technique. Resampling is a straightforward method for aligning the demographic composition of one group with that of another. We consider the following demographic characteristics: gender, measured by the share of women; place of residence, measured by the share of former-residents in North Hamgyong Province; subjective social class, measured by the share of respondents identifying themselves as middle or lower class; and occupation, measured by the share of respondents who have experiences of running small-scale business. Province of origin is included because the compositional difference across the two periods is fairly large. Subjective social class and occupation are included to capture potential differences in the economic status of respondents between the two periods.

First, 200 observations are drawn from each period using a resampling procedure designed to make the compositions of the selected variables as similar as possible across periods, with the initial 10% of observations selected randomly. Table 6 compares the demographic compositions before and after resampling and shows that distributional differences across all selected variables are substantially reduced.

Table 6. Summary Statistics of Selected Variables Before and After Resampling

	Before Resampling				After Resampling			
	Period	Mean	Diff.	Freq.	Period	Mean	Diff.	Freq.
Women	1	0.6038		366	1	0.6150		200
	2	0.5831	0.0207	415	2	0.6000	0.0150	200
	Total	0.5928		781	Total	0.6075		400
N. Hamgyong Prov.	1	0.4153		366	1	0.3900		200
	2	0.2530	0.1623	415	2	0.3300	0.0600	200
	Total	0.3291		781	Total	0.3600		400
Middle/Lower Social Class	1	0.7377		366	1	0.7400		200
	2	0.7398	-0.0021	415	2	0.7400	0.0000	200
	Total	0.7388		781	Total	0.7400		400
Small-scale Business	1	0.4595		346	1	0.4400		200
	2	0.3570	0.1025	395	2	0.4050	0.0350	200
	Total	0.4049		741	Total	0.4225		400

* Note: Share of middle/upper subjective social classes' variable was constructed based on the question "Which social class do you think your living standard belonged to when you were living in North Korea." A dummy variable was constructed taking value 1 if the respondent has chosen "middle class" or "lower class" and 0 if the respondent has chosen 'upper class'. 'Share of small-scale business' variable was constructed as a dummy variable equal to 1 if the respondent has chosen "retail", "individual services", "individual manufacturing", "part-time jobs" and 0 if otherwise.

Next, identical analysis was conducted as in the baseline model but only with the resampled observations. Table 7 and Figure 6 report the MRP index estimation and relative distribution analysis results, respectively. All of the estimated coefficients are positive and statistically significant in MRP index estimation as in the baseline model with marginal differences in coefficients and t-values.

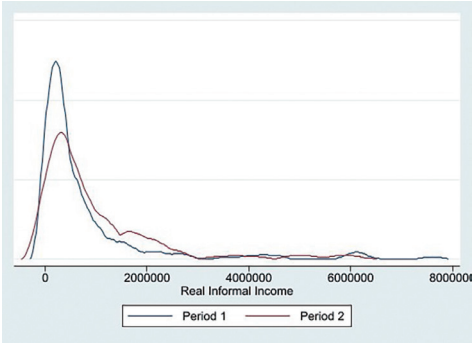
Table 7. Median Relative Polarization Index (Resampled)

Polarization Category	Coefficient.	t	P>t
MRP	0.2399**	2.28	0.023
	(0.1053)		
LRP	0.3207*	1.82	0.070
	(0.1763)		
URP	0.1591*	1.91	0.057
	(0.0835)		
Period 1 Obs.	200		
Period 2 Obs.	200		
Obs.	400		

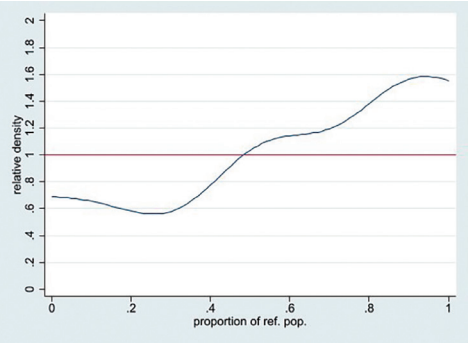
* Note: Standard errors are in parentheses. (*** p<0.01, ** p<0.05, * p<0.1)

Figure 6. Relative Distribution Analysis (Resampled)

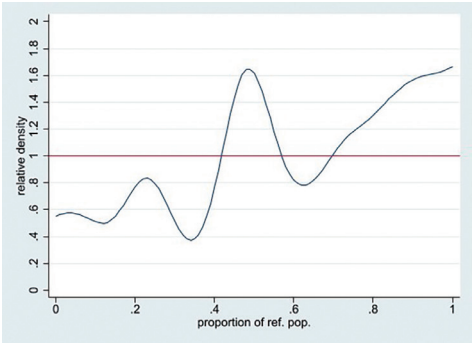
(a) Distribution



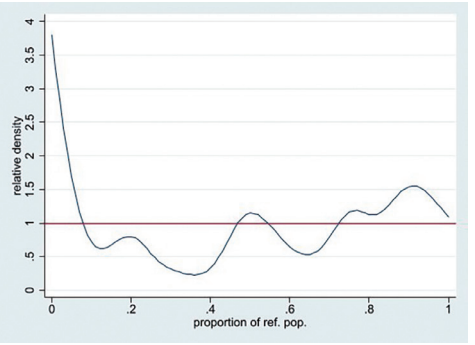
(b) Relative Distribution



(c) Location Effect



(d) Shape Effect



* Note: Informal Income is in 2015 KPW and unknown densities are estimated by kernel density estimates with adaptive bandwidth.

To further assess the robustness of the results, propensity score matching (PSM) is employed. The method is applied to adjust for differences in demographic compositions across two periods. Specifically, samples from Period 1 constitute the control group, while those from Period 2 form the treatment group.

Since the primary objective of employing PSM in this study is to harmonize the demographic compositions between the two periods, the analysis focuses on the quality of the matching and the extent of bias reduction in the selected covariates, rather than on the magnitude of the estimated treatment effect. Following the matching procedure, both the MRP index analysis and the relative distribution analysis are conducted using only the matched samples.

Although the set of demographic covariates largely overlaps with those used in the resampling approach, minor modifications are introduced. Core demographic variables—age, gender, and the share of small-scale business participants—are included in the same manner as before. In addition, educational attainment is newly incorporated using a dummy variable indicating secondary education completion. Subjective social class is also redefined as a dummy variable capturing respondents who self-identify as middle class. Furthermore, the province-of-origin variable is expanded to include residents from Ryanggang Province, in addition to those from North Hamgyong Province.

The results of the PSM estimation are reported in Table A5 and illustrated in Figure A1 in the Appendix. As shown, differences across all covariates are substantially reduced after matching, with the exception of age. In terms of percentage reduction, discrepancies in the shares of residents from Ryanggang and North Hamgyong Provinces, small-scale business participants, middle-class respondents, and secondary education graduates decrease by 98.7%, 98.5%, 94.9%, 94.2%, 62.0%, and 54.7%, respectively (refer to Table A4 for matched sample size by year).

Next, the MRP estimation and the relative distribution analysis are conducted using the matched samples. While the MRP estimation results differ slightly from the baseline findings, both the direction and statistical significance

of the main coefficients remain largely consistent, as reported in Table 8 and illustrated in Figure 7.

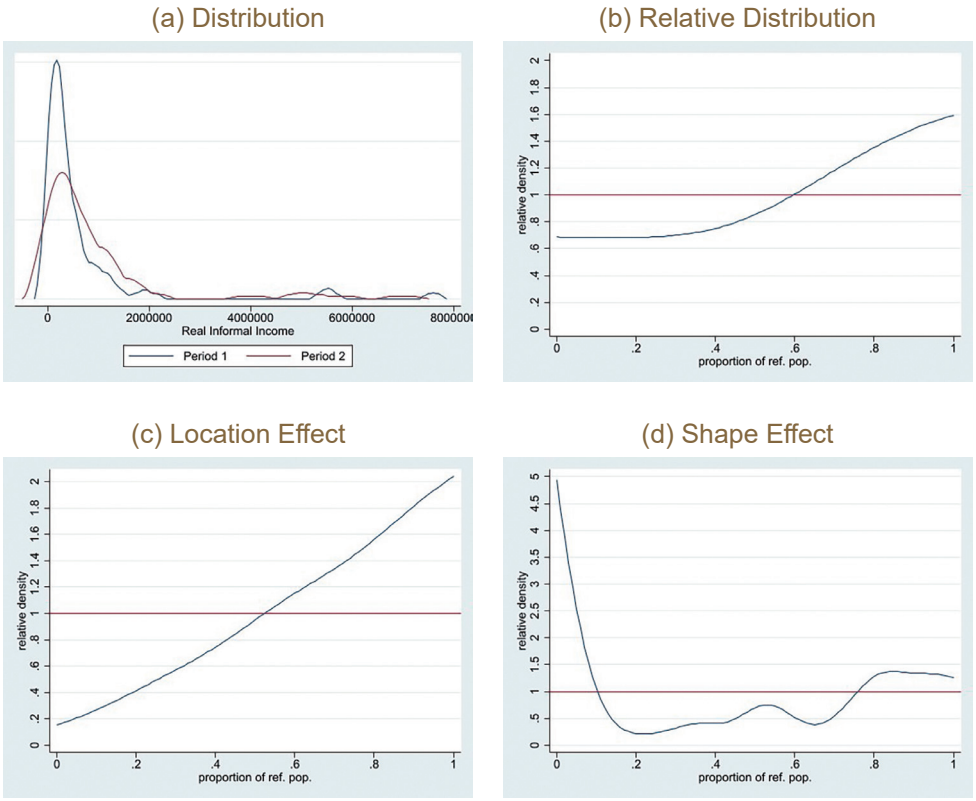
One notable difference from the baseline results is that the estimated coefficients of both MRP and LRP are larger in magnitude, whereas the coefficient of URP is no longer statistically significant. This change may partly reflect the reduced sample size following the matching procedure. This pattern may also reflect structural features of income generation in North Korea's quasi-marketized economy. Upper-tail incomes are likely to be concentrated among a relatively small group of individuals with privileged access to state connections, capital, or rent-seeking opportunities, whose economic positions are less sensitive to short-term macroeconomic shocks. As a result, changes at the upper tail may appear statistically unstable in smaller matched samples, while lower-tail dynamics—reflecting income losses among market-dependent and vulnerable households—remain robust. From this perspective, the attenuation of URP estimates in the matched sample is consistent with an asymmetric polarization process driven primarily by lower-tail expansion rather than by broad-based upper-tail gains.

Table 8. Median Relative Polarization Index (PSM Model)

Polarization Category	Coeff.	t	P>t
MRP	0.4164***	4.30	0.000
	(0.0968)		
LRP	0.7190***	5.62	0.000
	(0.1279)		
URP	0.1138	0.87	0.388
	(0.1315)		
Period 1 Obs.	77		
Period 2 Obs.	77		
Obs.	154		

* Note: Standard errors are in parentheses. (*** p<0.01, ** p<0.05, * p<0.1)

Figure 7. Relative Distribution Analysis (PSM)



* Note: Informal Income is in 2015 KPW and unknown densities are estimated by kernel density estimates with adaptive bandwidth.

2. Discussions on Sample Selection

Empirically analyzing changes in income distribution using non-randomly selected survey samples inevitably raises concerns about sample selection bias, which is extremely difficult to completely eliminate. Nevertheless, in the absence of credible data on the North Korean economy, we argue that survey-based analyses can still provide useful insights into the North Korean economy, provided that possible sample selection bias is carefully addressed. While these exercises do not eliminate all identification concerns, they help establish that the observed increase in polarization—particularly in the lower tail—is not

solely an artifact of sample composition, but reflects a consistent distributional pattern following the shock.

To investigate whether potential sample selection bias affected the results, we have considered the main demographic distortions of the defectors' survey data, namely, gender and province-of-origin and constructed subsamples for empirical analysis. First notable distortion has to do with gender disproportion where the female sample size is larger than that of the male. To address the problem, we have conducted the analyses with female and male separately. The results are largely consistent with the main findings for both subsample groups as reported in Table A6 in the Appendix.

Next, identical subgroup analysis was conducted for regional disproportions. The subgroups now are separated by border and non-border provinces. The border provinces include North Hamgyong and Ryanggang Province which constitute vast majority of the samples, whereas the non-border province subgroup includes all other province-of-origins. The results are reported in Table A7 in the Appendix showing that the results mostly support the main results except for the change in URP where the coefficient is estimated to be positive but no statistical significance was evident, likely attributable to insufficient sample size.

To further address the concern, we adopt a deliberately conservative interpretation grounded in the self-selection framework of Borjas (1987). Suppose that the 2014–2015 economic shock disproportionately increased defection among lower-income individuals, generating stronger negative selection after the shock. Under this worst-case assumption, the observed thickening of the lower tail in the defector income distribution could arise even if individual incomes within North Korea remained unchanged.

However, Borjas (1987) demonstrates that negative selection into migration is more likely when income inequality, dispersion, or downside risk in the origin economy increases. In this framework, heightened out-migration of economically vulnerable individuals is not a statistical artifact but a behavioral response to worsening distributional conditions at home.

Applied to our context[14], if the post-2014 increase in polarization were driven entirely by increased negative selection of low-income defectors, this mechanism itself would imply that income distribution within North Korea deteriorated following the economic shock. In this case, selection does not constitute an alternative explanation that undermines our findings; rather, it operates as an indirect channel through which distributional stress in the origin economy is revealed.

Given these considerations, we refrain from making strong claims about the magnitude of population-level inequality. Instead, consistent with Borjas' self-selection logic, we advance a minimal but credible qualitative conclusion: regardless of whether polarization manifests through direct income changes or through endogenous selection into defection, the post-2014 period is characterized by increased income polarization reflecting heightened economic vulnerability at the lower tail.

14) First, the Borjas (1987) framework assumes that migration decisions are at least partly responsive to expected income prospects or downside risk in the origin economy. This assumption is plausible in our context, as the 2014–2015 shock likely have caused food and energy shortages, and income instability, disproportionately affecting low-income and market-dependent households. Second, the framework assumes that changes in migrant composition are not driven by a selective reduction in migration costs for specific income groups. During the period under study, there is no evidence of institutional or policy changes that would have reduced defection costs for low-income individuals; if anything, border controls and enforcement risks remained stable or intensified. Under these conditions, an increase in negative selection following the shock can be interpreted as an endogenous response to deteriorating income distribution in the origin economy rather than as a mechanical sampling artifact.

VII. Conclusion

This paper examines how adverse economic shocks reshape the income distribution in an economy characterized by quasi-marketization, where market activities expand in the absence of fully institutionalized market-supporting institutions. Using micro-level survey data from North Korean defectors and focusing on distributional shape rather than average inequality, the analysis documents a significant increase in informal income polarization in North Korea following the 2014–2015 economic shock. Crucially, this rise in polarization is driven primarily by an expansion of the lower tail of the income distribution, rather than by disproportionate gains at the top.

These findings highlight an important distributional mechanism operating under weak institutional environments, consistent with the emphasis on distributional shape rather than average inequality outlined in the introduction. In the absence of formal labor markets, social safety nets, fair competition and effective redistribution policies, adverse shocks are less likely to be absorbed evenly across households and more likely to translate into asymmetric income losses concentrated among economically vulnerable groups. In North Korea's quasi-marketized setting, rising food prices, energy shortages, and constrained income-generating opportunities appear to have disproportionately affected low-income and market-dependent households, while those with access to capital, connections, or rent-seeking opportunities may have been in a better position to shield themselves from the shock. As a result, the shock manifested not merely as increased dispersion, but as a structural thickening of the lower tail of the income distribution.

Finally, the fact that polarization does not significantly reverse after 2016 is consistent with a hysteresis interpretation. In a quasi-marketized setting without market-supporting institutions, households pushed into the lower tail by a large negative shock may face persistent barriers to re-entering the middle. In asset-based poverty-trap terms, drought-related income losses and price pressures can move households below critical asset or liquidity thresholds, slowing recovery even when aggregate conditions stabilize (Carter and Barrett, 2006).

This study also addresses concerns related to sample selection inherent in defector-based survey data. While selection effects cannot be fully ruled out, a series of robustness checks—including resampling, propensity score matching, and subgroup analyses—suggest that the main results are not solely driven by compositional differences across periods. Moreover, drawing on the theoretical insight of Borjas (1987), the observed increase in lower-tail concentration is itself consistent with rising population-level inequality in the sending economy, even if negative selection is present. From this perspective, the findings provide indirect but theoretically grounded evidence that income inequality in North Korea deteriorated following the adverse economic shock.

Beyond the North Korean case, this paper can contribute to the broader literature on inequality and economic shocks by emphasizing the importance of distributional shape in environments with incomplete institutions. The results suggest that in quasi-marketized or weak-institutional settings, adverse shocks may intensify income polarization.

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Appendix Tables

Table A1. Comparison of Demographics between North Korean Defector Population and North Korean Defectors' Survey Samples

Category	Variable	North Korean Defector Population	North Korean Defectors' Survey
Gender	Share of women	72.09	60.03
Level of Education	Share of secondary education graduates	69.24	68.09
Official Occupation	Worker	39.69	30.7
Region	Share of former residents of near-border provinces (Hamgyongbuk-do and Ryanggang-do)	76.30	85.88
Age Distribution	0~19	14.95	-
	20s	28.26	33.36
	30s	28.79	23.21
	40s	17.86	22.08
	50s	6.14	15.02
	60+	3.99	5.44

* Note: The survey only recruits defectors who are 20 years of age or older, whereas the population data includes those who are under 19.

Table A2. Consumer Price Index and Summary Statistics of Real Informal Income

Unit: 2015 KPW

Year of Defection	CPI	Mean	St. Dev.	Observations
2011	48.9	535,309	930,987	84
2012	92.1	631,415	1,087,172	82
2013	116.0	587,936	1,091,294	88
2014	111.3	843,359	1,072,729	112
2015	100.0	960,417	1,285,225	96
2016	99.5	1,060,255	1,291,827	109
2017	102.7	623,020	849,595	63
2018	112.3	863,286	1,062,598	85
2019	101.7	954,816	1,127,893	62

* Note: CPI estimates stated in the table are recalculated using the estimates of Kim and Kim (2016) for 2011 and 2012, and Choi (2021) for 2013 to 2019.

Table A3. Informal Income Quantiles by Year of Defection

Year of Defection	p10	p25	p50	p75	p90
2011	51,131	153,394	204,525	511,314	1,022,627
2012	76,017	108,595	325,786	760,166	1,085,952
2013	86,216	86,216	258,649	517,298	1,034,596
2014	134,713	269,426	538,852	898,086	1,796,172
2015	130,000	300,000	550,000	1,000,000	2,000,000
2016	100,503	251,256	502,513	1,306,533	2,512,563
2017	48,686	116,845	389,484	973,710	1,460,565
2018	178,094	267,142	445,236	1,157,614	1,780,944
2019	98,328	294,985	491,642	983,284	2,949,852

* Source: Institute for Peace and Unification Studies, Seoul National University, 2022. North Korean Refugee Survey 2022.

* Note: All informal income amounts are converted into 2015 KPW using available CPI data. For details, refer to Table A2.

Table A4. Number of Samples by Year after Matching

Year of Defection	Observations
2011	17
2012	17
2013	16
2014	27
2015	22
2016	21
2017	16
2018	7
2019	11
Total	154

Table A5. Propensity Score Matching Results

Variable	Unmatched / Matched	Mean Treated	Mean Control	% bias	% reduced bias	t-test t	t-test p>t
Age	U	37.941	38.201	-2.30	-74.1	-0.31	0.760
	M	37.92	37.468	3.90		0.55	0.581
Gender	U	.57653	.62099	-9.10	94.2	-1.23	0.221
	M	.57584	.57841	-0.50		-0.07	0.942
Education (Secondary=1)	U	.72194	.68222	8.70	54.7	1.18	0.240
	M	.72494	.74293	-3.90		-0.57	0.571
Middle Social Class (Subjective)	U	.63776	.68513	-10.00	62	-1.35	0.177
	M	.63753	.65553	-3.80		-0.52	0.600
Small-business Experiences	U	.35459	.45481	-20.5	94.9	-2.78	0.006
	M	.35219	.35733	-1.1		-0.15	0.881
Former residents of N.Hamgyong Province	U	.25255	.42566	-37.1	98.5	-5.05	0.000
	M	.24936	.25193	-0.6		-0.08	0.934
Former residents of Ryanggang Province	U	.625	.41983	41.9	98.7	5.67	0.000
	M	.62725	.62468	0.5		0.07	0.941

Table A6. Median Relative Polarization Index (Gender Subgroups)

	Female Subgroup			Male Subgroup		
Polarization Category	Coeff.	t	P>t	Coeff.	t	P>t
MRP	0.2299*** (0.0864)	2.66	0.008	0.2721* (0.1164)	2.34	0.020
LRP	0.3308** (0.1478)	2.24	0.026	0.3316* (0.1749)	1.90	0.059
URP	0.1291* (0.0740)	1.75	0.082	0.2126** (0.1007)	2.11	0.036
Period 1 Obs.	242			173		
Period 2 Obs.	221			145		
Total Obs.	463			318		

* Note: Standard errors are in parentheses. (*** p<0.01, ** p<0.05, * p<0.1)

Table A7. Median Relative Polarization Index (Region Subgroups)

	Border Province Subgroup			Non-border Province Subgroup		
Polarization Category	Coeff.	t	P>t	Coeff.	t	P>t
MRP	0.2268*** (0.0696)	3.26	0.000	0.5003*** (0.2258)	3.85	0.000
LRP	0.3573*** (0.1073)	3.33	0.000	0.5573*** (0.3973)	4.61	0.000
URP	0.0964** (0.0659)	1.46	0.012	0.4434 (0.1359)	1.28	0.205
Period 1 Obs.	365			50		
Period 2 Obs.	307			59		
Total Obs.	672			109		

* Note: Standard errors are in parentheses. (*** $p<0.01$, ** $p<0.05$, * $p<0.1$)

Table A8. OLS Regression Results: Threshold Year Model (Including All Outliers)

Dependent Variable: Absolute Deviation from Median	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015	(6) 2016	(7) 2017	(8) 2018
Age	8,609**	8,519**	8,504**	8,411**	8,398**	8,556**	8,378**	8,327**
	(4,080)	(4,062)	(4,033)	(4,059)	(4,096)	(4,115)	(4,128)	(4,104)
Gender	-178,032*	-186,026*	-176,579*	-173,268*	-172,641*	-169,672*	-173,404*	-175,490*
	(98,659)	(98,299)	(99,101)	(98,384)	(98,532)	(98,334)	(98,453)	(98,785)
Education (Tertiary=1)	-124,649	-106,949	-119,531	-121,080	-123,196	-130,529	-123,760	-124,855
	(197,961)	(198,339)	(198,426)	(202,722)	(201,712)	(201,410)	(199,801)	(198,517)
Education (Secondary=1)	-36,963	-29,033	-33,510	-31,637	-30,086	-28,679	-30,067	-30,295
	(113,269)	(112,598)	(113,818)	(112,739)	(113,126)	(112,693)	(113,170)	(113,186)
Party Membership (Member=1)	-113,626	-117,129	-110,042	-106,500	-106,017	-113,845	-105,685	-105,173
	(121,273)	(121,035)	(119,843)	(120,294)	(121,388)	(121,971)	(121,409)	(120,412)
yref11	214,505**							
	(108,299)							
yref12		183,592**						
		(88,673)						
yref13			84,606					
			(94,652)					
yref14				27,786				
				(99,143)				
yref15					8,565			
					(94,314)			
yref16						-85,042		
						(92,222)		
yref17							14,978	
							(102,538)	
yref18								61,108
								(142,089)
Constant	1.673e+06	1.693e+06	1.803e+06*	1.869e+06*	1.892e+06*	1.920e+06*	1.895e+06*	1.891e+06*
	(1.050e+06)	(1.052e+06)	(1.046e+06)	(1.079e+06)	(1.054e+06)	(1.042e+06)	(1.044e+06)	(1.046e+06)
Observations	791	791	791	791	791	791	791	791
R-squared	0.082	0.083	0.080	0.079	0.079	0.080	0.079	0.079
Region FE	YES	YES	YES	YES	YES	YES	YES	YES
Job FE	YES	YES	YES	YES	YES	YES	YES	YES

* Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

Table A9. OLS Regression Results: Threshold Year Model (Excluding Upper Outliers)

Dependent Variable: Absolute Deviation from Median	(1) 2011	(2) 2012	(3) 2013	(4) 2014	(5) 2015	(6) 2016	(7) 2017	(8) 2018
Age	4,441	4,355	4,383	4,199	4,105	4,248	4,078	4,061
	(3,359)	(3,338)	(3,328)	(3,348)	(3,360)	(3,385)	(3,395)	(3,361)
Gender	-145,609*	-152,579*	-148,164*	-143,111*	-139,478*	-140,729*	-144,675*	-146,885*
	(84,386)	(83,979)	(83,910)	(84,026)	(84,165)	(84,269)	(84,167)	(84,496)
Education (Tertiary=1)	26,274	42,304	34,804	48,354	42,908	26,891	30,273	25,931
	(170,474)	(170,833)	(170,730)	(171,970)	(171,475)	(173,146)	(171,626)	(170,986)
Education (Secondary=1)	17,808	25,145	17,247	16,235	24,041	24,239	24,135	23,777
	(88,908)	(88,168)	(88,405)	(88,560)	(88,361)	(88,692)	(88,892)	(88,754)
Party Membership (Member=1)	-18,815	-21,800	-18,040	-10,309	-4,524	-12,030	-7,023	-8,875
	(111,646)	(111,304)	(110,517)	(110,629)	(110,603)	(111,320)	(111,200)	(110,467)
yref11	196,982*							
	(106,952)							
yref12		164,549*						
		(86,932)						
yref13			148,304*					
			(77,973)					
yref14				158,786**				
				(79,574)				
yref15					113,563			
					(80,278)			
yref16						1,778		
						(81,878)		
yref17							86,942	
							(94,661)	
yref18								138,007
								(134,439)
Constant	572,776	593,403*	614,988*	594,917*	706,060**	776,495**	767,890**	761,285**
	(364,446)	(351,849)	(351,532)	(354,042)	(335,005)	(343,074)	(347,139)	(350,987)
Observations	787	787	787	787	787	787	787	787
R-squared	0.078	0.079	0.079	0.080	0.077	0.075	0.076	0.076
Region FE	YES	YES	YES	YES	YES	YES	YES	YES
Job FE	YES	YES	YES	YES	YES	YES	YES	YES

* Robust standard errors in parentheses (*** p<0.01, ** p<0.05, * p<0.1).

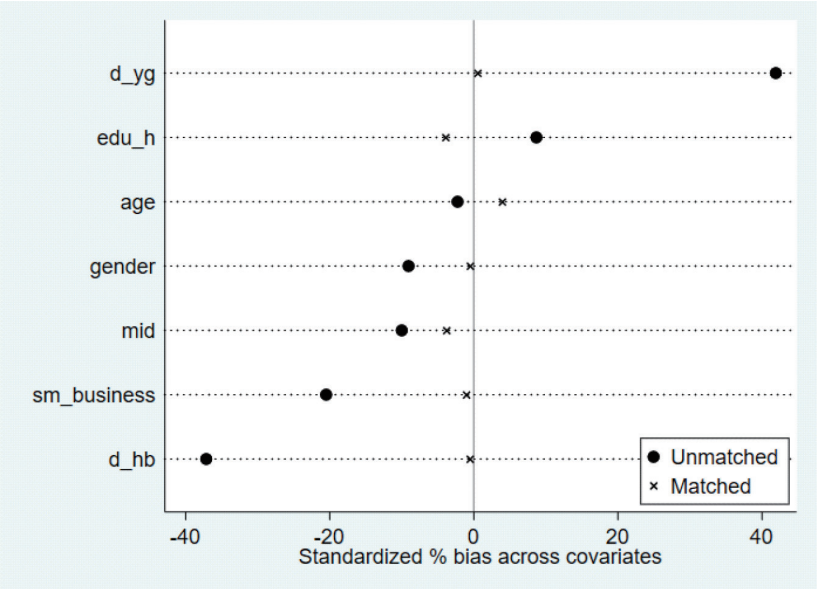
Table A10. Median Relative Polarization Index (Including All Outliers)

Polarization Category	Coefficient.	t	P>t
MRP	0.2322****	3.59	0.000
	(0.0647)		
LRP	0.3321***	3.24	0.001
	(0.1025)		
URP	0.1324*	2.16	0.031
	(0.0612)		
Period 1 Obs.	376		
Period 2 Obs.	415		
Obs.	791		

* Note: Standard errors are in parentheses. (*** p<0.01, ** p<0.05, * p<0.1)

Appendix Figure

Figure A1. Propensity Score Matching Result



* Note: 'edu_h' is a dummy variable taking value 1 if the respondent has graduated secondary education, and 0 otherwise. 'mid' is a dummy variable equal to 1 if the respondent considers him/herself belonging to 'middle' social class and 0 if otherwise. 'sm_business' equals to 1 if the respondent is a participant of a small-scale business and 0 otherwise. 'd_hb' and 'd_yg' both equal to 1 if the respondent has lived in North Hamgyong and Ryanggang province respectively, and 0 if lived in other regions.

BOK 경제연구 발간목록

한국은행 경제연구원에서는 Working Paper인 『BOK 경제연구』를 수시로 발간하고 있습니다. 『BOK 경제연구』는 주요 경제 현상 및 정책 효과에 대한 직관적 설명 뿐 아니라 깊이 있는 이론 또는 실증 분석을 제공함으로써 엄밀한 논증에 초점을 두는 학술논문 형태의 연구이며 한국은행 직원 및 한국은행 연구용역사업의 연구 결과물이 수록되고 있습니다.
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